Appendix B: Supplementary Reports

Extended Phase 1 Habitat Survey	(Echoes Ecology 2016)
Mammal Survey	(Echoes Ecology 2016)
Ornithology Survey Report	(MacArthur Green 2015-2017)

ECHOES Ecology Ltd
www.echoesecology.co.uk

EXTENDED PHASE 1 HABITAT SURVEY

GRANGEMOUTH FLOOD PROTECTION SCHEME

DATE: 28 JUNE 2016

CONTRACT REF: HAL02.16.1282

SITE LOCATION: GRANGEMOUTH

OS GRID REF: NS 925 825

CLIENT: CH2M

ECHOES ECOLOGY LTD

UNIT 39 HAYPARK BUSINESS CENTRE

MARCHMONT AVENUE

POLMONT

FK2 0NZ

[This page is intentionally left blank]

Contact Details

All correspondence relating to this report should in the first instance be addressed to:

Heather Simpson ACIEEM
Echoes Ecology Ltd

Unit 39, Haypark Business Centre
Marchmont Avenue
Polmont
Falkirk
FK2 0NZ

Tel: 0870 234 0002

Email: heather.simpson@echoesecology.co.uk

Website: www.echoesecology.co.uk

Confidentiality Statement / Copyright

The details contained within this report are confidential and intended purely for the use of CH2M and Falkirk Council. As such, no reproduction, copying or transferring of this report or the data and methods used in this report, other than for the purposes for which it was originally intended, is permitted without the prior written consent of Echoes Ecology Ltd.

Document Control

Version	Date	Prepared By	Approved By
1	28 June 2016	[Redacted] Heather Simpson ACIEEM Senior Ecologist	Neil Middleton ACIEEM Director

Contents of Report

Executive Summary

The proposed Grangemouth Flood Protection Scheme (FPS) aims to reduce flood risk in the Grangemouth area. It will include the River Carron, Grange Burn, River Avon and the River Forth Estuary shoreline. The works will include a combination of new and enhanced defences in the form of flood walls and defences, and possible upstream measures to attenuate flow. For a plan of the site as it currently exists please refer to Appendix I.

Echoes Ecology Ltd were appointed by CH2M, on behalf of Falkirk Council, to carry out an extended Phase 1 habitat survey of the land covered by the proposed Grangemouth FPS. Habitats within the site, and where possible up to 100 metres (m) outwith the boundary, were surveyed. A Habitat Suitability Index assessment for great crested newt (*Triturus cristatus*) was also completed on all suitable water bodies within the site, and where possible up to 500m outwith the boundary. An assessment of the survey area was completed during the period 18.02.16 to 20.05.16.

The Firth of Forth Special Protection Area (SPA) / Site of Special Scientific Interest (SSSI) / RAMSAR lies directly adjacent to and in some places within the site boundary. The Avon Gorge SSSI also lies adjacent to the south-east corner of the site. Further assessment will be required on the potential impacts upon the Firth of Forth SPA/SSSI/RAMSAR and the Avon Gorse SSSI as a result of the works.

The site contains the following Falkirk Local Biodiversity Action Plan (LBAP) priority habitats: intertidal mudflats, saltmarsh, broadleaved and mixed woodland, swamp, rivers and streams, and standing open water. These habitats should be retained and protected where possible, as the habitats on site form an important wildlife corridor through the built-up environment of Grangemouth. Emphasis should be made to protect the saltmarsh and mudflats around the Firth of Forth, as these are notified features of the SSSI, and to protect the semi-natural broad-leaved woodland along the River Avon, as it links up to the Avon Gorge SSSI. A Habitat Management Plan is recommended to be produced in order to detail how the habitats on site will be protected and monitored during and after the works.

Non-native species including Japanese knotweed (*Fallopia japonica*) and Himalayan balsam (*Impatiens glandulifera*) were recorded on site. The Code of Practice on Non-Native Species (Scottish Government, 2012) should be adhered to and any soil that may contain non-native plant material should be moved in line with good practice guidance. In order to prevent the spread of these invasive species a 7m exclusion zone for Japanese knotweed and 1m exclusion zone for Himalayan balsam should be adhered to.

The marshy grassland and swamp within the site are potentially Ground Water Dependent Terrestrial Ecosystems (GWDTEs). Therefore, further botanical surveys (NVC survey) or hydrogeological screening may be required to confirm the presence and location of GWDTEs within the site.

There is habitat within the site and its surroundings that is suitable for over-wintering birds, breeding birds, bats, great crested newt (*Triturus cristatus*), reptiles, badger (*Meles meles*), otter (*Lutra lutra*) and water vole (*Arvicola amphibius*). Ornithological surveys, as well as badger, water vole and otter surveys, have been conducted on site and will be reported on separately.

As there are structures and mature trees on site that may hold potential for roosting bats, further bats surveys are recommended. Further presence/absence surveys for great crested newts is recommended on 14 of the ponds. Although the site has a low potential for reptiles, any vegetation or potential hibernacula (e.g. rubble mounds) should still be removed in a reptile sensitive manner as a precautionary measure.

Section 1 - Introduction

1.1 Contract Overview

1.1.1 Echoes Ecology Ltd were appointed by CH2M on behalf of Falkirk Council to carry out an extended Phase 1 habitat survey of the land covered by the proposed Grangemouth Flood Protection Scheme (FPS) and to complete a Habitat Suitability Index (HSI) assessment for great crested newt (*Triturus cristatus*) on all suitable water bodies. The aims of the survey were:

- To record the broad habitat types across the site
- To determine the potential for protected species at the site
- To carry out an initial assessment (Habitat Suitability Index) of water bodies within the site and a buffer of 500m around the site to determine the potential for use by great crested newt
- To assess the likely impacts of development on the ecology of the site
- To recommend any further surveys which may be required at the site.

1.1.2 The proposed Grangemouth FPS aims to reduce flood risk in the Grangemouth area. It will include the River Carron, Grange Burn, River Avon and the River Forth Estuary shoreline. The works will include a combination of new and enhanced defences in the form of flood walls and defences, and possible upstream measures to attenuate flow. The Grangemouth FPS was identified in the Scottish Environment Protection Agency's (SEPA) Flood Risk Management Strategy as being the number one ranked scheme (out of 41) for prioritisation. For a plan of the site as it currently exists refer to Appendix I, Figure I.1

1.1.3 The following documents have been provided to Echoes Ecology Ltd in order to assist in carrying out this contract:

- Site plan

1.1.4 The survey work reported upon within this document was carried out during the period 18.02.16 to 20.05.16. If works at the site do not commence prior to 01.05.18, then further surveys should be commissioned in order to ascertain that the situation at the site has not changed and thus the conclusions of this report are still valid.

Section 2 - Relevant Legislation and Biodiversity

2.1 Wild Plants

2.1.1 Wild plants are protected under the following UK Legislation:

- The Conservation (Natural Habitat. &c.) Regulations 1994, as amended
- The Wildlife and Countryside Act 1981, as amended

2.1.2 A small number of wild plants occurring within the UK are regarded as European Protected Species (EPS), under The Conservation (Natural Habitats, &c.) Regulations 1994 as amended. Under these regulations, it is an offence to:

- Intentionally or recklessly pick, collect, cut, uproot or destroy such a plant or anything derived from it. This applies to all stages of the biological cycle.
- Possess specimens of these plants or derivatives of them.

2.1.3 Under Schedule 8 of the Wildlife and Countryside Act 1981 as amended, it is an offence for:

- Any person to intentionally or recklessly pick, uproot or destroy any wild plant included in Schedule 8
- An unauthorised person to intentionally or recklessly uproot any wild plant not included in Schedule 8.

2.1.4 With regards to invasive species, the Wildlife and Natural Environment (Scotland) Act 2011 makes it an offence to cause any non-native plant species to grow in the wild.

2.2 Ground Water Dependent Terrestrial Ecosystems (GWDTEs)

2.2.1 There is growing national and international recognition of the potential for developments to impact upon the ecological integrity of hydrogeological systems.

2.2.2 At an international level, river habitats and species are protected in the Natura 2000 Network under the Council Directive 92/43/EEC on the 'Conservation of natural habitats and of wild fauna and flora', commonly known as the 'Habitats Directive 1992', and the 'Council Directive 2000/60/EC establishing a framework for community action in the field of water policy', otherwise known as the 'Water Framework Directive', which regulates the protection of all water bodies. In Scotland, 'Water Environment and Water Services (Scotland) Act 2003' (WEWS) regulates developments in accordance with the Water Framework Directive (WFD).

2.2.3 Groundwater dependent terrestrial ecosystems (GWDTEs), protected under WEWS, are types of wetland that are critically dependant on groundwater and/or groundwater chemistry. GWDTEs in the UK include specific communities of mires, swamps, wet grassland, heathland, woodland, dune slacks and machair (TAG, 2005). Their value does not relate to their intrinsic value to nature conservation *per se*, but to a wider concept of ecosystem function (e.g. water purification, flood management etc.). Their vulnerability to hydrological change, which includes anthropogenic factors such as drainage, water abstraction and changes to local hydrology, is also taken into account.

2.2.4 The Scottish Environment Protection Agency (SEPA) advises developers to consider the impacts upon GWDTEs as part of the planning process. If wetlands have been identified within the zone of influence of a proposed development then National Vegetation Classification (NVC) surveys may be required to identify potential GWDTEs. The results of NVC surveys are used in conjunction with SEPA's planning guidance (SEPA, 2014) to identify GWDTEs and provide an indication whether a community is 'highly groundwater dependant' or 'moderately groundwater dependant'. Those recognised as being moderately dependent on ground water have a limited dependency in certain hydrogeological settings. Those recognised as being highly dependent on ground water are considered sensitive to changes in ground water flows. Impacts upon GWDTEs should be minimised through avoidance and, if this is not possible then further assessment may be required to determine potential impacts and/or if mitigation is required.

2.3 European Protected Species

2.3.1 European Protected Species (such as bats and great crested newt) and their places of rest/shelter are protected under UK and European Legislation. In Scotland, this is mainly provided by the Conservation (Natural Habitats, &c.) Regulations 1994, as amended.

2.3.2 It is an offence to deliberately or recklessly disturb an EPS (including injuring, capturing and/or killing), or damage, obstruct, alter or destroy an EPS shelter/resting place. An EPS shelter/resting place is protected at all times irrespective as to whether any EPS are using the shelter/resting place at a given time.

2.3.3 If the work proposed affects an EPS or their resting place/shelter, a Habitats Regulations licence, issued by the licensing authority Scottish Natural Heritage under Regulation 44 will be required so as to permit an otherwise illegal activity. There are three tests that must be satisfied before a licence will be granted, in addition to which mitigation and/or compensation will almost certainly be required. The three tests are:

- The activity must fall within one of the licensable purposes listed in Regulation 44 (including preserving public health or public safety or other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment, and preventing serious damage to livestock, foodstuffs for livestock, crops, vegetables, fruit, growing timber, property or fisheries)
- There must be no satisfactory alternative
- The action authorised will not be detrimental to the maintenance of the population of the species at a favourable conservation status in their natural range.

2.4 Reptiles

2.4.1 In Scotland, reptiles are protected under the Wildlife and Countryside Act 1981 as amended.

2.4.2 For common reptiles (slow worm *Anguis fragilis*, common lizard *Zootoca vivipara* and adder *Vipera berus*) it is an offence to:

- Intentionally or recklessly kill or injure
- Sell, transport for sale or advertise for sale.

2.4.3 There are no licensing procedures under UK Legislation for permitting derogation of Section 9(5) (and parts of Section 9[1]) for development purposes. However, provision is made within the WCA whereby a person shall to be guilty of an offence if it can be shown that the act was the incidental result of a lawful operations, and could not reasonable have been avoided.

2.5 Biodiversity in the UK

2.5.1 In 1992, 150 government leaders from around the world (including the UK) signed the Convention on Biological Diversity at the United Nations Conference on Environment and Development (also known as The Rio Earth Summit). By doing so, the signatory nations were committing to promoting sustainable development, and at a national level implementing plans to do so.

2.5.2 In the UK, the governmental response to the Convention on Biological Diversity was the UK Biodiversity Action Plan (UKBAP), which depicts the biological resources of the UK and the detailed plans to protect them.

2.5.3 In 2004 'Scotland's Biodiversity: It's in Your Hands - A strategy for the conservation and enhancement of biodiversity in Scotland' was published (Scottish Executive, 2004). This set out a 25-year strategy to assist government, the private and public sectors, non-governmental bodies and individual members of the public to conserve and enhance biodiversity in Scotland.

2.5.4 The Scottish Biodiversity List (SBL) was published in 2005 and last updated in 2012. It is a list of animals, plants and habitats that are considered to be of principal importance for biodiversity conservation. The list fulfils requirements under Section 2(4) of the Nature Conservation (Scotland) Act 2004 and allows public bodies to carry out their biodiversity duty.

2.5.5 In 2012, the UK Post-2010 Biodiversity Framework, produced by the Four Countries Biodiversity Group, succeeded the UK Biodiversity Action Plan (JNCC and Defra, 2012). It covers the period 2011 to 2020. The priority species and habitats listed under the UKBAP are still relevant and form much of the work carried out within the four individual countries.

2.5.6 The document '2020 Challenge for Scotland's Biodiversity' (Scottish Government, 2013) was published in 2013 which supplements the 2004 guidance and together the two documents form the Scottish Biodiversity Strategy.

Section 3 - Survey Methodology

3.1 Desk Study Methods

3.1.1 A search for nearby designated sites (and/or other protected habitats), protected species and species listed on Falkirk Council's Local Biodiversity Action Plan (LBAP) was carried out. This desk study allowed for data within a 2 kilometre (km) radius of the site to be considered and assisted in evaluating the ecological value of habitats and features present within the survey area. The following resources were consulted:

- SiteLink (Scottish Natural Heritage, 2016)
- Falkirk Local Biodiversity Action Plan (2011-2014)

3.2 Field Survey Methods

3.2.1 The survey methods employed are described below within Table 3.1.

Table 3.1 - Survey methods

Number and Type of Surveys	Extended Phase 1 habitat survey including HSI assessment (great crested newt) of suitable water bodies, conducted over 17 visits	**Surveyors**	Heather Simpson Laura Carter-Davis Elaine Anderson April Park Craig Johnson Susan McAuley Aaron Middleton Laura Spence Mingaile Zebaite
Survey Date	18.02.16, 19.02.16, 29.02.16, 04.03.16, 09.03.16, 10.03.16, 11.03.16, 15.03.16, 01.04.16, 05.04.16, 06.04.16, 10.04.16, 11.04.16, 15.04.16, 04.05.16, 19.05.16 and 20.05.16.		
Methods Used			
Extended Phase 1 Habitat Survey Methods (CIEEM, 2013; JNCC 2010): Aerial photography and OS maps were referred to with a view to aid in the assessment of boundary features and habitat boundaries. All habitats within the site were surveyed, plus a buffer of up to 100 metres (m) outwith the site boundary, where possible. Habitats were mapped and given alphanumeric classification codes. Target notes were used to identify the presence and location of features of particular interest or those too small to map. The abundance of each plant species was recorded using the DAFOR scale, as follows: (D= Dominant, A= Abundant, F= Frequent, O= Occasional, R= Rare). Signs of protected species or habitats suitable for protected species were noted. **Habitat Suitability Index (HSI) Assessment (Great Crested Newt)** A walkover of the survey area was completed in order to assess the potential for the water bodies to contain great crested newts (GCN). The most commonly adopted approach is to use the HSI as developed by Oldham *et al.* (2000). The HSI is a measure of the likelihood of GCN presence but is not a substitute for presence/absence surveys. Although a low HSI score may indicate that a water body is unlikely to contain GCNs this is not conclusive and conversely a high score does not mean that GCNs will definitely be present. For full details of the HSI method refer to Appendix VII. **Survey Equipment Used**: GPS, digital camera, dictaphone, peat probe, hand lens x10 and x20, plant ID books. **Nomenclature**: Higher plants: Stace (2010), Bryophytes: British Bryological Society (2009).		

Section 4 - Overview of Desk Study Results

4.1 Biodiversity Action Plan (BAP) Considerations

4.1.1 Falkirk Council Local Biodiversity Action Plan (LBAP) was prepared by a partnership of many organisations actively engaged in nature conservation. The LBAP, which was written for the period 2011 to 2014 but is still the most recent publication, takes an ecosystem approach, whereby ecosystem types were identified as all requiring targeted action in the short, medium and long term. The ecosystems which have relevance for the site being studied in this case are shown below:

- Urban
- Woodland
- Estuary
- Inland water and wetland
- Farmland and grassland

4.1.2 Species Action Plans on the LBAP which are relevant to the survey area include:

- Badger *(Meles meles)*
- Hedgehog *(Erinaceus europaeus)*
- Brown long-eared bat *(Plecotus auritus)*
- Soprano pipistrelle *(Pipistrellus pygmaeus)*
- European otter *(Lutra lutra)*
- Water vole *(Arvicola amphibius)*

4.1.3 A number of bird species are also listed on the LBAP, of which the following have the potential to utilise the site:

- Barn owl *(Tyto alba)*
- Black-tailed godwit *(Limosa limosa)*
- Bullfinch *(Pyrrhula pyrrhula)*
- Common tern *(Sterna hirundo)*
- Cuckoo *(Cuculus canorus)*
- Curlew *(Numenius arquata)*
- Dipper *(Cinclus cinclus)*
- Dunlin *(Calidris alpina)*
- Golden plover *(Pluvialis fulva)*
- Grasshopper warbler *(Locustella naevia)*
- Great crested grebe *(Podiceps cristatus)*
- Green woodpecker *(Picus viridis)*
- Grey partridge *(Perdix perdix)*
- Greylag goose *(Anser anser)*
- House sparrow *(Passer domesticus)*
- Kestrel *(Falco tinnunculus)*
- Kingfisher *(Alcedo atthis)*
- Knot *(Calidris canutus)*
- Lapwing *(Vanellus vanellus)*
- Lesser redpoll *(Acanthis cabaret)*
- Linnet *(Linaria cannabina)*
- Pink-footed goose *(Anser brachyrhynchus)*
- Pintail *(Anas acuta)*
- Red-breasted merganser *(Mergus serrator)*
- Redshank *(Tringa totanus)*
- Reed bunting *(Emberiza schoeniclus)*
- Sand martin *(Riparia riparia)*
- Sedge warbler *(Acrocephalus schoenobaenus)*
- Shelduck *(Tadorna tadorna)*

- Skylark *(Alauda arvensis)*
- Snipe *(Gallinago gallinago)*
- Song thrush *(Turdus philomelos)*
- Spotted flycatcher *(Muscicapa striata)*
- Starling *(Sturnus vulgaris)*
- Swallow *(Hirundo rustica)*
- Swift *(Apus apus)*
- Teal *(Anas crecca)*
- Tree pipit *(Anthus trivialis)*
- Tree sparrow *(Passer montanus)*
- Water rail *(Rallus aquaticus)*
- Wood warbler *(Phylloscopus sibilatrix)*
- Woodcock *(Scolopax rusticola)*
- Yellowhammer *(Emberiza citrinella)*

4.2 Designated Sites and Other Protected Sites

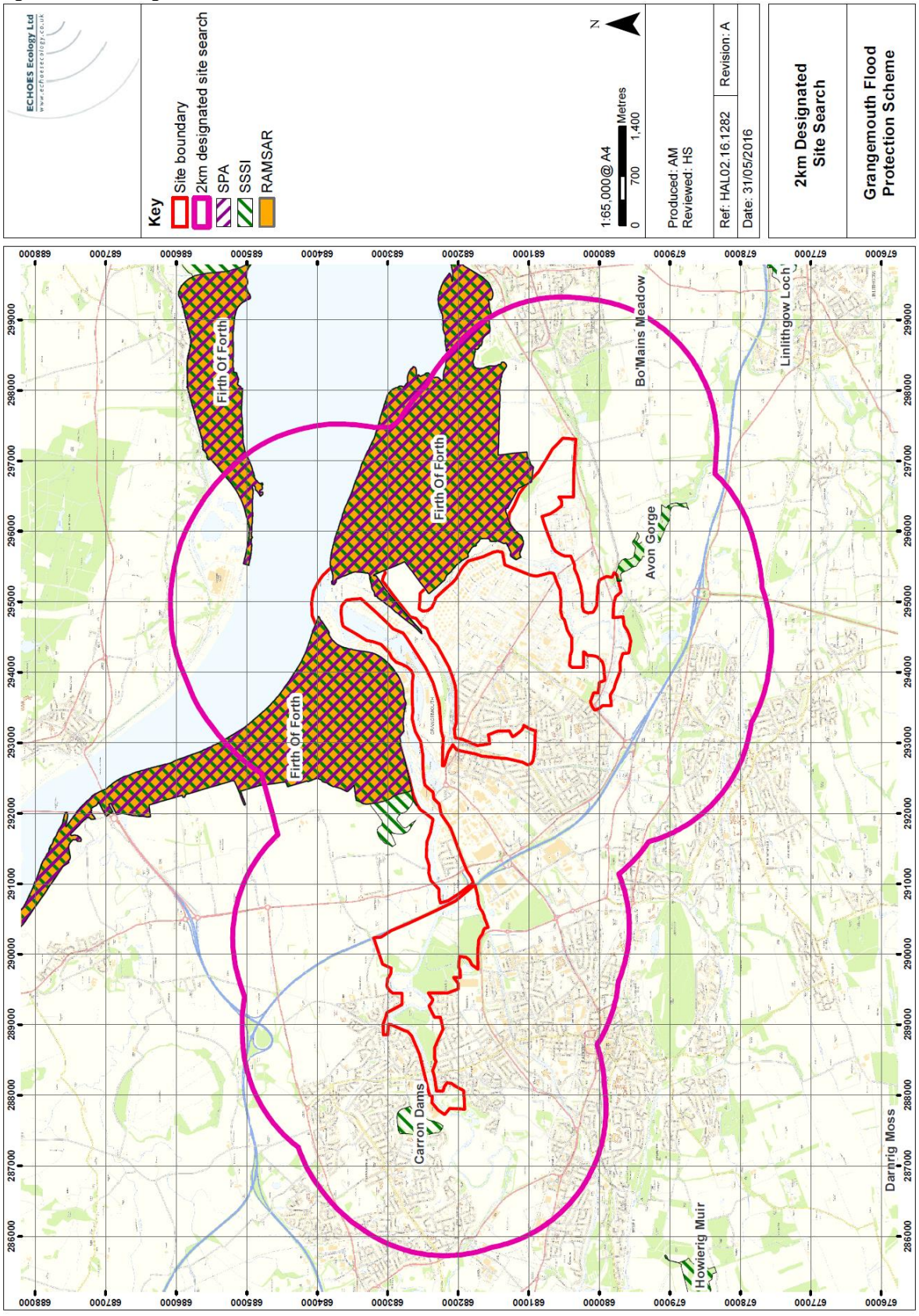
4.2.1 A search for nearby designated sites and other protected sites was carried out in March 2016. Three designated sites were identified and the results are shown in Table 4.1 and Figure 4.1 below.

Table 4.1 - Search results for nearby designated sites (Scottish Natural Heritage, 2016)

Site Name	Details
Site name: Firth of Forth **Local planning authority:** Falkirk Council are the local planning authority for the section of the Firth of Forth bordering the site	**Designation:** Special Protection Area (SPA) / Site of Special Scientific Interest (SSSI) / Ramsar **Area:** 6313.68 ha **Distance from development site:** Adjacent and in some areas within the site **Description:** The Firth of Forth is located on the east coast of central Scotland. It is a complex estuarine site, stretching for over 100 km from the River Forth at Stirling eastwards past Edinburgh and along the coasts of Fife and East Lothian to a wide estuary mouth. A wide range of coastal and intertidal habitats is found within the site. Skinflats is the named area of the Firth of Forth SPA/SSSI, which lies closest to the site. RSPB Skinflats, is a section of the upper Forth Estuary and has important numbers of passage and wintering birds. It is designated as both a Site of Special Scientific Interest and Special Protection Area on the grounds of the internationally important bird numbers, and the scarcity of salt marsh in the Forth Estuary. The reserve is home to over 100 bird species, including wintering pink-footed goose, black-tailed godwit, grey plover (*P. squatarola*) and golden plover, as well as breeding species such as skylark, tree sparrow and reed bunting. **Notified natural features:** **SPA:** The Firth is of major importance for a rich assemblage of waterbirds in the migration periods and through the winter, including divers, sea-ducks, geese, other ducks, waders and terns. Some of these species, notably the sea-ducks and divers,

Site Name	Details
	also feed, loaf and roost outside the SPA in the open waters of the estuary. **SSSI:** Recognised for its biological importance regarding waterfowl and botanically rich grasslands, which contain both nationally and locally rare plant species can be found all around the Forth. **Ramsar:** The primary reason for designation are the species/populations occurring at levels of international importance. These species include pink-footed goose, shelduck, redshank and ruddy turnstone *(Arenaria interpres interpres)*
Site name: Avon Gorge **Local planning authority:** Falkirk Council	**Designation:** SSSI **Area:** 19.34 ha **Distance from development site:** Adjacent to the site **Notified natural features:** Avon Gorge Site of Special Scientific Interest comprises the steep, wooded banks of the River Avon, approximately 2km south-east of Grangemouth. It is of biological importance and designated for its woodlands. This site is one of the few remaining ancient, semi-natural woodland sites in the Falkirk area. The wood has been relatively undisturbed and there is a good variety and age structure of native deciduous trees, including elm (*Ulmus sp.*), oak (*Quercus sp.*), alder (*Alnus glutinosa*), hazel (Corylus avellana), ash (*Fraxinus excelsior*), rowan (*Sorbus aucuparia*) and wild cherry (*Prunus avium*).
Site name: Carron Dams **Local planning authority:** Falkirk Council	**Designation:** SSSI/LNR **Area:** 16.68 ha **Distance from development site:** Approximately 150m west of the site **Description:** A biologically important wetland, rich fen and deciduous woodland. Specialised plants such as gypsywort (*Lycopus europaeus*), remote sedge (*Carex remota*) and water-plantain (*Alisma plantago-aquatica*) thrive in the wetlands, which is one of the largest in the area. Water voles and water rails may also be glimpsed along the banks.

Figure 4.1 - Designated sites within 2km



4.3 Protected Species

4.3.1 A database search for protected species and species listed on ScoMam was carried out in March 2016, the results of which are shown in Table 4.2 below. Further information relating to protected mammals can be found in the separate mammal report.

Table 4.2 - ScoMam database search results

Species	Record type	Location
Chiroptera (exact species unknown)	Roost (Building)	Three roost locations within 2km of the site (two of which are maternity roosts)
Soprano pipistrelle (*Pipistrellus pygmaeus*)	Field	Within 2km of the site
Common pipistrelle (*P. pipistrellus*)	Field	Within 2km of the site
Soprano pipistrelle (*Pipistrellus pygmaeus*)	Roost (Building)	Within 2km of the site
Pipistrelle Species *(Pipistrellus sp.)*	Roost (Building)	Within 2km of the site
Myotis Species (*Myotis sp.)*	Field	Within 2km of the site
Daubenton's bat *(M. daubentonii)*	Field	Within 2km of the site
Natterer's bat (*M. nattereri*)		Known to occur in this area
Brown long-eared bat (*Plecotus auritus*)		Known to occur in this area

Section 5 - Field Survey Results

5.1 Overview

5.1.1 The Phase 1 habitat survey maps are presented in Appendix II, Figures II.1 to II.5 and target notes are presented in Table 5.1. A list of the habitats and their coverage within the site is shown in Table 5.2 and photographs of the site are presented in Appendix III.

5.1.2 The site encompasses the habitats alongside the River Carron, Grange Burn, and River Avon. The east of the site encompasses the petrochemical works and Forth Ports, where the majority of the site is hardstanding and industrial buildings with only isolated patches of woodlands and small corridors of habitats alongside the water courses. In comparison, the west of the site is relatively undeveloped with a range of natural habitats. The site has been split into three areas associated with the three watercourses.

5.2 River Carron

5.2.1 At the western end, the site to the south of the River Carron encompasses an area of parkland with amenity grassland and small areas of mixed plantation woodland and dense/continuous scrub. The amenity grassland has a short sward and is species-poor, where perennial rye-grass (*Lolium perenne*), Yorkshire-fog (*Holcus lanatus*) and creeping buttercup (*Ranunculus repens*) are abundant, and a carpet of *Calliergonella cuspidata* and *Rhytidiadelphus squarrosus* is present in the damper depressions. The plantation woodlands contains species such as hazel (*Corylus avellana*), silver birch (*Betula pendula*), lime, (*Tilia sp.*) willow (*Salix sp.*), red oak (*Quercus rubra*) and alder (*Alnus glutinosa*).

5.2.2 At the western end of the site, the southern banks of the River Carron are covered with a mixture of dense and scattered bramble (*Rubus fruticosus*) scrub and tall ruderals including hogweed (*Heracleum sphondylium*) and rosebay willowherb (*Chamerion angustifolium*). Moving eastwards along the river, the bankside habitat develops into mixed and broad-leaved plantation woodland with scattered bramble scrub still persisting in the understorey. Additional tree and scrub species along the river include ash (*Fraxinus excelsior*) and elder (*Sambucus nigra*). To the north of the River Carron, there is an inactive area of landfill, where plants have started to colonise the disturbed ground (see target note 1 for full details). Moving eastwards from the landfill, the river corridor on the northern bank narrows to only a few metres and consists of a line of scattered broad-leaved trees as it flows alongside the settlements of Caron and Carronshore. Chapel Burn flows into the River Carron from the north, where dense/continuous bramble scrub is present along the banks of the burn along with scattered broad-leaved trees. To the north of the river, between the meander and the settlement of Carronshore, there is the Riverside Stables, which consists of improved fields with scattered hawthorn (*Crataegus monogyna*) scrub.

5.2.3 To the east of Carron Road (B902) a large area of broad-leaved plantation woodland extends along the southern banks of the River Carron. The plantation woodland extends eastwards up until the Dalderse Waste Water Treatment Works (WWTW) and Abbots Road, with a small gap where the settlement of Bainsford encroaches on the river corridor. The plantation woodland is species-poor as it is separated into compartments of single species, which include, silver birch, hazel, oak and alder. The woodland has a sparse understorey and some of the plantation compartments are lined with a species-poor hawthorn hedge. Areas of swamp and semi-improved neutral grassland are present along the banks of the River Carron and within the plantation woodland (target note 5). A wet ditch runs through the plantation woodland to the west of Riverside Stables, which was flooded during the survey visits in February 2016. To the south of the plantation woodland there is a large area of amenity grassland with a similar species composition to the parkland at the western end of the site.

5.2.4 A small ditch with a 5m wide section of swamp, which was dominated by common reed (*Phragmites australis*), runs behind the houses on Lomond Drive and flows into the River Carron. A corridor of semi-improved neutral grassland also runs through the plantation woodland under the powerline and alongside Abbots Road, where there is abundant tufted hair-grass

(*Deschampsia cespitosa*), thistle species (*Cirsium sp.*), creeping buttercup and cock's-foot (*Dactylis glomerata*) and the occasional selfheal (*Prunella vulgaris*).

5.2.5 North of the River Carron and to the east of Carronshore, there is an agricultural matrix of arable and improved fields. Two of the field boundaries are lined with wet ditches and there is a species-poor intact hedge along another. There is also an area of swamp in the centre of the agricultural matrix with marshy grassland adjacent. Around Carron House there is an area of semi-improved neutral grassland with a large number of scattered mature broad-leaved trees. In this area of the site, marginal habitat in the form of common reed is present along the northern banks of the River Carron and there is a large area of swamp along the southern banks of the river. This large area of swamp is dominated by reed canary grass (*Phalaris arundinacea*) with an area of semi-improved neutral grassland in the centre and a line of broad-leaved trees around the perimeter (see target note 6 for more detail).

5.2.6 At the eastern extent of the broad-leaved plantation woodland, the Bainsford Burn runs through the woodland (see target note 8 for more details) and there is a large area of swamp (see target note 9 for more details). At the northern extent of the swamp, where it adjoins the confluence of the Bainsford Burn with the River Carron, there is a large area of open water (see target note 10 for more details). East of Dalderse WWTW runs the Ladysmill Burn (see target note 11 for more detail), which runs alongside the WWTW and an arable field. Between the Ladysmill Burn and the Forth and Clyde Canal lies areas of semi-improved neutral grassland, dominated by tufted hair-grass and with abundant crested dog's-tail (*Cynosurus cristatus*), marshy grassland with abundant soft-rush (*Juncus effusus*) and areas of swamp dominated by common reed. East of the Forth and Clyde Canal lies the built-up environment associated with the Kelpies.

5.2.7 To the east of the M9 the site narrows to a corridor along the River Carron roughly 300m in width. Initially there is a strip of semi-improved neutral grassland and amenity grassland along the southern banks of the river until the end of the canal. Further downstream, the industrial developments of the Forth Ports and petrochemical works soon encroach on the southern banks, where the habitat south of the river consists of hardstanding and industrial buildings with areas of standing water in the form of the docks. At this point, there is a strip of intertidal mudflats and saltmarsh habitat present along both banks of the River Carron below the high-water mark (see target note 12 for more detail) and at the confluence with the Firth of Forth there is a substantial area of intertidal mudflats (target note 14). To the north of the River Carron, there is a strip of semi-improved neutral grassland with arable fields beyond, where areas of swamp are associated with the field ditches.

5.3 Grange Burn

5.3.1 The site also follows a corridor along the Grange Burn, which runs just to the south of the River Carron (see target note 15 for more detail). At the upstream reaches of the burn it runs through Zeatland Park which is made up of amenity grassland and scattered mature broad-leaved trees. There is also small areas of landscaped vegetation, which are mostly coniferous trees and introduced shrubs. A species-poor intact hedge also lines the east boundary of the park.

5.3.2 As the Grange Burn runs through residential areas, before it enters the petrohemical works, it is bordered by mature broad-leaved trees. The river habitat corridor for the Grange Burn is restricted for the entire length within the site, as either residential or industrial developments or amenity grassland encroaches.

5.3.3 At the confluence with the Firth of Forth there are large expanse of intertidal mud flats, areas of semi-improved neutral grassland and small isolated areas of semi-natural broad-leaved woodland. The habitat to the south of the Firth of Forth is on the whole permanently moist with abundant marsh foxtail (*Alopecurus geniculatus*), meadowsweet (*Filipendula ulmaria*) and soft-rush (*Juncus effusus*). Reed canary grass and common reed are also found in the areas that feed into the swamp habitats.

5.4 River Avon

5.4.1 The site continues along the shoreline of the Firth of Forth, where there is a thin strip of vegetation between the petrochemical works and the Firth of Forth, which consists of permanently damp semi-improved neutral grassland and swamp. A large area of intertidal mudflats still exists below the high-water mark. Around the confluence with the River Avon, the site consists of semi-improved neutral grassland with isolated patches of swamp and semi-natural broad-leaved woodland around the edge of the former Kinneil Kerse landfill site. Beyond this lies a matrix of arable fields, which are lined with wet ditches.

5.4.2 As the site follows the River Avon upstream, the river corridor is reduced due to the encroachment of the petrochemical works. However, just downstream of the A905, the standoff between the river and the petrochemical works increases and arable fields, semi-improved neutral grassland and isolated patches of swamp and semi-natural broad-leaved woodland exist. The broad-leaved woodland on the southern banks of the River Avon, adjacent to the A905, had a well-developed understorey with a similar species assemblage to target note 17, which is located further upstream.

5.4.3 Upstream of the A905, a scattering of mature broad-leaved trees, which is mostly comprised of white willow (*Salix alba*) and sycamore (*Acer pseudoplatanus*), line the banks with arable and improved fields beyond. As the river habitat corridor widens downstream, semi-natural broad-leaved woodland persists, where the wooded banks have a well-developed understorey and are relatively species-rich (see target note 17 for full details). At the most upstream extent of the site, ancient woodland indicators such as bluebell (*Hyacinthoides non-scripta*) and wild garlic (*Allium ursinum*) are present in the understorey of the woodland (see target note 18 for full details).

5.4.4 Also in this area of the site, concrete drains which are bordered by scattered scrub and broad-leaved trees run parallel to the A905 and adjoin the River Avon. To the south of the drains lies arable and improved fields and at the western end, an unmanaged field which has become semi-improved neutral grassland with marshy grassland and swamp around the edges (see target note 19 for full details). The Millhall Burn also runs to the south of the A905 and flows between private gardens before its confluence with the River Avon (see target note 20 for full details).

Table 5.1 - Target notes

Target Note	OS Grid Reference	Description
1	NS 87715 82138	Inactive part of landfill where on the slope leading down to the River Carron areas of tall ruderal and scattered bramble scrub have established along with short perennial/ephemeral plants which merge into an area of semi-improved neutral grassland at the top of the slope.
2	NS 88044 82322	Stone derelict bridge over the River Carron, which may have crevices with bat roost potential (Figure III.1, Appendix III)
3	NS 88217 82386	Active road bridge over the River Carron (Stenhouse Road) with stone walls and piers that may have bat roost potential (Figure III.2, Appendix III)
4	NS 88332 82423	Active flat deck concrete road bridge over the River Carron (B902), which may have bat roost potential in the expansion joints (Figure III.3, Appendix III).
5	NS 88909 82448	Swamp habitat in the form of a flooded area of grassland measuring roughly 40 x 20m dominated by reed canary grass and with areas of standing water. Due to the ephemeral nature and the small areas of open water, it was not deemed a suitable water body for great crested newts (Figure III.4, Appendix III).
6	NS 89572 82772	An area of swamp dominated by reed canary grass and common reed. In the centre of the swamp there was an area of semi-improved neutral grassland with abundant Yorkshire-fog and thistle species and with a carpet of mosses which was mostly comprised of *Calliergonella cuspidata* and *Rhytidiadelphus squarrosus.* As there was no open water visible within the swamp it was not deemed suitable for great crested newts (Figure III.5, Appendix III).
7	NS 89745 82945	Carron House is an old stone ruin with may have bat roost potential in crevices within the stonework (Figure III.6, Appendix III).
8	NS 89781 82352	The Bainsford Burn is a slow flowing tidal stream which at the confluence with the River Carron is 2 to 3m wide and has vegetated banks dominated with common reed and areas of exposed mud during low tide. The substrate of the streambed is mud and as the burn runs alongside Abbots Road is becomes much narrower at only 0.5m wide with short vertical muddy banks less than 1m high (Figure III.7, Appendix III).
9	NS 93271 82116	A large area of swamp located at the eastern extent of the plantation broadleaved woodland, which is dominated by common reed with occasional areas of greater reedmace (*Typha latifoli*). There are areas of standing water within the swamp and 3 active heron's nests were identified in the trees that border the swamp (Figure III.8, Appendix III).
10	NS 89940 82422	A substantial area of open water with greater reedmace and reed canary grass at the margins, which may provide suitable breeding habitat for great crested newts (Figure III.9, Appendix III also see Pond 13).
11	NS 90500 81693	The Ladysmill Burn is a slow flowing tidal stream 0.5 to 1m in width with short vertical vegetated banks less than 1m high and dominated by common reed. The substrate of the streambed is mud and during low tide the top section of the muddy banks is exposed (Figure III.10, Appendix III).

Target Note	OS Grid Reference	Description
12	NS 91189 82357	In the section of the River Carron east of the M9, leading to the confluence with the Firth of Forth, there is an area of exposed mud at low tide measuring roughly 5m in width. Above the exposed mud and below the high-water mark there is a strip of saltmarsh habitat measuring roughly 1 to 4m in width, which is then bordered by semi-improved neutral grassland and tall ruderals, which exist above the high-water mark. Common saltmarsh grass (*Puccinellia maritima*) and red fescue (*Festuca rubra*) are abundant in the saltmarsh and sea arrowgrass (*Triglochin maritima*) and common scurvygrass (*Cochlearia officinalis agg.)* are frequent (Figure III.11, Appendix III).
13	NS 92049 82493	Stone structure to the north of the River Carron, which may have crevices within the stonework that would be suitable for roosting bats (Figure III.12, Appendix III).
14	NS 93165 82865	As the River Carron flows into the Firth of Forth there is a strip of salt marsh below the high tide mark roughly 15 to 20m in width and below this a large expanse of mud (Figure III.13, Appendix III).
15	NS 89987 82113	Grange Burn is roughly 1 to 2m in width, with short vertical grassy banks less than 1m high and with a slow flow. The burn is a tidal stream with a 1 to 2m wide strip of saltmarsh below the high-water mark with a similar species assemblage to the River Carron (Figure III.14, Appendix III).
16	NS 94530 79567	Small stone bridge over a dry burn, which may have crevices within the stonework that would be suitable for roosting bats (Figure III.15, Appendix III).

<table>
<tr><th>Target Note</th><th>OS Grid Reference</th><th>Description</th></tr>
<tr><td>17</td><td>NS 94837 79724</td><td>The River Avon is a large river roughly 6m in width with shallow vegetated banks and a slow flow (Figure III.16, Appendix III). There are several vegetated small islands within the river channel just upstream from the A904. Where the river is bordered by arable fields, plants from the field margins merge into the river habitat corridor such as sweet cicely (Myrrhis odorata), common fumitory (Fumaria officinalis), groundsel (Senecio vulgaris) and crosswort (Cruciata laevipes). Downstream of the A905, mudflats and saltmarsh habitat exists below the high-water mark, where the saltmarsh had a similar species assemblage to the River Avon. Upstream of the A905, the corridor is mostly comprised of scattered broad-leaved trees with a well-developed understorey of herbs. A species list for the river habitat corridor at this point is presented below
<table>
<tr><th>English Name</th><th>Latin Name</th><th>DAFOR</th></tr>
<tr><td>Cleavers</td><td>Galium aparine</td><td>A</td></tr>
<tr><td>Common nettle</td><td>Urtica dioica</td><td>A - LD</td></tr>
<tr><td>Common comfrey</td><td>Symphytum officinale</td><td>A - LD</td></tr>
<tr><td>Butterbur</td><td>Petasites hybridus</td><td>F</td></tr>
<tr><td>White willow</td><td>Salix alba</td><td>F</td></tr>
<tr><td>Sycamore</td><td>Acer pseudoplatanus</td><td>F</td></tr>
<tr><td>Leopard's-bane</td><td>Doronicum pardalianches</td><td>F - LD</td></tr>
<tr><td>Wild garlic</td><td>Allium ursinum</td><td>F - LD</td></tr>
<tr><td>Red campion</td><td>Silene dioica</td><td>O</td></tr>
<tr><td>Hogweed</td><td>Heracleum sphondylium</td><td>O</td></tr>
<tr><td>Wood avens</td><td>Geum urbanum</td><td>O</td></tr>
<tr><td>White dead-nettle</td><td>Lamium album</td><td>O</td></tr>
<tr><td>Meadowsweet</td><td>Filipendula ulmaria</td><td>O</td></tr>
<tr><td>Raspberry</td><td>Rubus idaeus</td><td>O</td></tr>
<tr><td>Wych elm</td><td>Ulmus glabra</td><td>O</td></tr>
<tr><td>Elder</td><td>Sambucus nigra</td><td>O</td></tr>
<tr><td>Wood speedwell</td><td>Veronica montana</td><td>O</td></tr>
<tr><td>Herb-Robert</td><td>Geranium robertianum</td><td>O</td></tr>
<tr><td>Bluebell</td><td>Hyacinthoides non-scripta</td><td>R</td></tr>
<tr><td>Hybrid bluebell</td><td>Hyacinthoides x massartiana</td><td>R</td></tr>
<tr><td>Monkshood sp.</td><td>Aconitum sp.</td><td>R</td></tr>
</table></td></tr>
</table>

Target Note	OS Grid Reference	Description
18	NS 95292 79802	The broad-leaved semi-natural woodland at the upstream reaches of the River Avon contained ancient woodland indicators such as wild garlic and bluebell and connects to the woodland within the Avon Gorge SSSI (Figure III.17, Appendix III). A species list and abundance for the area within the site is listed below English Name — *Latin Name* — DAFOR Ivy — *Hedera helix* — A Wild garlic — *Allium ursinum* — A - LD Wych elm — *Ulmus glabra* — F Wood avens — *Geum urbanum* — F Ground elder — *Aegopodium podagraria* — F Cleavers — *Galium aparine* — F Beech — *Fagus sylvatica* — F Sycamore — *Acer pseudoplatanus* — F Male fern — *Dryopteris filix-mas* — O Holly — *Ilex aquifolium* — O Hawthorn — *Crataegus monogyna* — O Bluebell — *Hyacinthoides non-scripta* — O Wood millet — *Milium effusum* — O Red campion — *Silene dioica* — O Oak — *Quercus sp.* — R Hybrid bluebell — *Hyacinthoides x massartiana* — R
19	NS 93528 80004	Around the edges of the field there is an area of swamp, which lines a wet ditch and is dominated by common reed. Marshy grassland borders the swamp as it grades into semi-improved neutral grassland where soft-rush is frequent and wild angelica (*Angelica sylvestris*), meadowsweet and cuckooflower (*Cardamine pratensis*) are occasional. The grassland is dominated by tufted hair-grass (Figure III.18, Appendix III).
20	NS 94336 79653	The Millhall Burn is a small burn 1 to 2m in width with a medium flow. In places the banks are reinforced with brick walls and in other places there are steep vegetated banks. The substrate of the channel is cobbles and boulders and the river habitat corridor is reduced due to the encroachment of gardens (Figure III.19, Appendix III).

Table 5.2 - Total area of habitats present within boundary, excluding boundary features (e.g. fence lines, linear features), overlying vegetation types (e.g. tree lines) and areas too small to map

Habitat Type	Area (hectares)
Amenity grassland	46
Arable grassland	72
Bare ground	2
Broad-leaved plantation	42
Building	2
Built up area	259
Continuous scrub	1
Ephemeral / short perennial	2
Hardstanding	2

Habitat Type	Area (hectares)
Improved grassland	27
Marginal	3
Marshy grassland	3
Mixed plantation	4
Mixed scattered trees	2
Mudflats	31
No access	13
Recently felled broad-leaved plantation	3
Running water	83
Saltmarsh	2
Scattered broad-leaved trees	19
Scattered scrub	11
Semi-improved neutral grassland	59
Semi-natural broad-leaved woodland	15
Semi-natural broad-leaved woodland / scattered scrub	2
Standing water	3
Swamp	35
Tall ruderal	8
Total	**751**

5.5 Non-Native Species

5.5.1 Japanese knotweed (*Fallopia japonica*) stands are scattered alongside the River Caron and River Avon. Extensive areas of Himalayan balsam (*Impatiens glandulifera*) exist along the River Avon and the drainage ditches to the south of the A905. Figures IV.1 to IV.5 in Appendix IV present the location of the invasive species within the site. Garden escapes were also abundant in the mixed plantation woodland within the site in the parkland at the upstream extent of the River Carron.

5.6 Protected Plants Species

5.6.1 Bluebells were recorded in the woodland alongside the River Avon and are listed on Schedule 8 of the Wildlife and Countryside Act, which protects them against sale.

5.7 Bats

5.7.1 There were several structures and trees throughout the site that had potential to have bat roost features.

5.7.2 There were several stone bridges (see target notes 2 to 4) crossing the River Carron which may hold bat roost potential and a small stone bridge crossing a dry burn in the woodland to the south of the River Avon (see target note 16). Carron House (target note 7) is located adjacent to the River Carron and may also hold bat roost potential along with a stone structure to the north of the River Carron (target note 13).

5.7.3 The River Carron, River Avon and the Grange Burn were lined with mature broad-leaved trees that may have features with bat roost potential. The plantation woodland to the south of the River Carron had a few scattered mature trees that may also have features with bat roost potential and the stone walls within the site may have crevices that would be suitable for roosting bats. Figures V.1 to V.5 in Appendix V present the locations of these trees and stone walls within the survey area.

5.8 Badgers

5.8.1 Habitats such as the plantation and semi-natural woodland, areas of grassland and tall ruderal are suitable for use by badgers. A full badger survey of the site has been conducted and the results are detailed in a separate report. Therefore, badgers are not discussed further in this report.

5.9 Otters and Water Voles

5.9.1 The water courses and water bodies within and around the site provide potential for otter and water vole. A full otter and water vole survey of the site has been conducted and the results are detailed in a separate report. Therefore, otter and water vole are not discussed further in this report.

5.10 Great Crested Newts

5.10.1 A total of 28 water bodies were identified from OS maps and assessed for their suitability for great crested newts. Figures VI.1 to VI.5 in Appendix VI highlights the locations of the 28 water bodies. Ponds 1, 2, 10, 11, 20 and 21 were areas of swamp with no visible areas of open water and were therefore discounted as having any potential for great crested newts (GCNs). Although the majority of Pond 3 was also a swamp, there was a small corner with open water and so the pond was subject to further assessment. Pond 23 was a damp area of woodland with no standing water, and Ponds 22 and 24 to 26 were brackish lagoons and so unsuitable for use by GCNs. The remaining water bodies were deemed to have potential for GCN and were assessed using the Habitat Suitability Index (HSI). A total of 17 areas of standing water within the survey area were assessed using the HSI. Based on the resulting HSI scores each water body was classed as having either 'poor', 'below average', 'average', 'good' or 'excellent' potential to support GCNs (see Table 5.3 below). For full HSI survey results refer to Appendix VII, Tables VII.1 to VII.17.

Table 5.3 - Results of habitat suitability index

Water Body	HSI Score	Suitability for Great Crested Newts	Description	Further surveys recommended?
3	0.54	Below Average	A small area of standing water at the edge of a large swamp dominated by common reed	Yes
4	0.45	Poor	A large water body located within parkland with areas of plantation woodland nearby	Yes
5	0.70	Good	A medium water body located within an area of derelict land between industrial developments with a good cover of macrophytes and little in the way of shade	Yes
6	0.75	Good	A medium pond located within an area of disused land between industrial developments with a good cover of macrophytes and little in the way of shade	Yes
7	0.55	Below Average	A medium water body located within an industrial complex with limited macrophytes and a poor water quality.	Yes
8	0.68	Average	A medium water body with a good cover of macrophytes but surrounded by amenity grassland and residential developments	No
9	0.60	Average	A medium water body with a good cover of macrophytes but surrounded	No

Water Body	HSI Score	Suitability for Great Crested Newts	Description	Further surveys recommended?
			by amenity grassland and residential developments	
12	0.74	Good	A Sustainable Drainage System (SuDS) pond adjacent to an industrial complex and dominated by common reed	Yes
13	0.68	Average	An area of open water within a swamp (see target note 9)	Yes
14	0.81	Excellent	A medium sized SuDS pond dominated by rushes and greater reedmace adjacent to the Forth and Clyde Canal.	Yes
15	0.77	Good	A medium sized SuDS pond with a good cover of macrophytes and located adjacent to the Forth and Clyde Canal.	Yes
16	0.70	Good	A small SuDS pond with a limited cover of macrophytes located in proximity to the Forth and Clyde Canal and industrial developments.	Yes
17	0.49	Poor	A large water body with greater reedmace and common reed at the margins and in proximity to the Forth and Clyde Canal and industrial developments.	Yes
18	0.73	Good	A large water body located at the edge of arable fields and in proximity to woodland and swamp but with a limited cover of macrophytes.	Yes
19	0.70	Good	A small water body at the edge of arable fields and in proximity to woodland and swamp and with a good cover of macrophytes.	Yes
27	0.43	Poor	A large water body located at the edge of Kinneil Wood.	No
28	0.81	Excellent	A medium water body located within private land near Polmonthill, which from satellite imagery seems to have a good cover of macrophytes.	Yes

5.11 Reptiles

5.11.1 The woodland edges, grasslands and scrub within the site provide suitable foraging habitat. However, due to the urban environment of the site it is isolated from more extensive areas of suitable habitat and so the site only has a limited potential for reptiles.

5.12 Birds

5.12.1 The habitat within the site boundary is such that it would be expected to hold potential for bird species associated with estuaries, rivers, water bodies, young woodland, swamp, arable and scrub habitat. Ornithological surveys are being conducted on site and so the relevant reports should be referred to with regards to the utilisation of the site by birds. Birds are not discussed further in this report.

Section 6 - Discussion

6.1 Limitations to Survey Work

6.1.1 There was free access to the majority of land within the proposed site boundary. Two small areas were inaccessible within the petrochemical works as well as the areas within Dalderse and Kinneil Waste Water Treatment Works. The area immediately surrounding Carron House (target note 7) was also inaccessible as it was private land.

6.1.2 Although a comprehensive species list could not be compiled due to the time of year of the survey, the assemblage of species recorded satisfied the definition of habitats identified.

6.2 Designated Sites

6.2.1 The Firth of Forth SPA/SSSI/RAMSAR lies directly adjacent to and in some places within the site boundary. The Avon Gorge SSSI also lies adjacent to the south-east corner of the site. Both sites are hydrologically linked to the site, with the Firth of Forth SPA/SSSI/RAMSAR positioned downstream and the Avon Gorge upstream of the site. Further assessment will be required on the potential impacts upon these designated sites as a result of the works.

6.2.2 Carron Dams is a partially drained reservoir located over 100m from the site with no hydrological link to the site. Therefore, it will not be impacted upon by the works.

6.3 Habitats on Site

6.3.1 The site contains the following Falkirk LBAP priority habitats: intertidal mudflats, saltmarsh, broadleaved and mixed woodland, swamp, rivers and streams, and standing open water. These habitats should be retained and protected where possible, as these habitats on site form an important wildlife corridor through the built-up environment of Grangemouth. Emphasis should be made to protect the saltmarsh and mudflats around the Firth of Forth as these are a notified feature of the SSSI, and to protect the continuous section of semi-natural broad-leaved woodland along the River Avon as it links up to the Avon Gorge SSSI.

6.3.2 If any of the LBAP priority habitats are to be removed or impacted upon then appropriate mitigation or compensation should be designed-in to the project. A Habitat Management Plan is recommended to be produced, in order to detail how the habitats on site will be protected and monitored during and after the works.

6.3.3 In the Estuary Habitation Action Plan (HAP) implemented projects include litter clean-ups. During the surveys, substantial amounts of litter were identified within the site, especially in the area west of the M9. Therefore, further little cleans-ups are recommended.

6.3.4 In the Inland Water and Wetland HAP there is an aspirational project to carry out an assessment of the opportunities for biodiversity enhancement along the Carron River Corridor and to promote invasive species monitoring and control. The Carron River and River Avon corridor would benefit from invasive species control and further biodiversity enhancements along the River Carron could include the thinning of the broad-leaved plantation woodland along the southern banks and the planting of native scrub in order to promote a well-developed understorey. Brash, log and rock piles could also be incorporated into the understorey to further increase the biodiversity of the woodland.

6.3.5 The marshy grassland and swamp within the site are potentially Ground Water Dependent Terrestrial Ecosystems (GWDTEs). Therefore, further botanical surveys (NVC survey) or hydrogeological screening may be required to confirm the presence and location of GWDTEs within the site.

6.4 Non-Native Species

6.4.1 Non-native species including Japanese knotweed and Himalayan balsam were recorded on site. The Code of Practice on Non-Native Species (Scottish Government, 2012) should be adhered to and any soil that may contain non-native plant material should be moved in line with good practice guidance. In order to prevent the spread of these invasive species, a 7m exclusion zone for Japanese knotweed and 1m exclusion zone for Himalayan balsam should be adhered to.

6.5 Bats

6.5.1 As there are structures and mature trees on site that may hold potential for roosting bats, further surveys of these features are recommended. Any structure confirmed to have potential for roosting bats may require activity surveys during the bat active season (May to September) if works are to occur on or within 30m of the structure. Trees with potential for roosting bats will initially need either ground, or where applicable aerial, inspections on all features of bat roosting potential if works are to occur on or within 30m of the tree. If features with bat roost potential are identified on any of the trees and these features cannot be fully inspected, activity surveys will be required in order to confirm whether they are being used by roosting bats.

6.6 Great Crested Newts

6.6.1 The survey area contained potential breeding sites, which when assessed using the HSI scored a 'poor' to 'excellent' suitability score for use by GCNs. Ponds 4, 17 and 27 had a poor suitability for GCNs due to their large size and lack of suitable marginal habitat. As Pond 27 is located over 250m from the site boundary, no further surveys of the water body is recommended. However, further presence/absence surveys is recommended for Ponds 4 and 17, as they are located within 250m of the site boundary. Ponds 8 and 9 had an average suitability for GCNs but are surrounded by residential developments, which act as an effective barrier for newts between the ponds and the site. Therefore, any newts within these ponds will not be impacted upon by the development and so no further survey of these ponds is recommended. Further surveys of the remaining 12 ponds are recommended as they either had Good or Excellent suitability or were located within 250m of the site and all of which also had no obvious barriers for newts between the site and the ponds.

6.7 Reptiles

6.7.1 Although the site has a low potential for reptiles, they may still be present in the more suitable habitats on site and so mitigation is required. The strimming of vegetation or removal of low level vegetation during the reptile active season (March to October) should be carried out in phases and towards retained habitat. The initial phase should involve cutting the vegetation to a height of 150mm and then the second phase down to ground level. This method allows any reptiles present to move out of the area ahead of works.

6.7.2 The presence of any rock and rubble mounds within the site provide suitable potential for hibernacula. If works are required outside the active season, an Ecological Clerk of Works (ECoW) will identify all suitable hibernating habitats within the site and if works need to take place within these areas then they will be supervised by the ECoW. If any inactive reptile is found, the feature within which it is found must be carefully replaced and the area delineated. No works will be allowed in areas where hibernating animals are found until the reptile active season (March to October).

Section 7 - Requirements and Recommendations

7.1 Requirements and recommendations

7.1.1 The following table (Table 7.1) summarises the requirements and recommendations relating to developments and future survey work required at the site.

Table 7.1 - Requirements and recommendations

Species	Requirement / Recommendation	Ownership	Target Date
Designated Sites	Further assessment will be required on the potential impacts upon the Firth of Forth SPA/SSSI/RAMSAR and the Avon Gorge SSSI, as they are located either adjacent or within the site as well as being hydrologically linked.	CH2M Falkirk Council	Prior to works
Non-Native Species	Non-native species were identified within the site. The Code of Practice on Non-Native Species (Scottish Government, 2012) should be adhered to and any soil that may contain any non-native plant material should be moved in line with good practice guidance. In order to prevent the spread of invasive species a 7m exclusion zone for Japanese knotweed and 1m exclusion zone for Himalayan balsam should be adhered to.	CH2M Falkirk Council	During works on site
LBAP Habitats	The LBAP priority habitats should be retained and protected where possible. Emphasis should be made to protect the saltmarsh and mudflats around the Firth of Forth as these are notified features of the SSSI, and to protect the continuous section of semi-natural broad-leaved woodland along the River Avon as it links up to the Avon Gorge SSSI. If any of the LBAP priority habitats are to be removed or impacted upon then appropriate mitigation or compensation should be designed-in to the project. A Habitat Management Plan is recommended to be produced, in order to detail how the habitats on site will be protected and monitored during and after the works. Further little cleans-up are recommended. The Carron River and River Avon corridor would benefit from invasive species control and further biodiversity enhancements along the River Carron could include the thinning of the broad-leaved plantation woodland along the southern banks and the planting of native scrub in order to promote a well-developed understorey. Brash, log and rock piles could also be incorporated into the understorey to further increase the biodiversity of the woodland.	CH2M Falkirk Council	Prior to works
GWDTEs	Further botanical surveys (NVC survey) or hydrogeological screening may be required to confirm the presence and location of GWDTEs within the site.	CH2M Falkirk Council	Prior to works

Species	Requirement / Recommendation	Ownership	Target Date
Bats	As there are structures and mature trees on site that may hold potential for roosting bats, further survey of these features is recommended, if works are to come within 30m.	CH2M Falkirk Council	Prior to works
Great crested newt	Further surveys will be required in order to confirm the situation regarding great crested newt for 14 of the ponds (Pond 3, 4, 5, 6, 7, 12, 13, 14, 15, 16, 17, 18, 19 and 28).	CH2M Falkirk Council	Prior to works
Reptiles	The strimming of vegetation or removal of low level vegetation during the reptile active season (March to October) should be carried out in phases and towards retained habitat. The initial phase should involve cutting the vegetation to a height of 150mm and then the second phase down to ground level. This method allows any reptiles present to move out of the area ahead of works. If works are required outside the active season, an ECoW will identify all suitable hibernating habitats within the site and if works need to take place within these areas then they will be supervised by the ECoW. If any inactive reptile is found, the feature within which it was found must be carefully replaced and the area delineated. No works will be allowed in areas where hibernating animals are found until the reptile active season (March to October).	CH2M Falkirk Council	During works

Section 8 - References

British Bryological Society (2009). **Checklist of British and Irish Bryophytes**. http://rbg-web2.rbge.org.uk/bbs/Resources/Downloads.htm

CIEEM (2013). **Guidelines for Preliminary Ecological Appraisal.** CIEEM, Winchester.

JNCC (2010). **Handbook for Phase 1 Habitat Survey - A Technique for Environmental Audit.** JNCC, Peterborough.

JNCC and Defra (on behalf of the Four Countries' Biodiversity Group) (2012). **UK Post-2010 Biodiversity Framework.** JNCC, Peterborough.

Oldham, R. S., Keeble, J., Swan, M. J. S. and Jeffcote, M. (2000). **Evaluating the Suitability of Habitat for the Great Crested Newt (*Triturus cristatus*).** Herpetological Journal, 10, 143 – 155.

SEPA. (2014). **Land Use Planning System SEPA Guidance Note 4: Planning Guidance on on-shore windfarm developments.**

Scottish Executive (2004). **Scotland's Biodiversity: It's in Your Hands - A strategy for the conservation and enhancement of biodiversity in Scotland.** Scottish Executive, Edinburgh.

Scottish Government (2012). **Code of Practice on Non-Native Species.** Accessed at: **http://www.scotland.gov.uk/Resource/0039/00396355.pdf on 26.05.16**.

Scottish Government (2013). **2020 Challenge for Scotland's Biodiversity.** Scottish Government, Edinburgh.

Scottish Natural Heritage (2016). **Sitelink.** Accessed at http://gateway.snh.gov.uk/sitelink/index.jsp+ on 01.04.16.

Stace, C. (2010). **New Flora of the British Isles, 3rd Edition.** Cambridge University Press

TAG (2005). **Criteria for determining significant damage UK Technical Advisory Group on the Water Framework Directive. Draft Protocol for determining "Significant Damage" to a "Groundwater Dependent Terrestrial Ecosystem".** Technical Advisory Group.

Appendix I: Site Plan

Figure I.1: Current site plan

Appendix II: Phase 1 Maps

Figure II.1 - Phase 1 map page 1

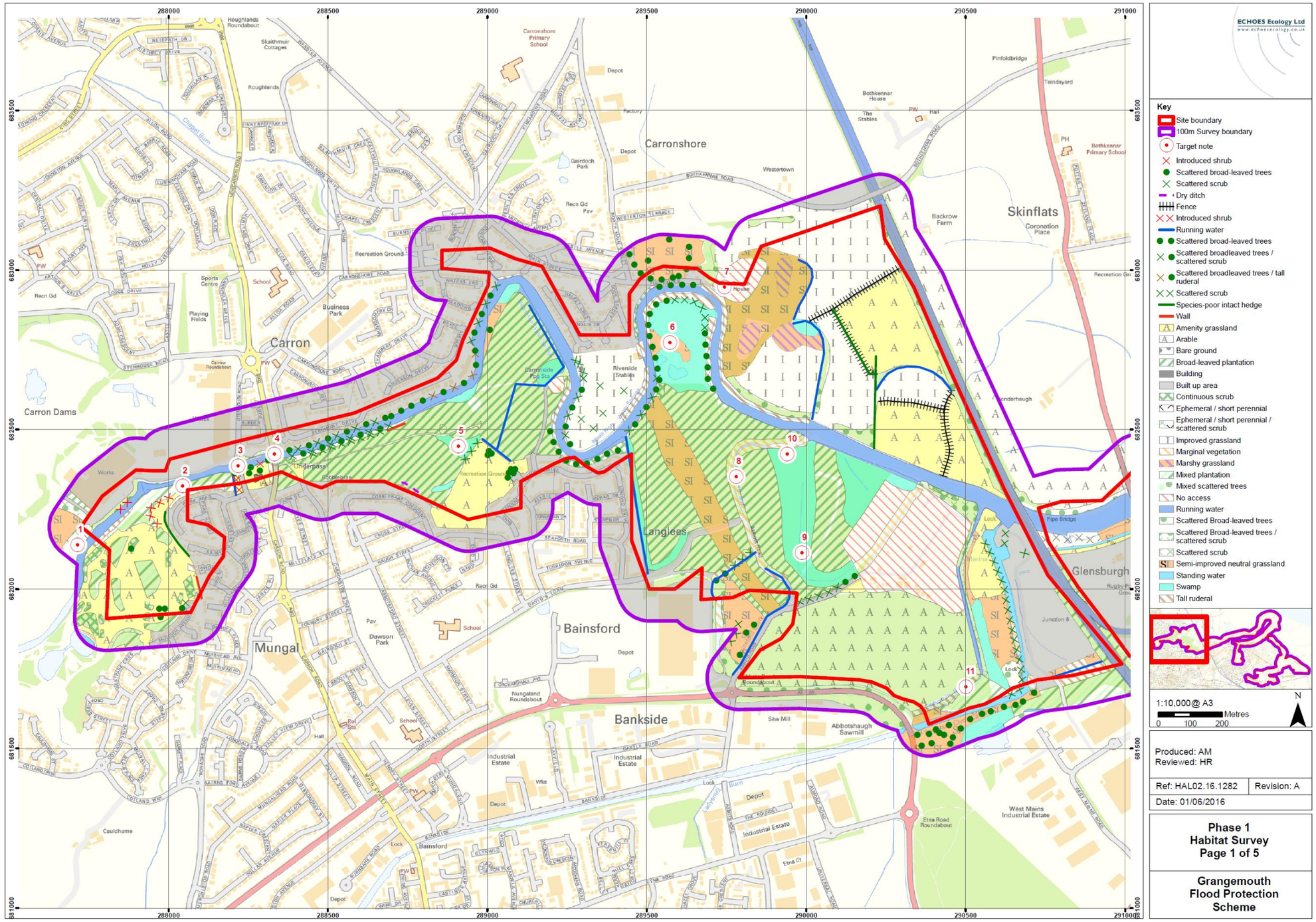


Figure II.2 - Phase 1 map page 2

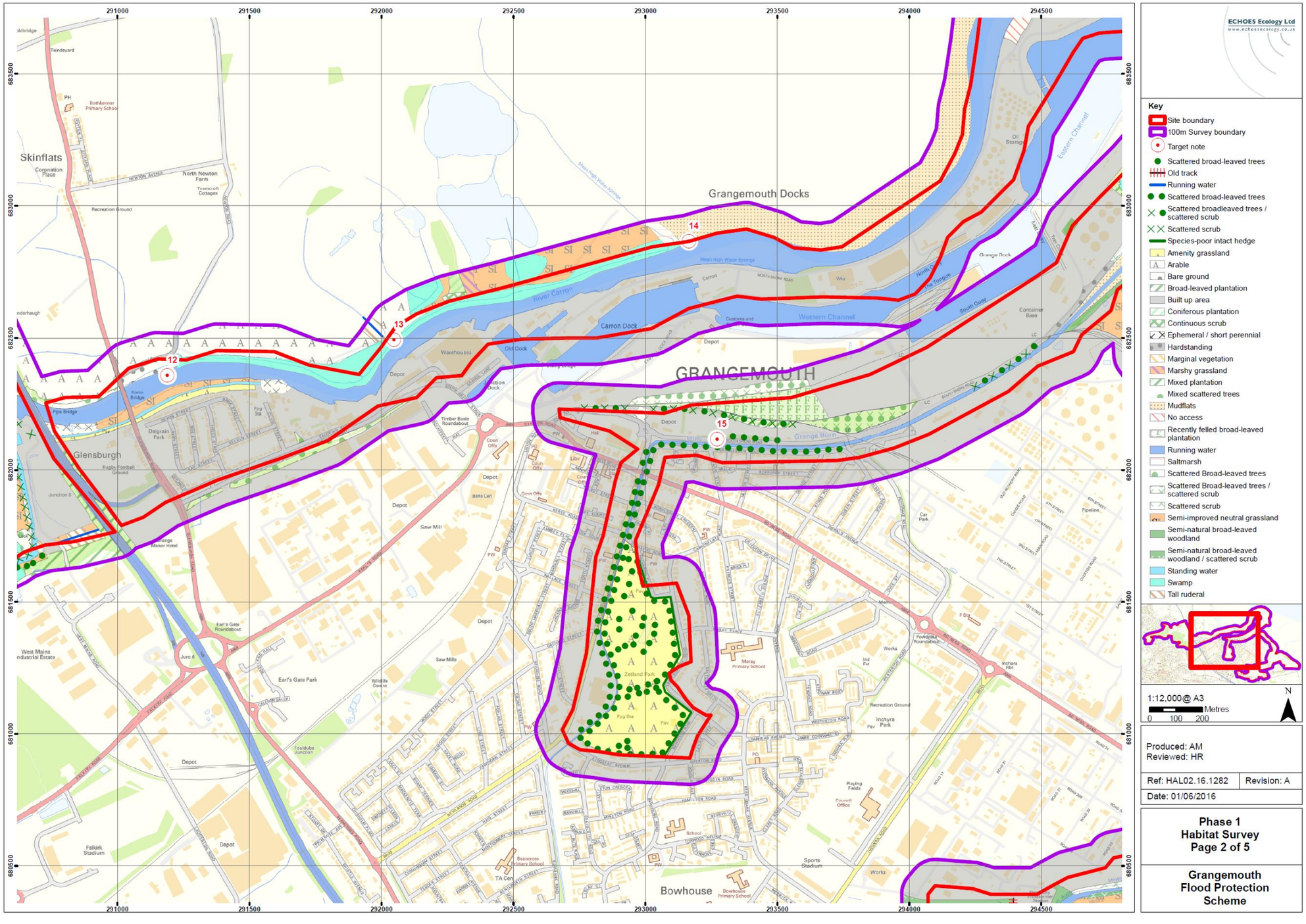


Figure II.3 - Phase 1 map page 3

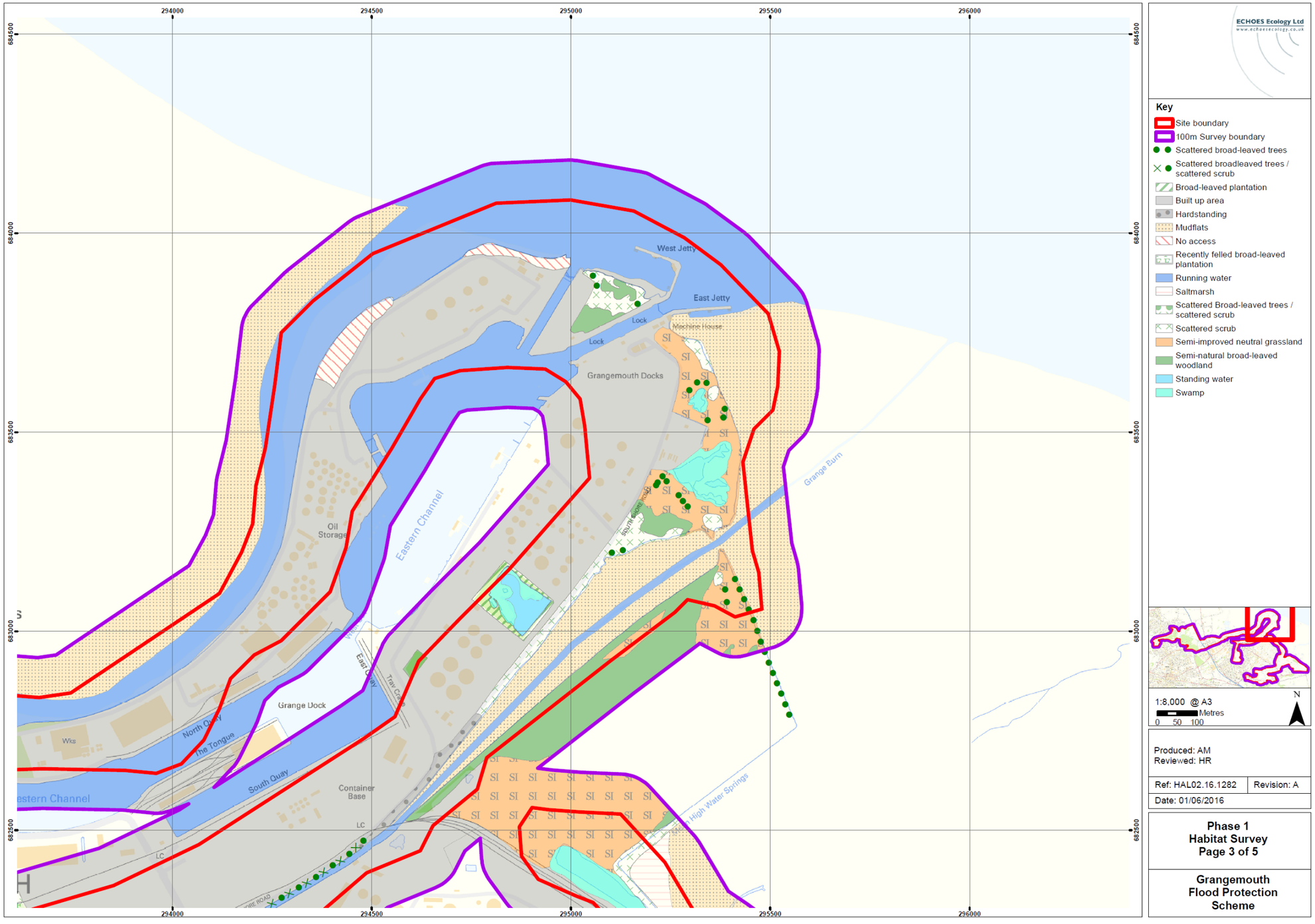


Figure II.4 - Phase 1 map page 4

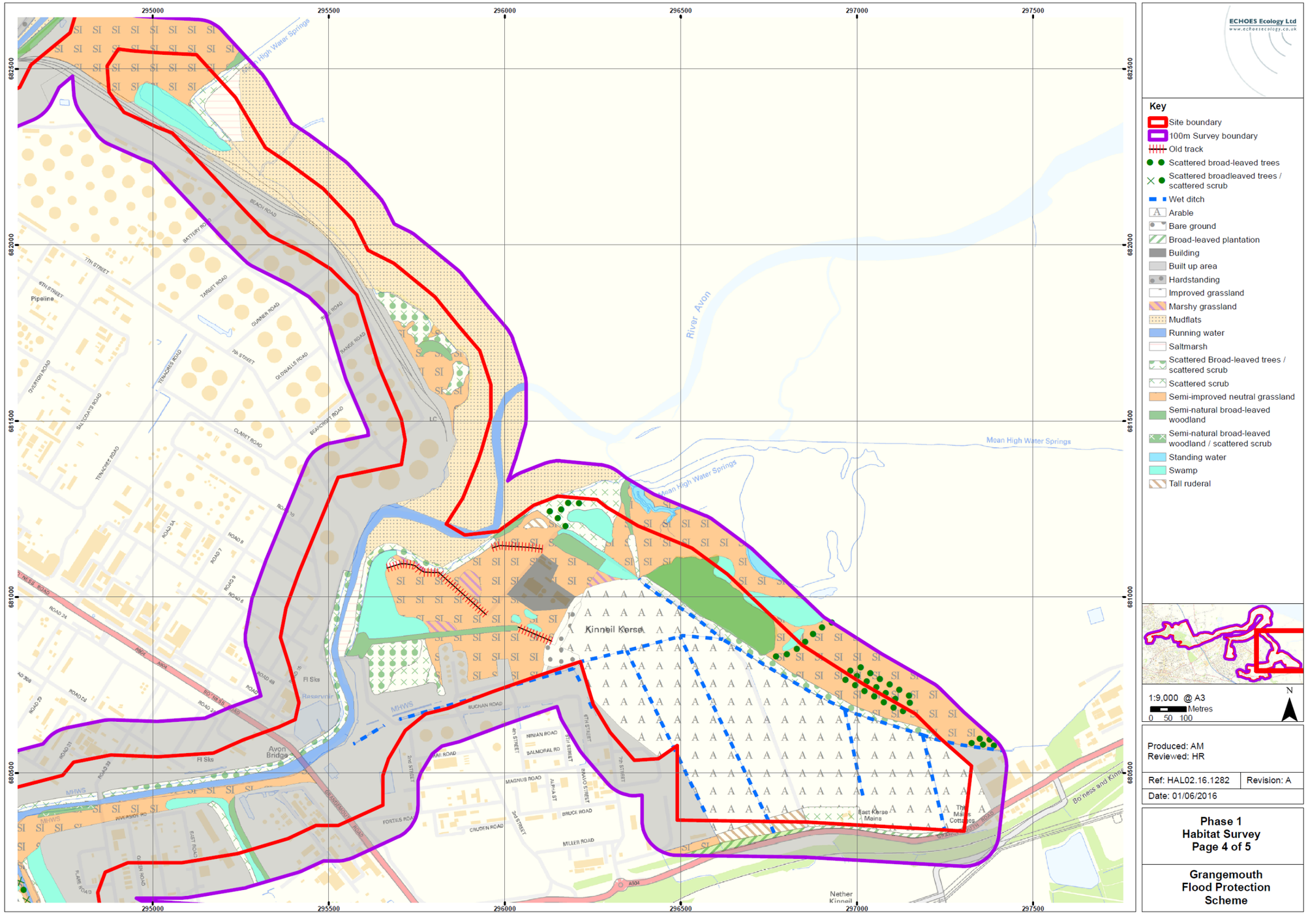
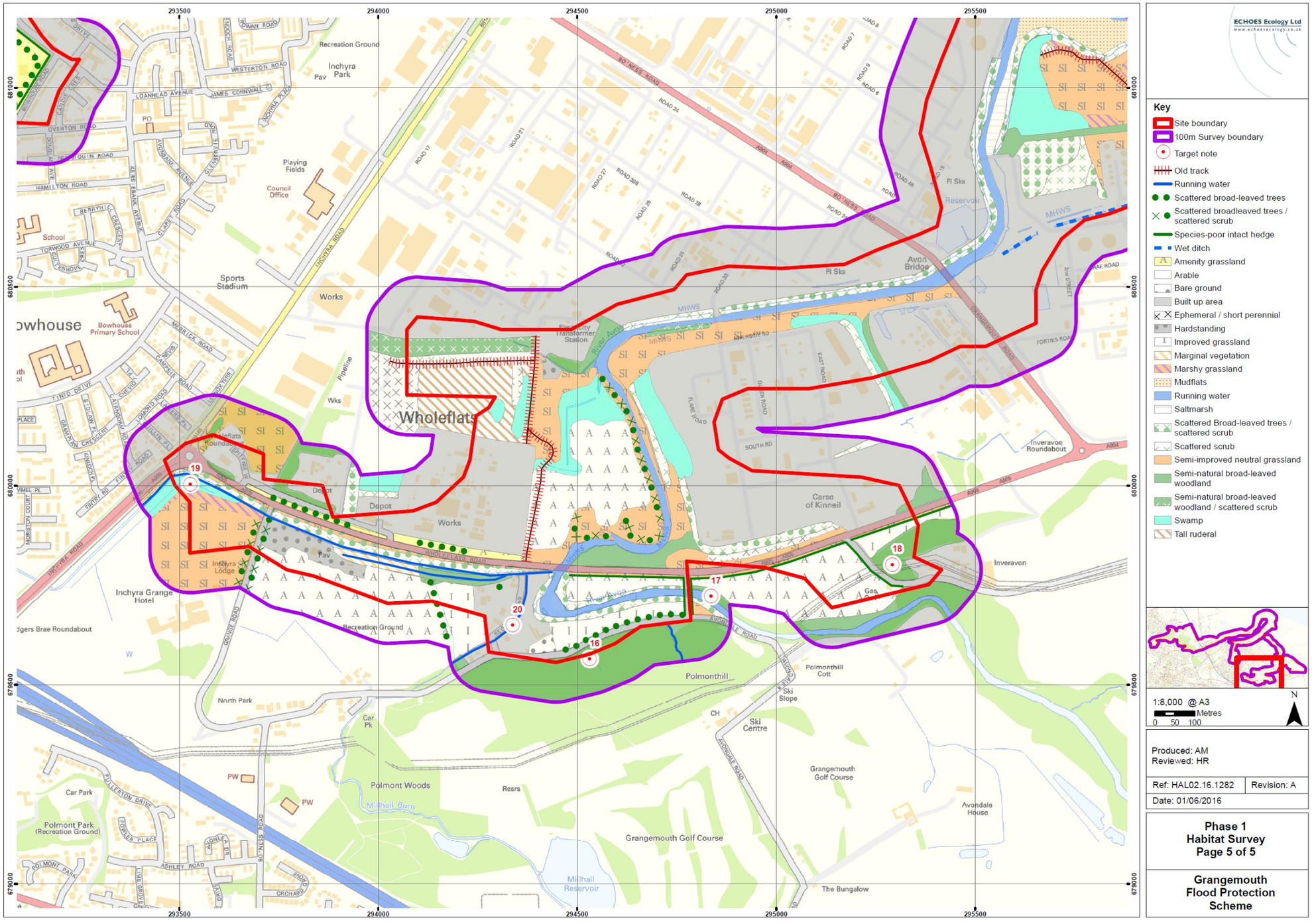


Figure II.5 - Phase 1 map page 5



Appendix III: Photographs

Figure III.1 - Stone derelict bridge over the River Carron (target note 2)

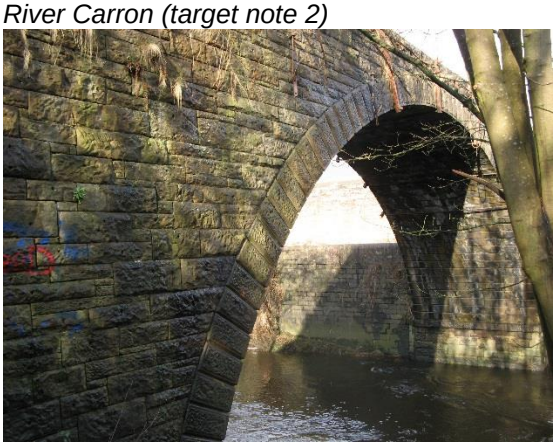


Figure III.2 - Road bridge over the River Carron (target note 3)

Figure III.3 -Road bridge over the River Carron (target note 4)

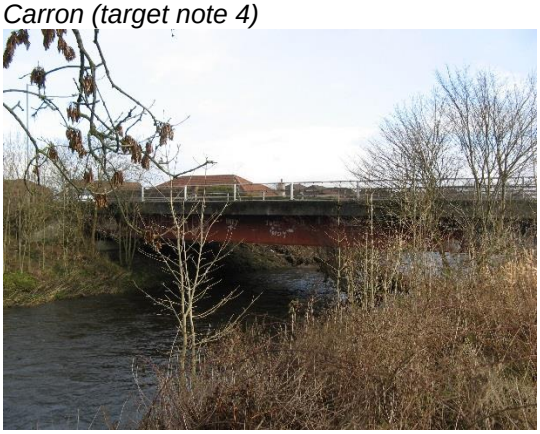


Figure III.4 - Flooded area of grassland (target note 5)

Figure III.5 - Area of swamp (target note 6)

Figure III.6 - Carron House (target note 7)

Figure III.7- Bainsford Burn near confluence with River Carron (target note 8)

Figure III.8 - Area of swamp with active Heron's nests (target note 9)

Figure III.9 -A substantial area of open water within the swamp (target note 10)

Figure III.10 - Ladysmill Burn (target note 11)

Figure III.11 - Intertidal mudflats and saltmarsh along the River Carron (target note 12)

Figure III.12 - Stone structure north of the River Carron (target note 13)

Figure III.13 - Large expanse of intertidal mud flats at confluence of River Carron with Firth of Forth (target note 14)

Figure III.14 - Grange Burn (target note 15)

Figure III.15 - Stone bridge over dry burn (target note 16)

Figure III.16 - Semi-natural broad-leaved woodland along the River Avon (target note 17)

Figure III.17 - Semi-natural broad-leaved woodland near Polmonthill (target note 18)

Figure III.18 - Swamp and marshy grassland around field edge (target note 19)

Figure III.19 - Millhall Burn (target note 20)

Appendix IV: Invasive Species Maps

Figure IV.1 - Invasive species map page 1

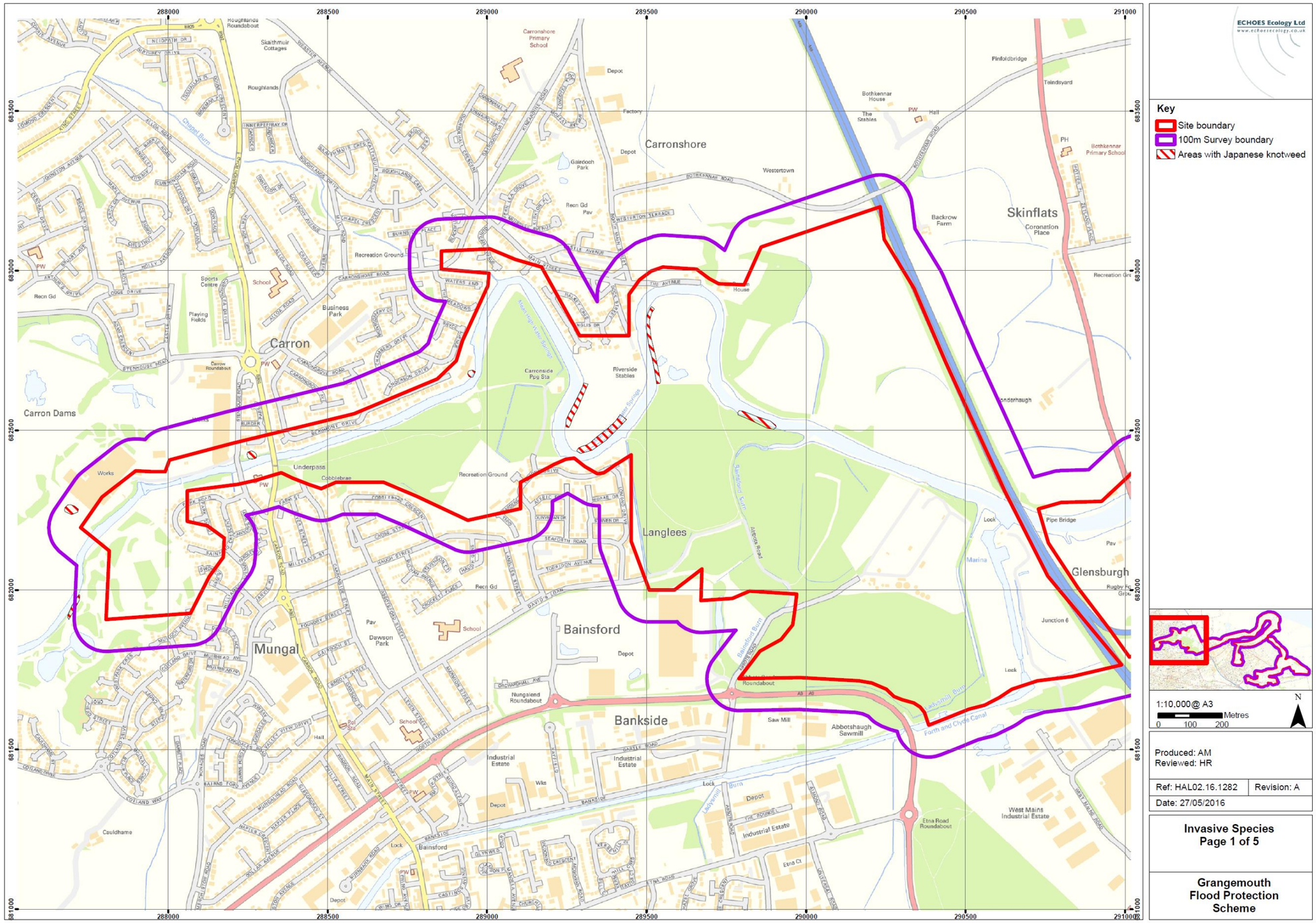


Figure IV.2- Invasive species map page 2

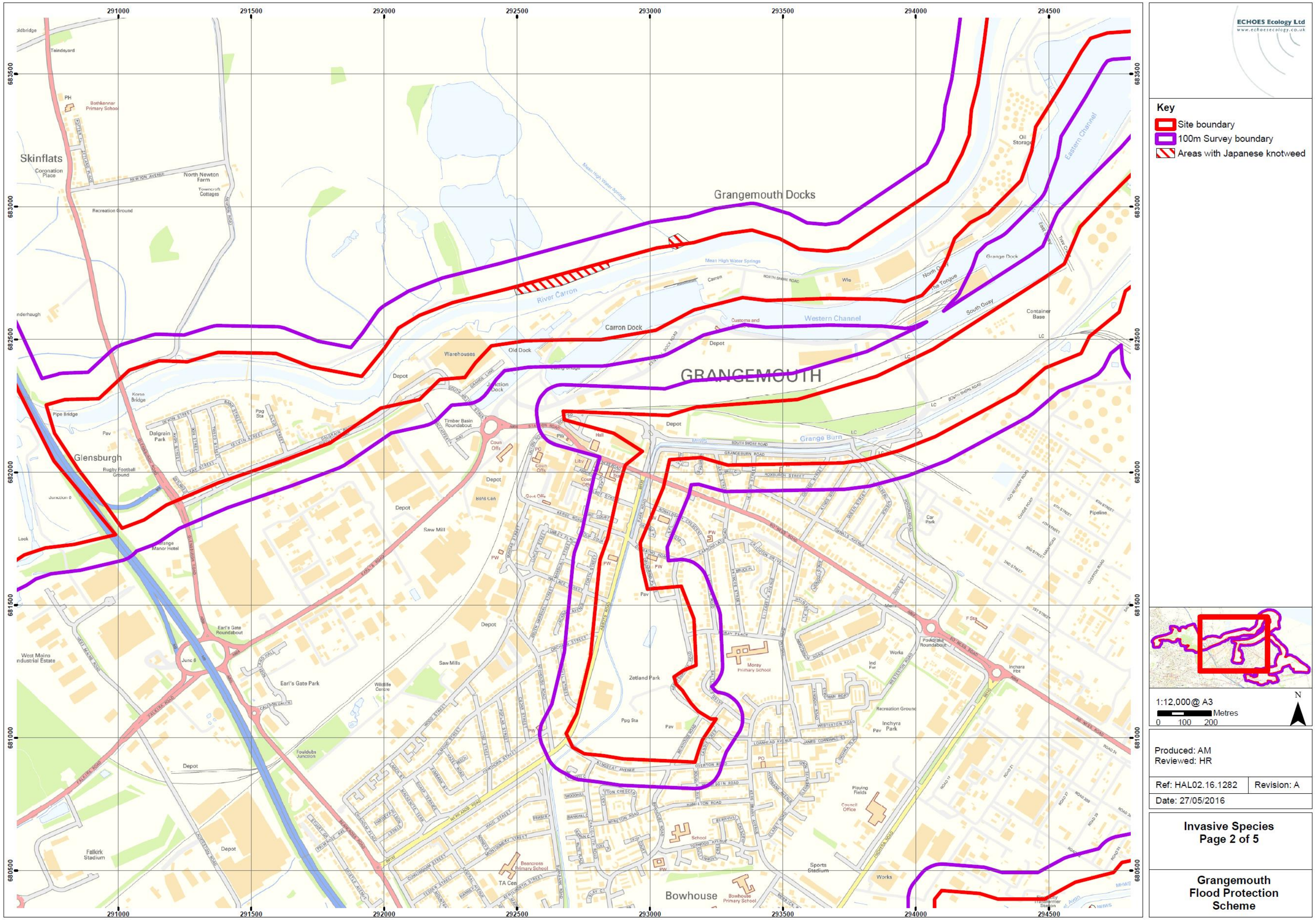


Figure IV.3 - Invasive species map page 3

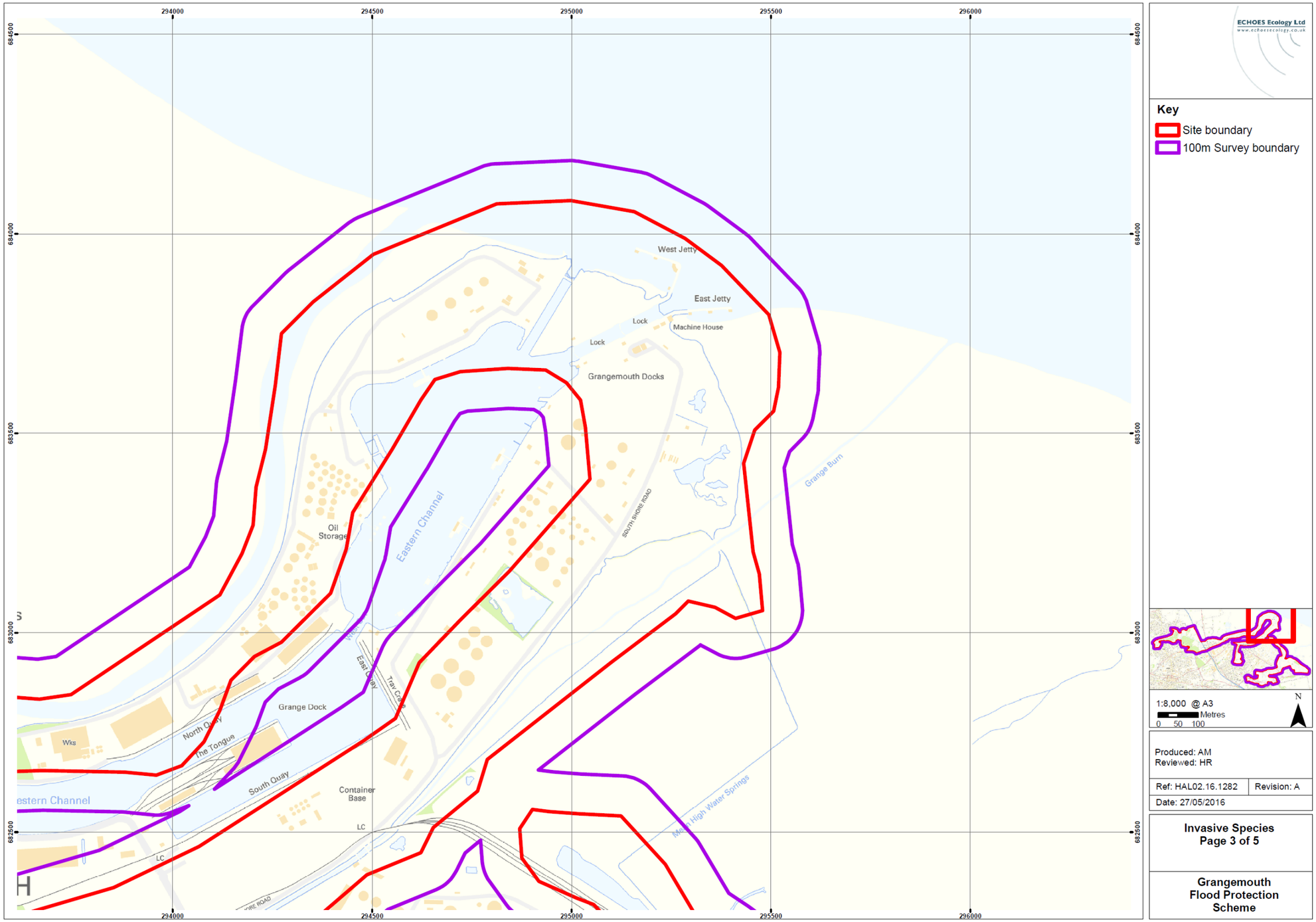


Figure IV.4 - Invasive species map page 4

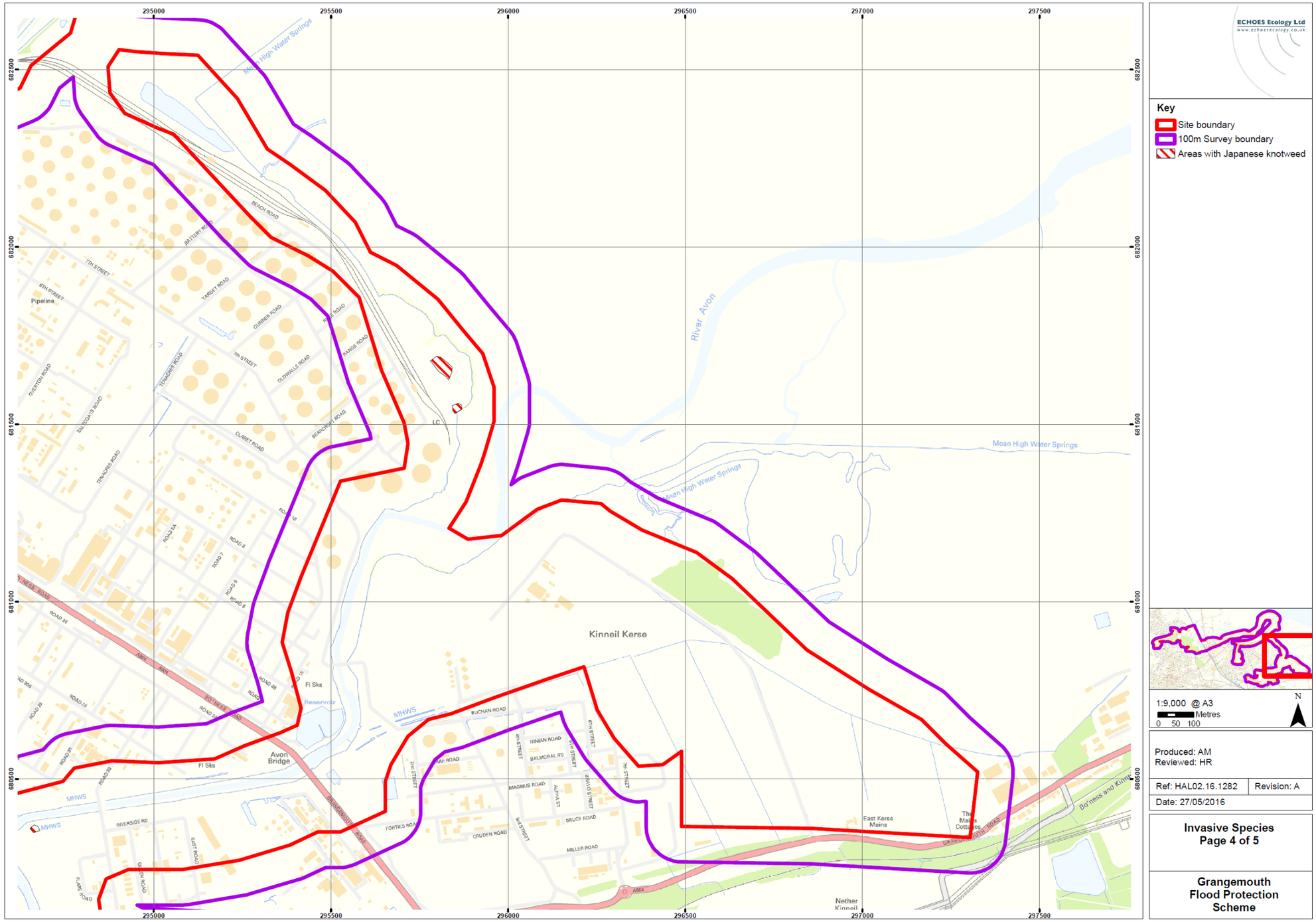
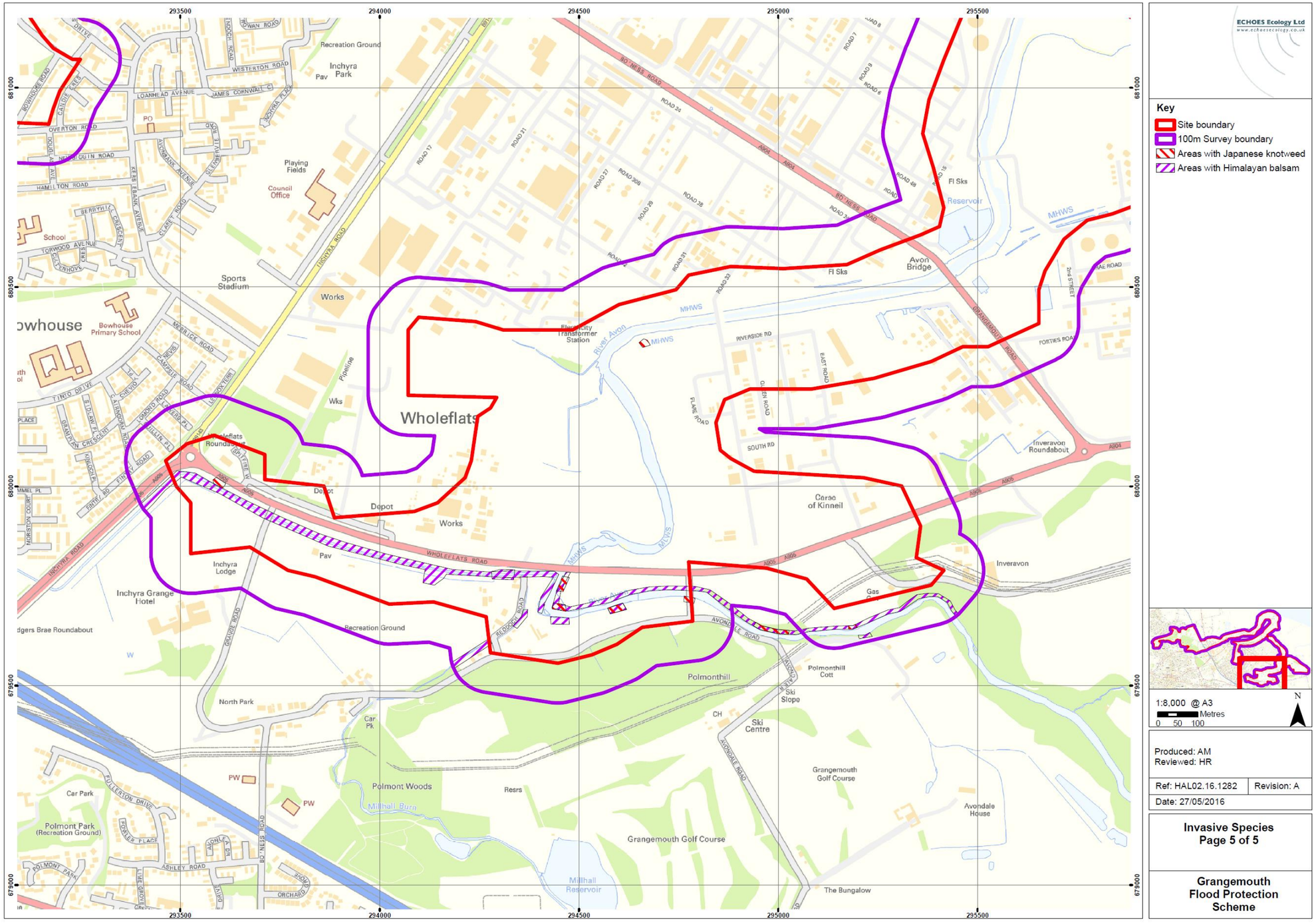


Figure IV.5 - Invasive species map page 5



Appendix V: Bat Roost Potential Maps

Figure V.1- Bat roost potential map page 1

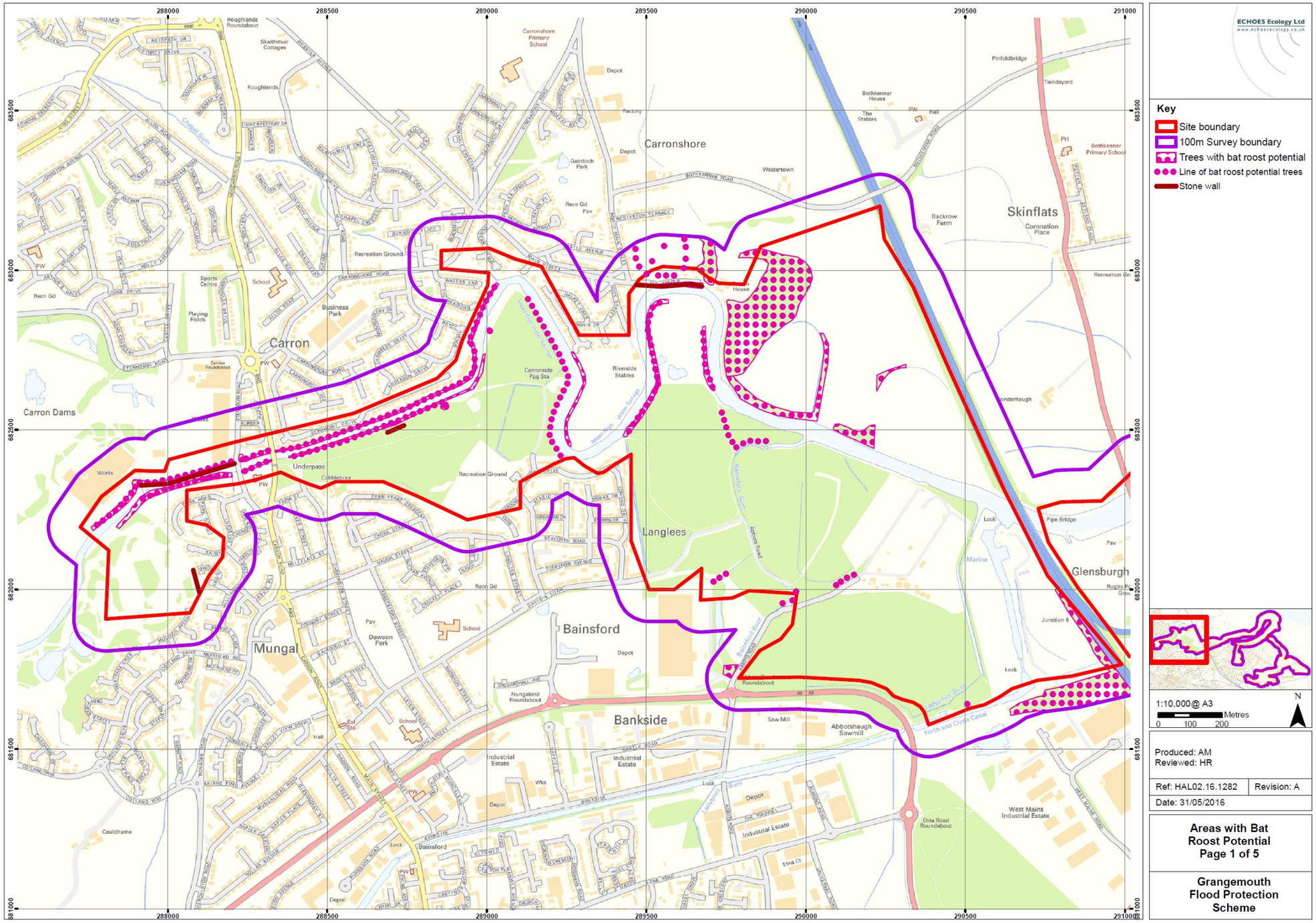


Figure V.2 - Bat roost potential map page 2

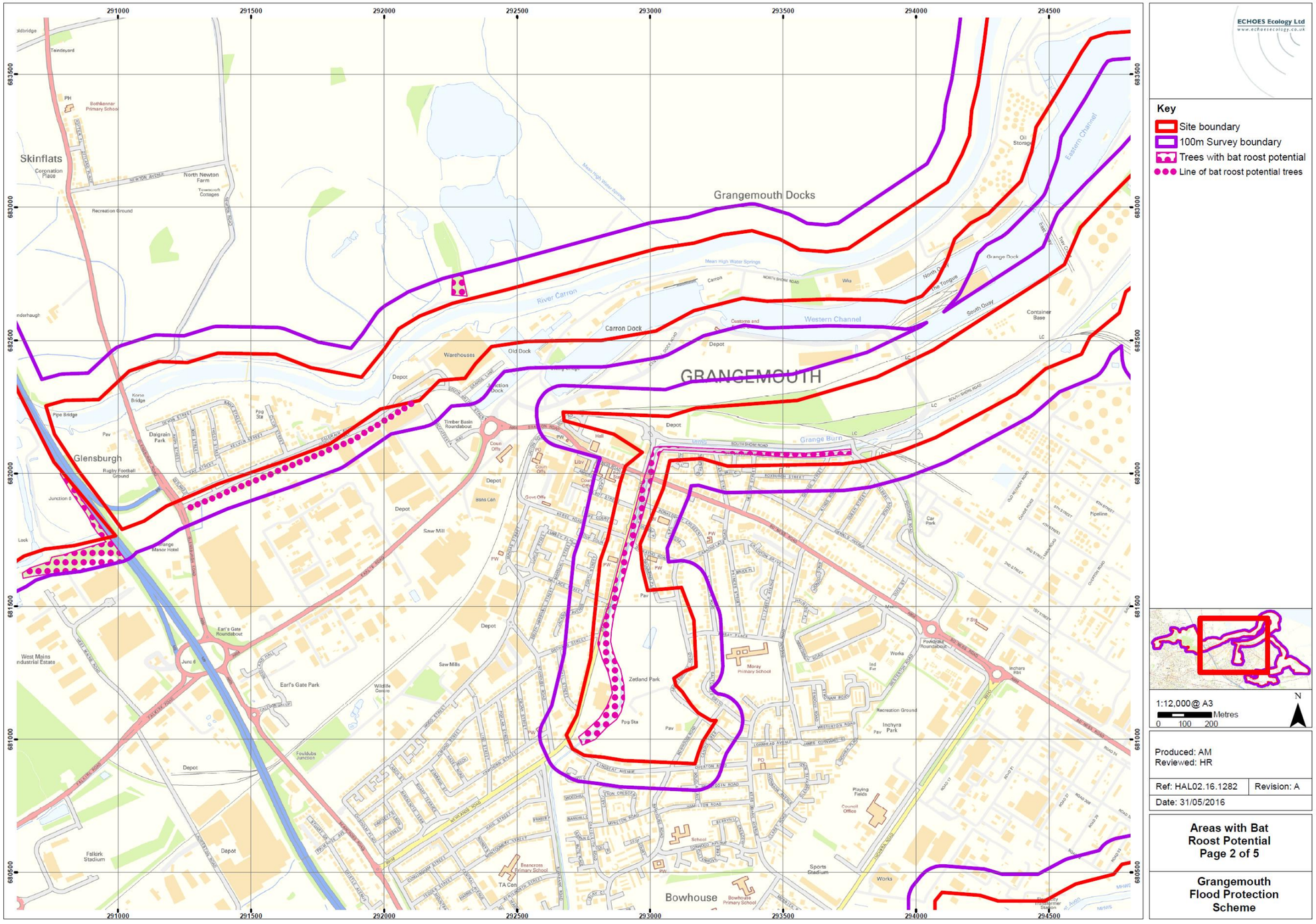


Figure V.3 - Bat roost potential map page 3

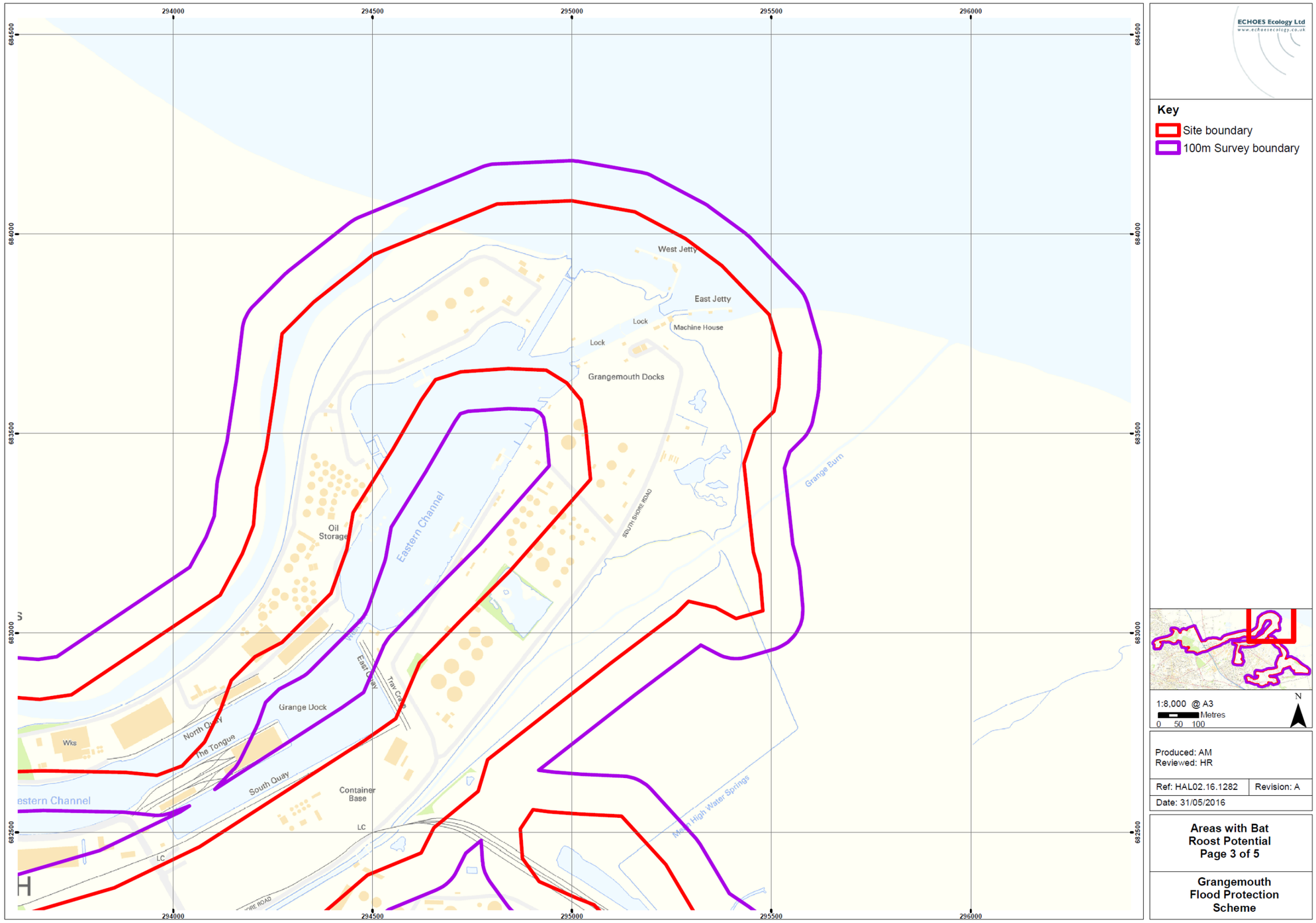


Figure V.4 - Bat roost potential map page 4

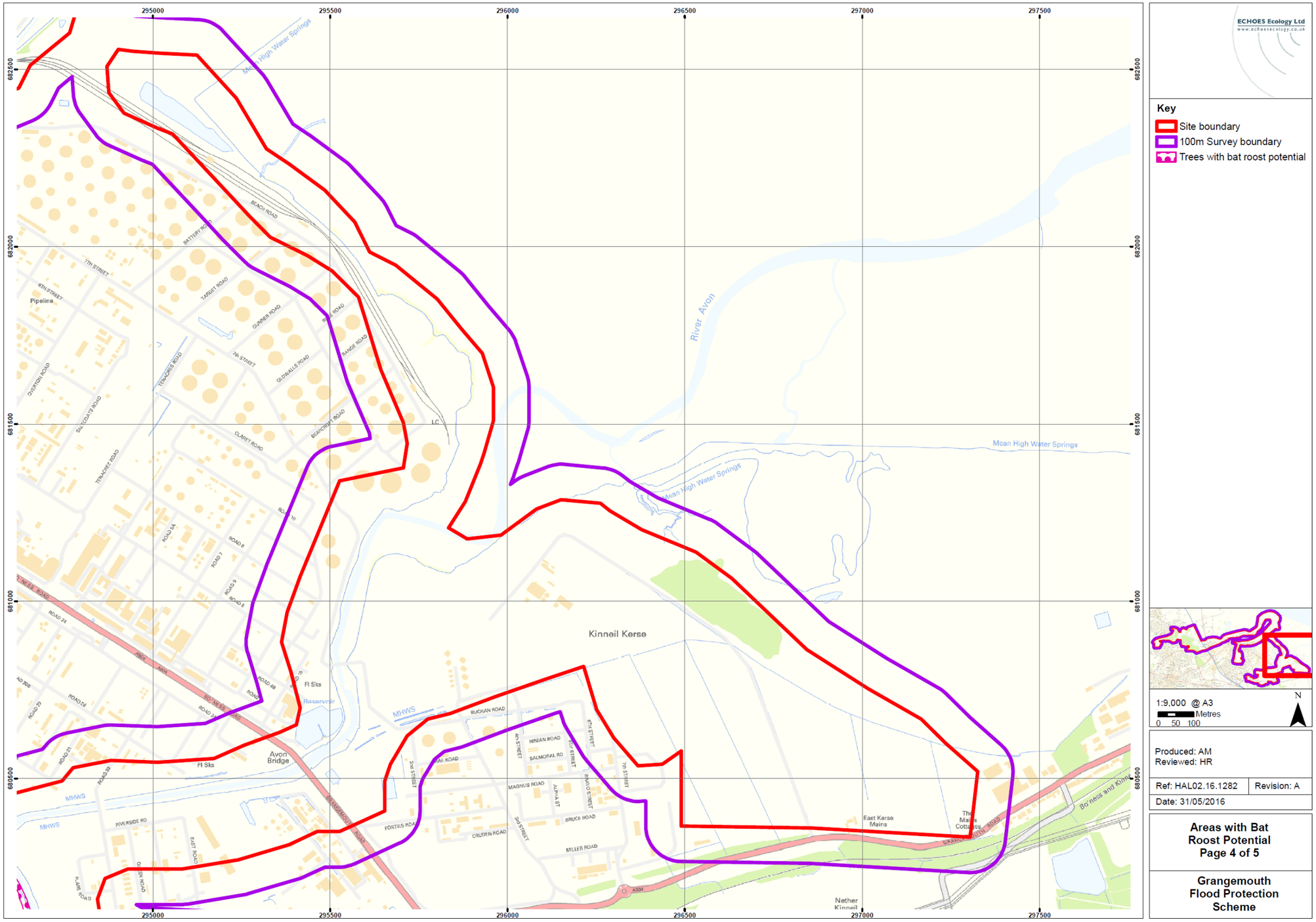
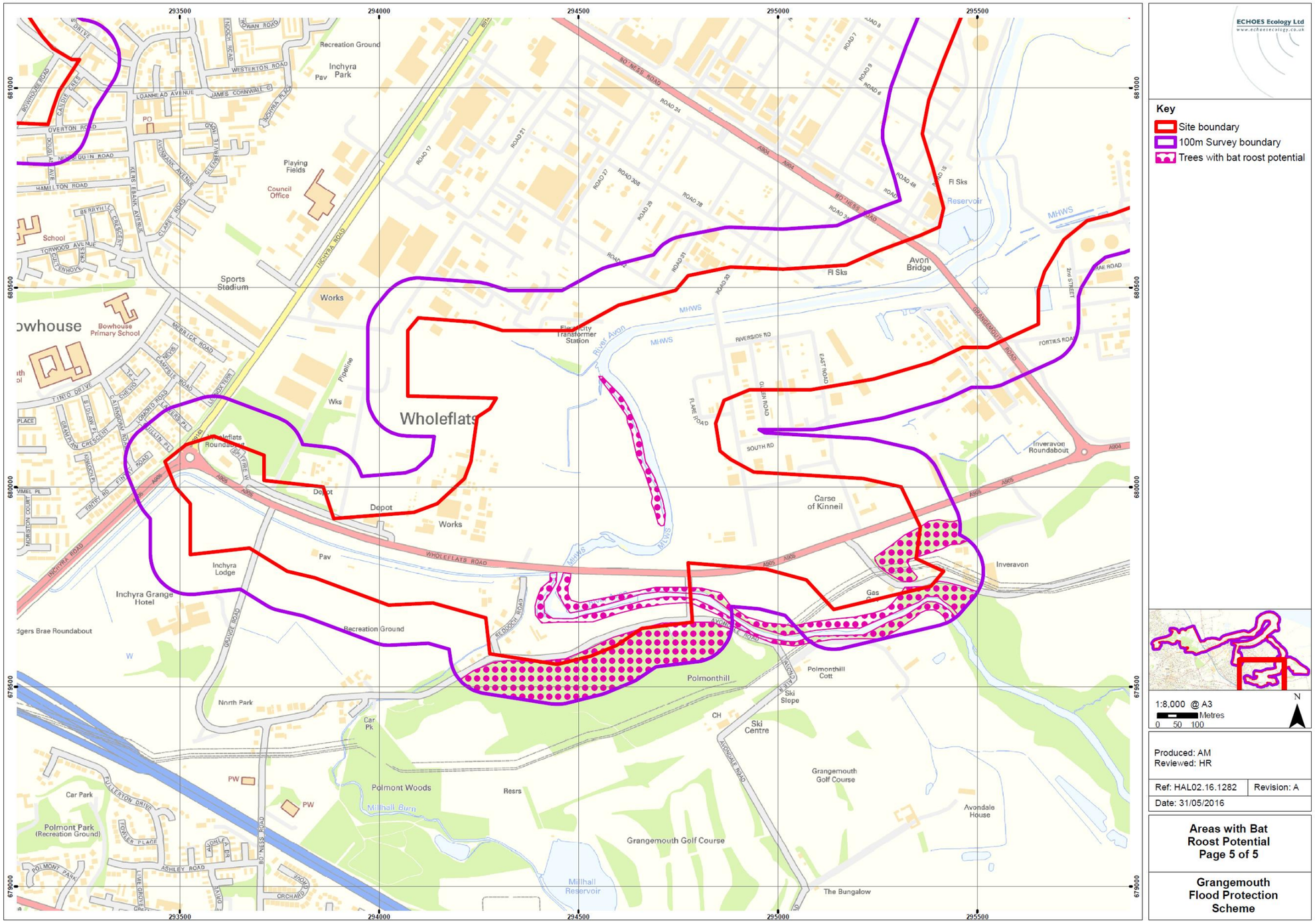
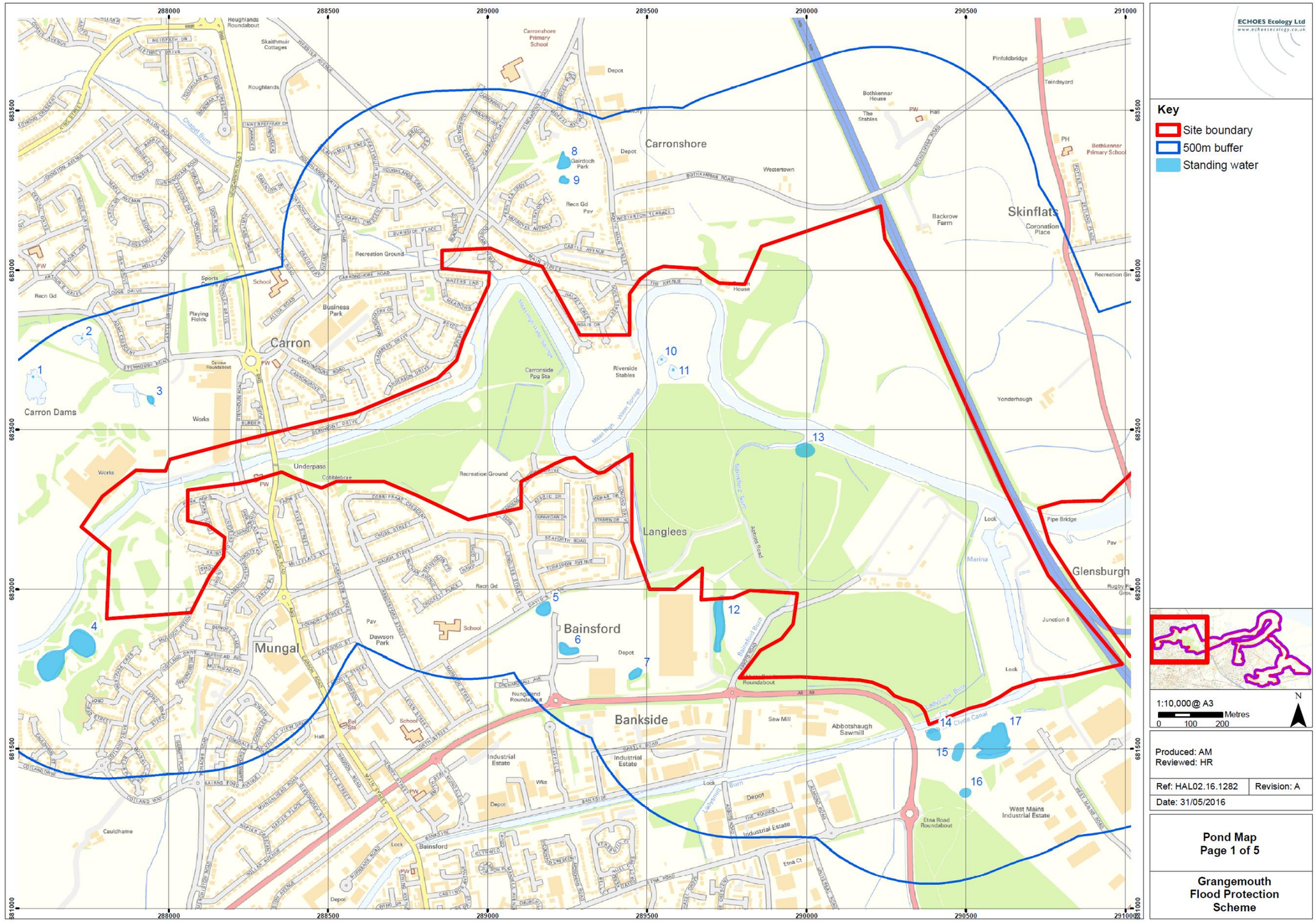


Figure V.5- Bat roost potential map page 5



Appendix VI: Pond Map

Figure VI.1- Pond map page 1



ECHOES Ecology Ltd
www.echoesecology.co.uk

Key

- Site boundary
- 500m buffer
- Standing water

1:10,000@ A3
N
0 100 200 Metres

Produced: AM
Reviewed: HR

Ref: HAL02.16.1282	Revision: A
Date: 31/05/2016	

Pond Map
Page 1 of 5

Grangemouth Flood Protection Scheme

Figure VI.2 - Pond map page 2

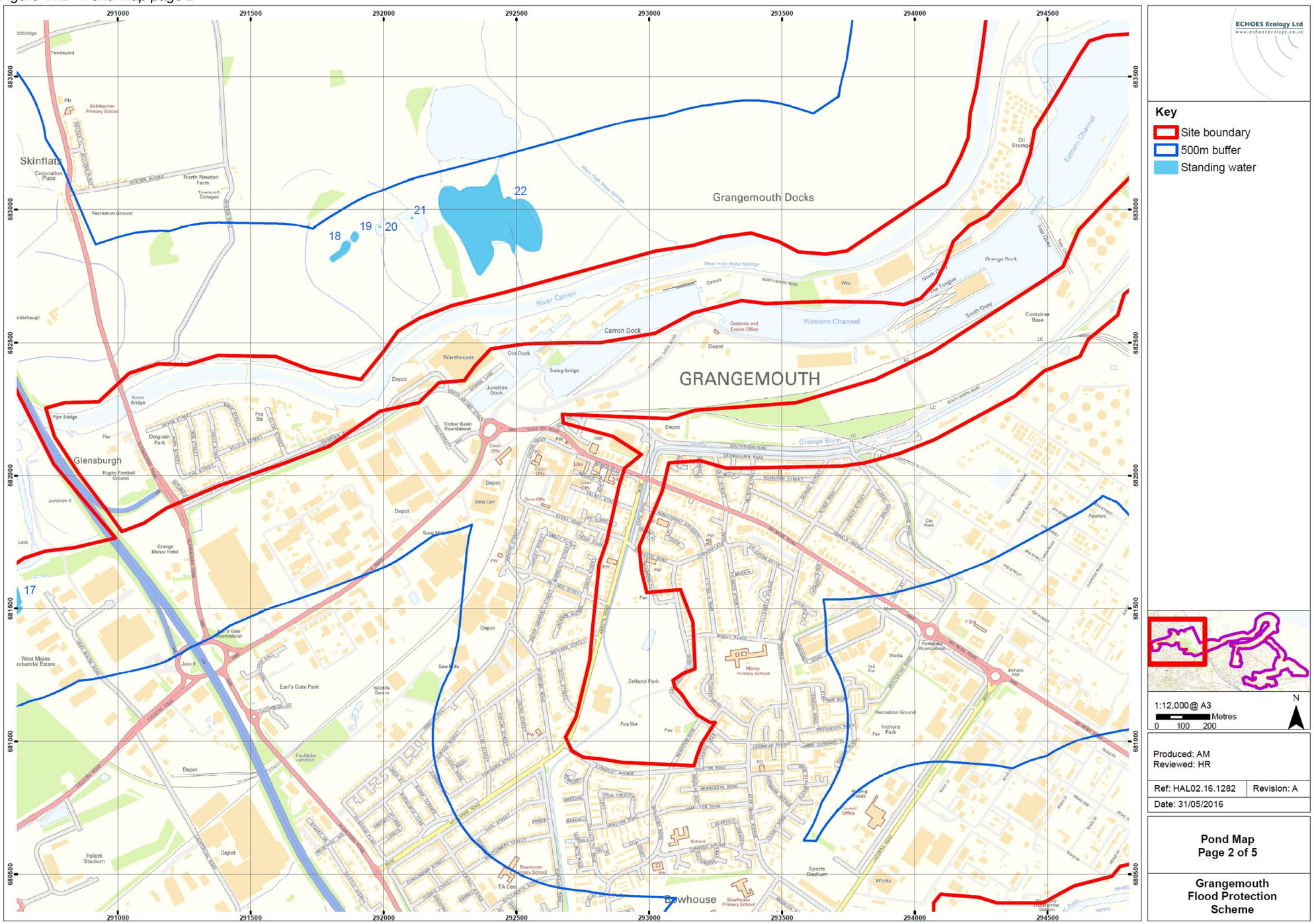


Figure VI.3 - Pond map page 3

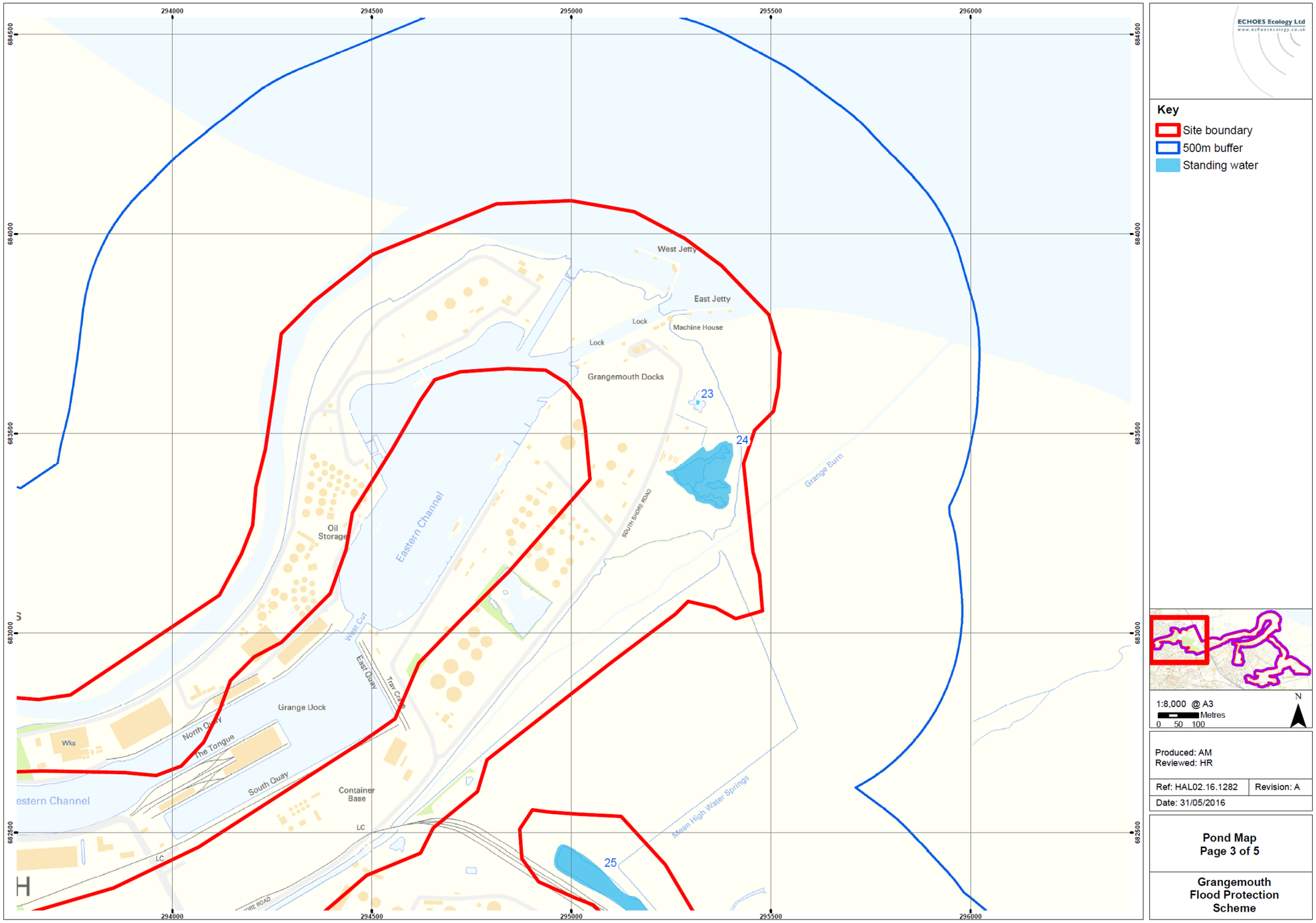


Figure VI.4 - Pond map page 4

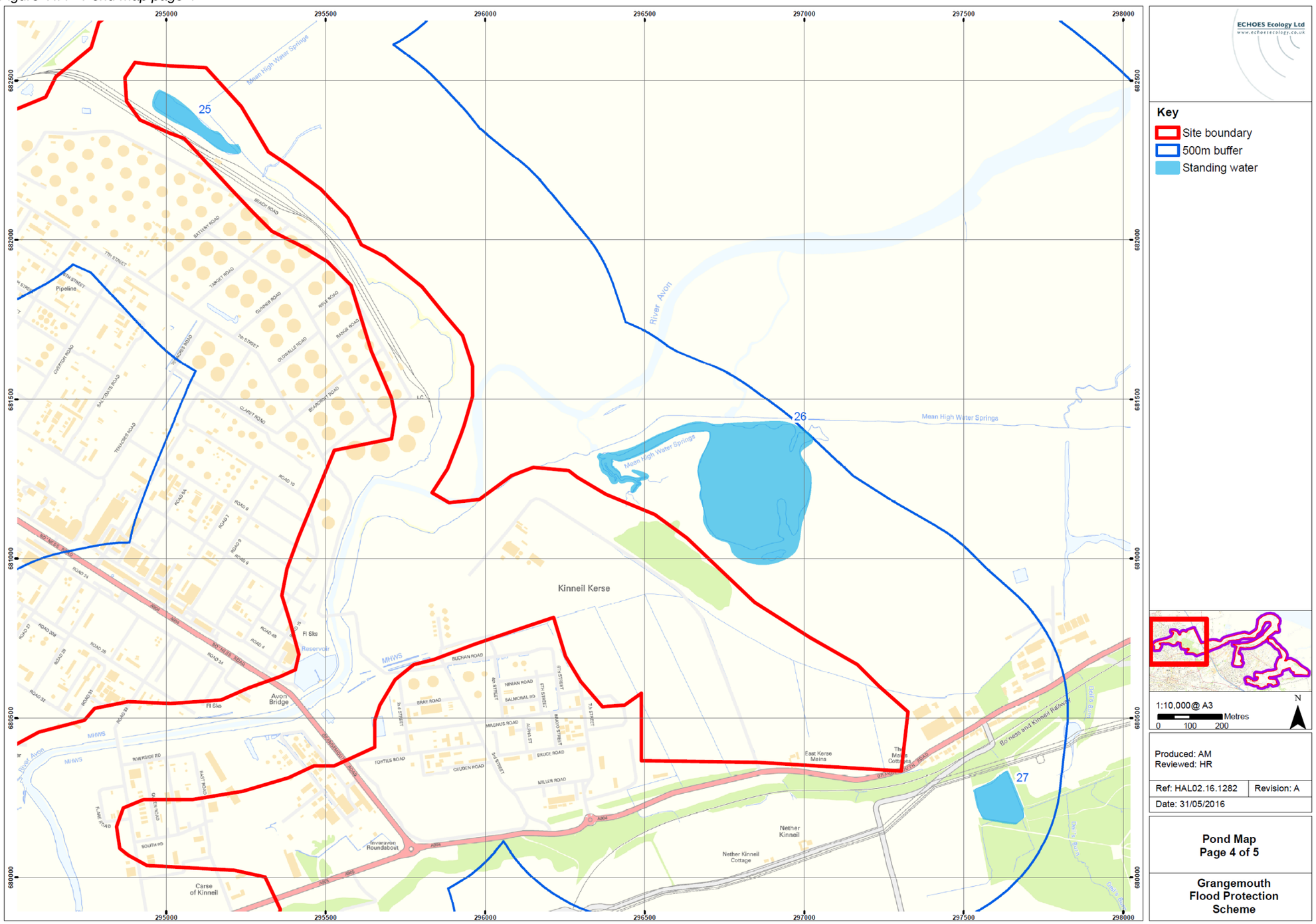
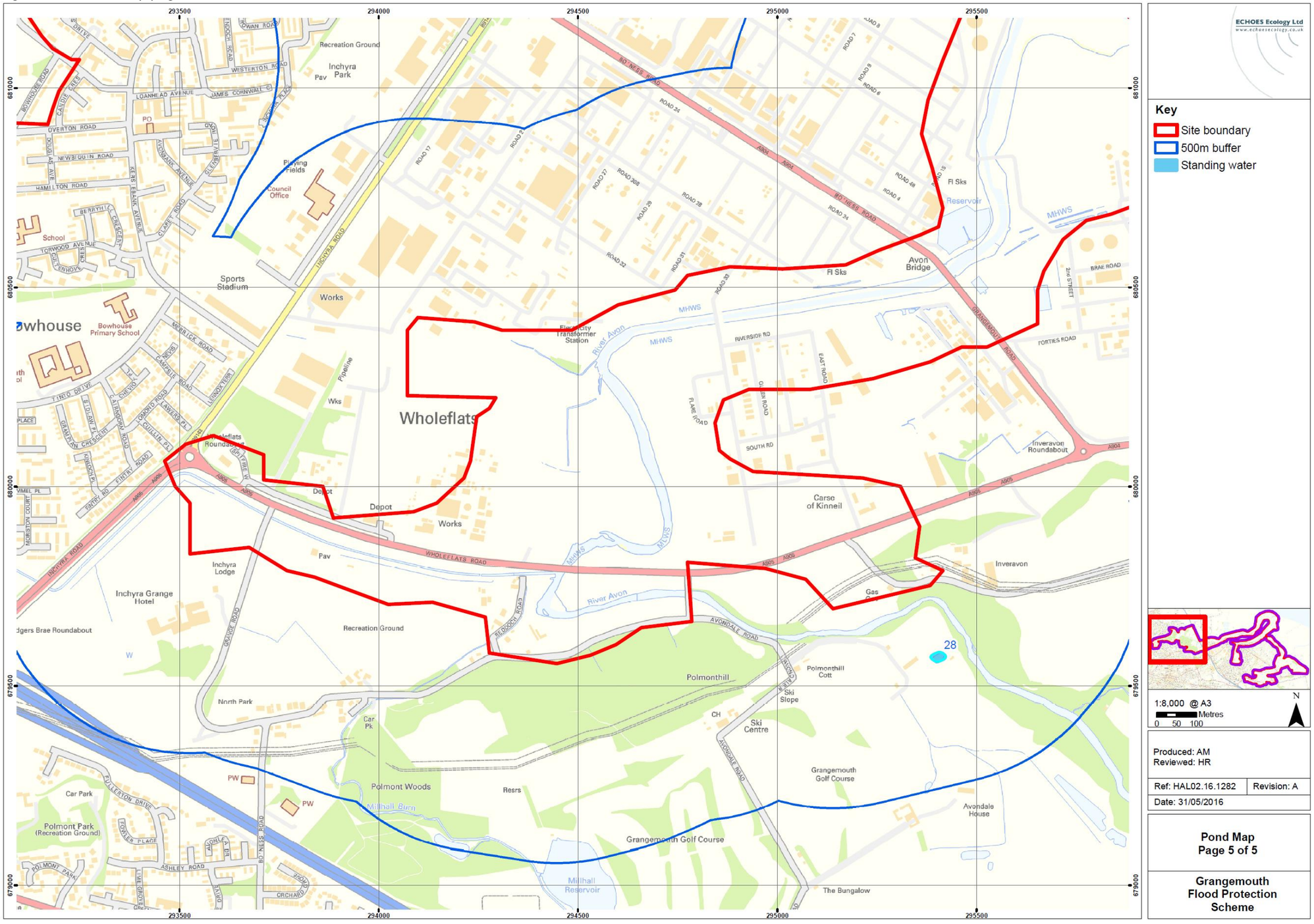


Figure VI.5 - Pond map page 5



ECHOES Ecology Ltd
www.echoesecology.co.uk

Key

- Site boundary
- 500m buffer
- Standing water

1:8,000 @ A3
0 50 100 Metres
N

Produced: AM
Reviewed: HR

Ref: HAL02.16.1282	Revision: A
Date: 31/05/2016	

Pond Map
Page 5 of 5

Grangemouth Flood Protection Scheme

Appendix VII: Habitat Suitability Index

Figure VII.1- Habitat Suitability Index (Oldham et al., 2000)

The Habitat Suitability Index (HSI)

- Based on the assumption that habitat quality determines newt population size
- Ten key habitat criteria assessed: Geographic location (SI_1), Pond area (SI_2), Pond permanence (SI_3), Water quality (SI_4), Pond shading (SI_5), number of waterfowl (SI_6), occurrence of fish (SI_7), pond density (SI_8), terrestrial habitat quality (SI_9) and macrophyte content (SI_{10}).
- Each habitat criteria is assigned a value between 0 (highly unsuitable) and 1 (highly suitable).
- The geometric mean of these values provides an overall suitability score for the site using the following equation: $\mathbf{HSI = (SI_1 * SI_2 * SI_3 * SI_4 * SI_5 * SI_6 * SI_7 * SI_8 * SI_9 * SI_{10})^{1/10}}$
- This score is then used to categorise a water body's suitability for use by great crested newts as shown in the table below.

HSI Score	Pond Suitability
< 0.5	Poor
0.5 – 0.59	Below Average
0.6 – 0.69	Average
0.7 – 0.79	Good
>0.8	Excellent

.

Table VII.1 - HSI calculation for Pond 3

Pond 3		
	Value	**HSI Value**
SI1 - Location	B	0.5
SI2 - Pond area	18m^2	0.04
SI3 - Pond drying	Never	0.9
SI4 - Water quality	Moderate	0.67
SI4 - Shade	0%	1
SI6 - Fowl	Absent	1
SI7 - Fish	Possible	0.67
SI8 - Ponds	3	1
SI9 - Terr'l habitat	Moderate	0.67
SI10 - Macrophytes	10%	0.41
	HSI Score:	0.54
	Pond Suitability:	**Below Average**

Table VII.2 - HSI calculation for Pond 4

Pond 4		
	Value	**HSI Value**
SI1 - Location	B	0.5
SI2 - Pond area	10666m^2	0.01
SI3 - Pond drying	Never	0.9
SI4 - Water quality	Moderate	0.67
SI4 - Shade	15%	1
SI6 - Fowl	Minor	0.67
SI7 - Fish	Possible	0.67
SI8 - Ponds	3	1
SI9 - Terr'l habitat	Moderate	0.67
SI10 - Macrophytes	5%	0.36
	HSI Score:	0.45
	Pond Suitability:	**Poor**

Table VII.3 - HSI calculation for Pond 5

Pond 5		
	Value	**HSI Value**
SI1 - Location	B	0.5
SI2 - Pond area	1284m^2	0.9
SI3 - Pond drying	Never	0.9
SI4 - Water quality	Moderate	0.67
SI4 - Shade	0%	1
SI6 - Fowl	Minor	0.67
SI7 - Fish	Possible	0.67
SI8 - Ponds	5	1
SI9 - Terr'l habitat	Poor	0.33
SI10 - Macrophytes	40%	0.71
	HSI Score:	0.70
	Pond Suitability:	**Good**

Table VII.4 - HSI calculation for Pond 6

Pond 6		
	Value	**HSI Value**
SI1 - Location	B	0.5
SI2 - Pond area	1332m^2	0.9
SI3 - Pond drying	Never	0.9
SI4 - Water quality	Moderate	0.67
SI4 - Shade	0%	1
SI6 - Fowl	Absent	1
SI7 - Fish	Possible	0.67
SI8 - Ponds	5	1
SI9 - Terr'l habitat	Poor	0.33
SI10 - Macrophytes	60%	0.91
	HSI Score:	0.75
	Pond Suitability:	**Good**

Table VII.5 - HSI calculation for Pond 7

Pond 7		
	Value	**HSI Value**
SI1 - Location	B	0.5
SI2 - Pond area	100m^2	0.2
SI3 - Pond drying	Never	0.9
SI4 - Water quality	Poor	0.33
SI4 - Shade	0%	1
SI6 - Fowl	Absent	1
SI7 - Fish	Possible	0.67
SI8 - Ponds	5	1
SI9 - Terr'l habitat	Poor	0.33
SI10 - Macrophytes	10%	0.41
	HSI Score:	0.55
	Pond Suitability:	**Below Average**

Table VII.6 - HSI calculation for Pond 8

Pond 8		
	Value	**HSI Value**
SI1 - Location	B	0.5
SI2 - Pond area	150m^2	0.3
SI3 - Pond drying	Never	0.9
SI4 - Water quality	Moderate	0.67
SI4 - Shade	10%	1
SI6 - Fowl	Absent	1
SI7 - Fish	Possible	0.67
SI8 - Ponds	3	1
SI9 - Terr'l habitat	Poor	0.33
SI10 - Macrophytes	70%	1
	HSI Score:	0.68
	Pond Suitability:	**Average**

Table VII.7 - HSI calculation for Pond 9

Pond 9		
	Value	**HSI Value**
SI1 - Location	B	0.5
SI2 - Pond area	49m^2	0.1
SI3 - Pond drying	Never	0.9
SI4 - Water quality	Moderate	0.67
SI4 - Shade	0%	1
SI6 - Fowl	Absent	1
SI7 - Fish	Possible	0.67
SI8 - Ponds	3	1
SI9 - Terr'l habitat	Poor	0.33
SI10 - Macrophytes	90%	0.9
	HSI Score:	0.60
	Pond Suitability:	**Average**

Table VII.8 - HSI calculation for Pond 12

Pond 12		
	Value	**HSI Value**
SI1 - Location	B	0.5
SI2 - Pond area	3661m^2	0.52
SI3 - Pond drying	Never	0.9
SI4 - Water quality	Good	1
SI4 - Shade	35%	1
SI6 - Fowl	Minor	0.67
SI7 - Fish	Possible	0.67
SI8 - Ponds	5	1
SI9 - Terr'l habitat	Moderate	0.67
SI10 - Macrophytes	35%	0.66
	HSI Score:	0.74
	Pond Suitability:	**Good**

Table VII.9 - HSI calculation for Pond 13

Pond 13		
	Value	**HSI Value**
SI1 - Location	B	0.5
SI2 - Pond area	2000m^2	0.79
SI3 - Pond drying	Never	0.9
SI4 - Water quality	Good	1
SI4 - Shade	80%	0.6
SI6 - Fowl	Minor	0.67
SI7 - Fish	Possible	0.67
SI8 - Ponds	1.6	0.79
SI9 - Terr'l habitat	Moderate	0.67
SI10 - Macrophytes	10%	0.41
	HSI Score:	0.68
	Pond Suitability:	**Average**

Table VII.10 - HSI calculation for Pond 14

Pond 14		
	Value	**HSI Value**
SI1 - Location	B	0.5
SI2 - Pond area	1051m^2	0.94
SI3 - Pond drying	Rarely	1
SI4 - Water quality	Moderate	0.67
SI4 - Shade	20%	1
SI6 - Fowl	Absent	1
SI7 - Fish	Possible	0.67
SI8 - Ponds	5	1
SI9 - Terr'l habitat	Moderate	0.67
SI10 -	95%	0.85
	HSI Score:	0.81
	Pond Suitability:	**Excellent**

Table VII.11 - HSI calculation for Pond 15

Pond 15		
	Value	**HSI Value**
SI1 - Location	B	0.5
SI2 - Pond area	1186m^2	0.92
SI3 - Pond drying	Rarely	1
SI4 - Water quality	Moderate	0.67
SI4 - Shade	60%	1
SI6 - Fowl	Absent	1
SI7 - Fish	Possible	0.67
SI8 - Ponds	4	1
SI9 - Terr'l habitat	Moderate	0.67
SI10 - Macrophytes	20%	0.51
	HSI Score:	0.77
	Pond Suitability:	**Good**

Table VII.12 - HSI calculation for Pond 16

Pond 16		
	Value	**HSI Value**
SI1 - Location	B	0.5
SI2 - Pond area	622m^2	1
SI3 - Pond drying	Sometimes	0.5
SI4 - Water quality	Moderate	0.67
SI4 - Shade	0%	1
SI6 - Fowl	Absent	1
SI7 - Fish	Possible	0.67
SI8 - Ponds	4	1
SI9 - Terr'l habitat	Moderate	0.67
SI10 - Macrophytes	5%	0.36
	HSI Score:	0.70
	Pond Suitability:	**Good**

Table VII.13 - HSI calculation for Pond 17

Pond 17		
	Value	**HSI Value**
SI1 - Location	B	0.5
SI2 - Pond area	7628m^2	0.01
SI3 - Pond drying	Never	0.9
SI4 - Water quality	Moderate	0.67
SI4 - Shade	10%	1
SI6 - Fowl	Minor	0.67
SI7 - Fish	Possible	0.67
SI8 - Ponds	4	1
SI9 - Terr'l habitat	Moderate	0.67
SI10 - Macrophytes	100%	0.8
	HSI Score:	0.49
	Pond Suitability:	**Poor**

Table VII.14 - HSI calculation for Pond 18

Pond 18		
	Value	**HSI Value**
SI1 - Location	B	0.5
SI2 - Pond area	400m^2	0.8
SI3 - Pond drying	Never	0.9
SI4 - Water quality	Moderate	0.67
SI4 - Shade	15%	1
SI6 - Fowl	Absent	1
SI7 - Fish	Possible	0.67
SI8 - Ponds	4	1
SI9 - Terr'l habitat	Moderate	0.67
SI10 - Macrophytes	10%	0.41
	HSI Score:	0.73
	Pond Suitability:	**Good**

Table VII.15 - HSI calculation for Pond 19

Pond 19		
	Value	**HSI Value**
SI1 - Location	B	0.5
SI2 - Pond area	150m^2	0.3
SI3 - Pond drying	Never	0.9
SI4 - Water quality	Moderate	0.67
SI4 - Shade	5%	1
SI6 - Fowl	Minor	0.67
SI7 - Fish	Possible	0.67
SI8 - Ponds	4	1
SI9 - Terr'l habitat	Moderate	0.67
SI10 - Macrophytes	80%	1
	HSI Score:	0.70
	Pond Suitability:	**Good**

Table VII.16 - HSI calculation for Pond 27

Pond 27		
	Value	**HSI Value**
SI1 - Location	B	0.5
SI2 - Pond area	16150m^2	0.01
SI3 - Pond drying	Never	0.9
SI4 - Water quality	Good	1
SI4 - Shade	80%	0.6
SI6 - Fowl	Minor	0.67
SI7 - Fish	Possible	0.67
SI8 - Ponds	0.32	0.45
SI9 - Terr'l habitat	Good	1
SI10 - Macrophytes	10%	0.41
	HSI Score:	0.43
	Pond Suitability:	**Poor**

Table VII.17 - HSI calculation for Pond 28

Pond 28		
	Value	**HSI Value**
SI1 - Location	B	0.5
SI2 - Pond area	500m^2	1
SI3 - Pond drying	Never	0.9
SI4 - Water quality	Moderate	0.67
SI4 - Shade	20%	1
SI6 - Fowl	Absent	1
SI7 - Fish	Possible	0.67
SI8 - Ponds	1.6	0.79
SI9 - Terr'l habitat	Moderate	0.67
SI10 -	90%	0.9
	HSI Score:	Excellent
	Pond Suitability:	**0.81**

ECHOES Ecology Ltd
www.echoesecology.co.uk

MAMMAL SURVEY

GRANGEMOUTH FLOOD PREVENTION SCHEME

The details provided in this report relating to the locations of badger setts must be treated as confidential and as such, this document is not suitable for online publication or inclusion within public access documents.

DATE: 28 JUNE 2016

CONTRACT REF: HAL02.16.1282

SITE LOCATION: GRANGEMOUTH

OS GRID REF: NS 94055 82839

CLIENT: CH2M

ECHOES ECOLOGY LTD

UNIT 39 HAYPARK BUSINESS CENTRE
MARCHMONT AVENUE
POLMONT
FK2 0NZ

[This page is intentionally left blank]

Contact Details

All correspondence relating to this report should in the first instance be addressed to:

Heather Simpson ACIEEM
Echoes Ecology Ltd

Unit 39, Haypark Business Centre
Marchmont Avenue
Polmont
Falkirk
FK2 0NZ

Tel: 0870 234 0002

Email: heather.simpson@echoesecology.co.uk

Website: www.echoesecology.co.uk

Confidentiality Statement / Copyright

The details contained within this report are confidential and intended purely for the use of CH2M and Falkirk Council. As such, no reproduction, copying or transferring of this report or the data and methods used in this report, other than for the purposes for which it was originally intended, is permitted without the prior written consent of Echoes Ecology Ltd.

Document Control

Version	Date	Prepared By	Approved By
1	28 June 2016	[Redacted] Heather Simpson ACIEEM Senior Ecologist	Neil Middleton ACIEEM Director

Contents of Report

Executive Summary

The proposed Grangemouth Flood Protection Scheme (FPS) aims to reduce flood risk in the Grangemouth area. It will include the River Carron, Grange Burn, River Avon and the River Forth Estuary shoreline. The works will include a combination of new and enhanced defences in the form of flood walls and defences, and possible upstream measures to attenuate flow. The Grangemouth FPS was identified in the Scottish Environment Protection Agency's (SEPA) Flood Risk Management Strategy as being the number one ranked scheme (out of 41) for prioritisation. For a plan of the site as it currently exists please refer to Appendix I.

Echoes Ecology Ltd were appointed by CH2M on behalf of Falkirk Council to carry out baseline ecological surveys, including otter, water vole and badger surveys to determine the potential for, or presence of, these species within the site.

A daytime assessment of the site was completed during the period 18.02.16 to 20.05.16. All water courses and water bodies within the site were surveyed for signs of water vole and otter, and the whole site was surveyed for badger evidence. Where possible, buffers of 100 metres (m) for badgers and 250m for otter and water vole outwith the site were surveyed.

Five badger setts and 26 mammal holes were identified within the survey area. Two of the confirmed badger setts are located within the site. If works are to be carried out within 30m of any setts entrances, a licence from SNH permitting disturbance to badgers must be applied for and granted first. The mammal holes that are located within 30m of any works should be camera trapped and lightweight sticks arranged in the entrances for at least two weeks within the active season to rule out the presence of badgers (Scottish Natural Heritage, 2014). If no badgers are found to be using the entrances, they can be destroyed.

[Redacted]

No evidence of water vole was found within the site. However, as the surveys were carried out in conjunction with otter surveys, at the early stages of the water vole active season, a pre-construction survey should be scheduled between May and August (during the main water vole breeding season) to determine if the species is present within the site.

Project Stage 3 - Options Appraisal will be completed in March 2017 and so it is unlikely that works will commence within 18 months of the mammal survey. Therefore, pre-construction mammal surveys will be required in order to confirm the situation regarding badger, otter and water vole on site hasn't changed in the interim period.

Section 1 - Introduction

1.1 Contract Overview

1.1.1 Echoes Ecology Ltd were appointed by CH2M on behalf of Falkirk Council to carry out an assessment of the site. The aims of the survey were:

- To inspect all watercourses within site and an additional 250m buffer surrounding the site boundary (survey area) to identify any evidence of otter and water vole usage
- To carry out an inspection of the site and a 50m buffer (survey area) to locate any evidence of badgers within the area
- To assess the likely impacts of the development on otters, badgers and water vole
- If necessary, to suggest mitigation and compensation to minimise any predicted impacts and maintain favourable conservation status of the species in question.

1.1.2 The proposed Grangemouth Flood Protection Scheme (FPS) aims to reduce flood risk in the Grangemouth area. It will include the River Carron, Grange Burn, River Avon and the River Forth Estuary shoreline. The works will include a combination of new and enhanced defences in the form of flood walls and defences and possible upstream measures to attenuate flow. The Grangemouth FPS was identified in the Scottish Environment Protection Agency's (SEPA) Flood Risk Management Strategy as being the number one ranked scheme (out of 41) for prioritisation. For a plan of the site as it currently exists refer to Appendix I, Figure I.1

1.1.3 The site is predominantly composed of tidal rivers and their associated habitat corridors, which consists of intertidal mudflat, saltmarsh, swamp, plantation and semi-natural woodland, semi-improved grassland and built-up areas associated with the Forth Ports, petrochemical works and residential developments.

1.1.4 The following documents have been provided to Echoes Ecology Ltd in order to assist in carrying out this contract:

- Site plan

1.1.5 The survey work reported upon within this document was carried out during the period 18.02.16 to 20.05.16. If works at the site do not commence prior to 01.11.17, then further surveys should be commissioned in order to ascertain that the situation regarding otters, badgers and water vole has not changed and thus the conclusions of this report are still valid.

1.1.6 The details provided in this report relating to the locations of badger setts must be treated as confidential and as such, this document is not suitable for on-line publication or inclusion with public access documents.

1.1.7 Appendix II provides an introduction to otters, badgers and water vole in the UK.

Section 2 - Relevant Legislation

2.1 Otter - Legal Considerations

2.1.1 Otters and their places of rest/shelter are protected under UK and European Legislation. In Scotland, this is mainly provided by the Conservation (Natural Habitats, &c.) Regulations 1994, as amended. Under this legislation, otters are regarded as European Protected Species (EPS).

2.1.2 It is an offence to deliberately or recklessly disturb an EPS (including injuring, capturing and/or killing), or damage, obstruct, alter or destroy the resting or breeding place of an EPS. The resting place of an EPS is protected at all times irrespective as to whether any animals are using it at a given time. Scottish Natural Heritage should always be consulted by planning authorities if any proposed work could affect EPS. Developers, planners and contractors (as well as everyone else involved) must make every effort to safeguard EPS and their breeding and resting places.

2.1.3 If the work proposed affects otters or their resting places, a Habitats Regulations licence, issued by the licensing authority Scottish Natural Heritage under Regulation 44 will be required so as to permit an otherwise illegal activity. There are three tests that must be satisfied before a licence will be granted, in addition to which mitigation and/or compensation will almost certainly be required. The three tests are:

- The activity must fall within one of the licensable purposes listed in Regulation 44 (including preserving public health or public safety or other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment)
- There must be no satisfactory alternative
- The action authorised will not be detrimental to the maintenance of the population of the species at a favourable conservation status in their natural range.

2.2 Water Voles - Legal Considerations

2.2.1 Water vole habitat is protected in Scotland by the Wildlife and Countryside Act 1981, as amended.

2.2.2 It is an offence to:

- Intentionally or recklessly damage or destroy or obstruct access to any structure or place which water voles use for shelter or protection
- Intentionally or recklessly disturb water voles whilst they are using such a place

2.3 Badger - Legal Considerations

2.3.1 In Scotland, badgers and their setts are protected under the Protection of Badgers Act 1992, as amended by the Nature Conservation (Scotland) Act 2004 and the Wildlife and Natural Environment (Scotland) Act 2011.

2.3.2 It is an offence to:

- Wilfully kill, injure, take, possess or cruelly ill-treat a badger
- Interfere with a sett by damaging or destroying it
- Obstruct access to, or any entrance of, a badger sett
- Cause a dog to enter a badger sett
- Disturb a badger when it is occupying a sett

2.3.3 A sett is defined as ‘any structure or place which displays signs indicating current use by a badger’. There is no legal definition as to what ‘signs indicating current use’ are, although Scottish Natural Heritage consider these to be field signs including bedding, fresh spoil heaps, hair, latrines, and footprints in or around the feature in question. If it is not immediately clear whether a feature is a sett, all potential entrances should simultaneously undergo active monitoring for at least two weeks using sand traps (to look for footprints) and light-weight sticks placed across the entrances (to monitor if any animal enters or leaves). Camera traps can also

be used. By doing the above immediately prior to the proposed works occurring, and checking regularly throughout the monitoring period, it should be possible to come to a decision as to whether the feature is a sett or not (Scottish Natural Heritage, 2014).

2.3.4 It is advised that no development takes place within 30m of the nearest sett entrance (Scottish Natural Heritage, 2001), although for forestry operations a distance of 20m normally applies (Forestry Commission, 1995).

2.3.5 Licences may be issued from Scottish Natural Heritage which allow otherwise illegal activities to be carried out, for example, working in proximity to a sett, for scientific or educational purposes, sett destruction, etc. Appropriate mitigation and compensation will be necessary if a sett is to be damaged or destroyed under licence.

2.3.6 Breaching of the Protection of Badgers Act 1992 as amended can incur a maximum penalty of a £5,000 fine and/or up to six months imprisonment.

Section 3 - Survey Methodology

3.1 Desk Study Methods

3.1.1 A desk study was carried out to obtain baseline data of otter, water vole and badger activity in or near to the study area. This desk study allowed for data within a 2km radius of the site to be considered. The following resources were consulted:

- Falkirk Council Local Biodiversity Action Plan (LBAP)
- Scottish Badgers
- Echoes Ecology Ltd, 'ScoMam' Database (a database of over 4,000 mammal records collected by Echoes Ecology Ltd and associate surveyors over 10 years of surveys).

3.2 Field Survey Methods

3.2.1 The survey methods employed are described below within Table 3.1.

Table 3.1 - Survey methods

Number and Type of Surveys	Otter, water vole and badger survey conducted over 17 visits.	Surveyors	Heather Simpson Laura Carter-Davis Elaine Anderson April Park Craig Johnson Susan McAuley Aaron Middleton Laura Spence Mingaile Zebaite
Survey Dates	18.02.16, 19.02.16, 29.02.16, 04.03.16, 09.03.16, 10.03.16, 11.03.16, 15.03.16, 01.04.16, 05.04.16, 06.04.16, 10.04.16, 11.04.16, 15.04.16, 04.05.16, 19.05.16 and 20.05.16.		
Methods Used			
[Redacted] **Water Vole Survey Methods (adapted from Strachan *et al.*, 2011):** All water courses and water bodies within the survey area were walked, in-channel where possible, looking for evidence of water vole presence such as burrows, latrines and feeding signs. **Badger Survey Methods (adapted from Scottish Badgers, 2005):** All ground within the survey area was surveyed, by walking transects through the area (distance between transect lines depended on vegetation cover). Badger setts were recorded, and signs such as dung pits, latrines, footprints, hair and snuffle holes were noted. Where possible, setts were classified according to type, as follows: • Main sett • Annexe sett • Subsidiary sett • Outlier sett See Appendix II, paragraph II.2.2 for sett definitions. If classification was difficult, setts were termed 'Other'. The sett entrances were recorded by degree of usage, as follows:			

- Well used - free of debris due to recent use, although may or may not display recent excavation.
- Part used - vegetation debris may be cluttering the entrance of the hole although could be cleared out easily to allow use.
- Disused - the holes are partially blocked and thus would need a lot of clearance before being used again, some to the extent they are just depressions in the ground. Other animals may have taken up residence (e.g. foxes, rabbits) so keeping holes open.

Survey Equipment Used:
Torch, GPS (Garmin eTrex and Garmin eTrex 10), digital camera

Section 4 - Overview of Results

4.1 Desk Study Results

4.1.1 Otter, water vole and badger all have Species Action Plans (SAPs) under the Falkirk Council Local Biodiversity Action Plan (2011-2014).

4.1.2 A resources and database search was carried out during March 2016. The results provided by Scottish Badgers are represented in map form as seen in Figure 4.1, where several setts and road kills were identified within 2km of the site. There were no ScoMam records found for otter, water vole or badger within 2km of the site. However, there is a known water vole population within Carron Dams Site of Special Scientific Interest (SSSI), which is approximately 150m west of the site.

4.2 Badger Field Survey Results

4.2.1 Five confirmed badger setts (two main setts and three outliers) were identified within the survey area. Two of the setts (Nos 1 and 3, Table 4.1) were found within the site, two of the setts were found just outside (Nos 2 and 4, Table 4.1) and one at the edge of the 100m buffer (No. 5, Table 4.1). Further evidence of badger was detected within the survey area in the form of dung pits, foraging signs and snuffle holes. A further 26 mammal holes were identified that were large enough to be utilised by badger but no badger evidence was detected around the entrances. 23 of the mammal holes were located within the site. Table 4.1 provides details relating to the setts found and badger field signs are shown in Table 4.2. Details of the mammal holes are presented in Table 4.3. The location of badger setts, badger field signs and mammal holes are presented in Appendix III, Figures III.1 to III.5. Photographs of the setts are presented in Appendix IV.

Table 4.1 - Setts, classification according to type and level of usage (refer to Figures III.1 to III.5 in Appendix III)

No.	OS Grid Reference	Sett Type	Badger Signs Recorded
1	NS 89211 82764	Outlier	One well used entrance with bedding (see Figure IV.1, Appendix IV)
2	NS 94847 82697	Main	Seven well-used entrances with dung pits and footprints (see Figure IV.2, Appendix IV)
3	NS 97213 80595	Outlier	One part used entrance with large materials excavated and badger hair at entrance (see Figure IV.3, Appendix IV)
4	NS 95371 79837	Outlier	Single well-used entrance on well-worn badger path, although no fresh spoil or bedding identified (see Figure IV.4, Appendix IV)
5	NS 97184 80244	Main	14 well-used holes with fresh bedding and well-worn path and excavation trenches (see Figure IV.5, Appendix IV)

Table 4.2 - Badger field evidence (refer to Figures III.1 to III.5 in Appendix III)

No.	**OS Grid Reference**	**Badger Signs Recorded**
6	NS 89840 81976	Badger dung pit
7	NS 95306 82831	Badger dung pit
8	NS 97019 80447	Badger dung pit
9	NS 97020 80433	Badger dung pit
10	NS 95431 79861	Badger dung pit
11	NS 95276 79804	Badger dung pit
12	NS 95265 79790	Badger dung pit
13	NS 95262 79786	Badger dung pit
14	NS 97066 80243	Foraging signs
15	NS 96765 80210	Snuffle hole

Figure 4.1 - Results from Scottish Badgers

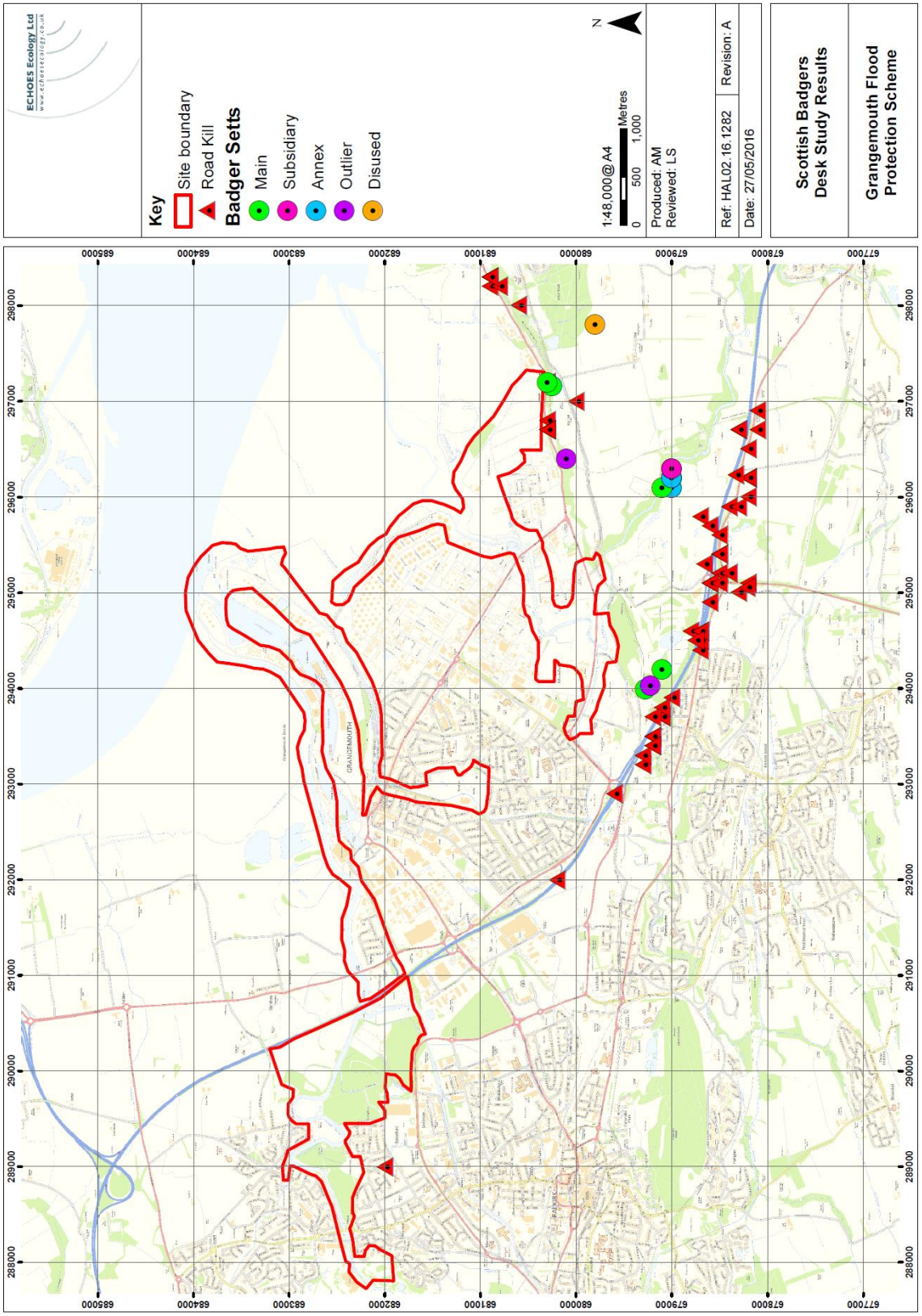


Table 4.3 - Mammal holes (refer to Figures III.1 to III.5 in Appendix III)

No.	OS Grid Reference	Mammal Signs Recorded
16	NS 97013 80420	One well-used hole which is large enough for use by badger. Badger dung close by on east bank of ditch
17	NS 87871 82560	Mammal hole with large spoil and large enough for use by badger
18	NS 87896 82643	Mammal hole beside swamp large enough for use by badger. No evidence detected and rabbit droppings beside entrance
19	NS 88488 82414	Four well used holes, large enough for badger but no evidence. Two of them smell of fox, one in crown-down
20	NS 88639 82382	Two well-used holes, fresh spoil, one with huge spoil, but no other evidence. Soil is very sandy so is easily dug
21	NS 88699 82488	One well-used mammal hole. No badger evidence but large enough for use by badger
22	NS 89002 82738	Four well-used mammal holes, small spoil heaps and a smell of fox but the holes are big enough for use by badgers. On the bank adjacent to river/woodland edge
23	NS 89003 82746	Five entrances, small spoil heap, no evidence but large enough for use by badger
24	NS 89009 82770	Mammal hole large enough for badger but no evidence detected
25	NS 89109 82918	Mammal hole large enough for badger but no evidence detected
26	NS 89180 82814	Two mammal holes large enough for badger but no evidence detected
27	NS 89185 82804	Mammal hole with two entrances large enough for badger
28	NS 89231 82722	Mammal hole with large spoil and large enough for badger but no evidence found
29	NS 89503 82828	Mammal hole with two entrances large enough for badger near the river edge.
30	NS 89523 82864	Mammal hole large enough for badger but no evidence detected
31	NS 89707 83056	Mammal hole large enough for badger but no evidence detected
32	NS 89519 82362	Mammal hole large enough for badger but no evidence detected
33	NS 89987 82006	Mammal hole with single well-used entrance 23cm wide and a tunnel narrowing to 20cm. No badger evidence detected but large enough for use by badger.
34	NS 90478 82588	Mammal hole which seems large enough for badger but no access as on the M9 verge.
35	NS 90514 82490	Mammal hole which seems large enough for badger but no access as on the M9 verge.
36	NS 90967 81731	Mammal hole which seems large enough for badger but no access as on the M9 verge.
37	NS 92203 82896	Possible old badger sett in woodland with four well-used entrances and two collapsed entrances. No badger evidence detected.
38	NS 92556 82198	Mammal hole with three well-used entrances large enough for badger but no evidence detected
39	NS 97017 80453	Mammal hole large enough for badger but no evidence detected on west bank of ditch
40	NS 96742 80380	Mammal hole large enough for badger but no evidence detected on east bank of ditch
41	NS 93889 80173	Mammal hole with five well-used entrances large enough for badger but no evidence detected. Possible fox den as rabbit hair and bones identified outside entrances.

4.3 Otter Field Survey Results

4.3.1 [Redacted]

[Redacted]

Table 4.5 Otter field evidence (refer to Figures III.1 to III.5 in Appendix III)

[Redacted]

4.4 Water Vole Field Survey Results

4.4.1 A number of potential small mammal burrows were identified in the banks of the rivers and burns within the survey area, which were large enough to be utilised by water vole. However, the burrows identified were all individual burrows located in isolated areas and no evidence of water vole was detected on any of the water courses. One area of burrows identified along the River

Avon in a sandy bank is believed to be created by sand martin (No. 77, Table 4.6). Details of the small mammal burrows are presented in Table 4.6 and in Appendix III, Figures III.1 to III.5.

Table 4.6 - Small mammal burrows (refer to Figures III.1 to III.5 in Appendix III)

No.	OS Grid Reference	Evidence
64	NS 96785 80862	Single hole wide enough for water vole but no further holes or evidence of water vole detected
65	NS 96724 80722	Single hole wide enough for water vole but no further holes or evidence of water vole detected
66	NS 96602 80679	Single hole wide enough for water vole but no further holes or evidence of water vole detected
67	NS 96818 80469	Single hole wide enough for water vole but no further holes or evidence of water vole detected
68	NS 96825 80452	Single hole wide enough for water vole but no further holes or evidence of water vole detected
69	NS 89193 82781	Single hole wide enough for water vole but no further holes or evidence of water vole detected
70	NS 90031 82597	Single hole wide enough for water vole but no further holes or evidence of water vole detected
71	NS 89953 81430	Single hole wide enough for water vole but no further holes or evidence of water vole detected
72	NS 90511 81892	Possible water vole burrow under elder but no further holes or signs in area
73	NS 92863 81533	Single hole wide enough for water vole but no further holes or evidence of water vole detected
74	NS 92873 81079	Single hole wide enough for water vole but no further holes or evidence of water vole detected
75	NS 92776 81005	Single hole wide enough for water vole but no further holes or evidence of water vole detected
76	NS 95213 79646	Holes in sandy bank but no signs of water vole
77	NS 94465 79722	Holes in sandy bank large enough for water vole but likely to be created by sand martins
78	NS 94187 79550	Single hole wide enough for water vole but no further holes or evidence of water vole detected

Section 5 - Discussion

5.1 Limitations to Survey Work

5.1.1 There was free access to the majority of land within the proposed site boundary. Two small areas were inaccessible within the petrochemical works as well as the area within Dalderse and Kinneil Waste Water Treatment Works. The area immediately surrounding Carron House was also inaccessible as it was private land.

5.1.2 The woodland to the south of the A904 along the Bo'ness and Kinneil Railway and along the River Avon near Polmonthill were very steep and it was not possible to walk the slopes. Instead the slopes were viewed from the bottom and top and so it is possible that some evidence may have been missed.

5.1.3 The optimum time for water vole surveys is during their breeding season (May to August). However, water courses were searched for historic water vole signs (e.g. old burrows) and early field evidence in conjunction with otter surveys.

5.2 Badger

5.2.1 Five badger setts were identified within the survey area. Two of the confirmed badger setts are located within the site. Three main setts were identified during the desk study in the woodland to the south-east of the site. One of the main setts was located within the survey area and was identified (No 5, Table 4.1). The remaining two setts were beyond 100m from the site and so will not be impacted upon by the development.

5.2.2 If works are to be carried out within 30m of setts entrances, a licence from SNH permitting disturbance to badgers must be applied for and granted first.

5.2.3 26 mammal holes large enough for badgers were found throughout the survey area. However, no definite evidence of use of the holes by badgers was found. The holes that are located within 30m of any works should be camera trapped and lightweight sticks arranged in the entrances for at least two weeks within the active season to rule out the presence of badgers (Scottish Natural Heritage, 2014). If no badgers are found to be using the entrances, they can be destroyed.

5.2.4 Requirements and recommendations with regards to badgers and the proposed works on site are discussed in Section 6.

5.3 Otter

5.3.1 [Redacted]

5.3.2

5.3.3

5.4 Water Vole

5.4.1 No evidence of water vole was found during surveys. The closest known population of water vole is within the Carron Dams SSSI. However, the SSSI is located over 100m from the site and

with no hydrological link. Therefore, the SSSI and water vole population will not be impacted upon by the works.

5.4.2 The current surveys were carried out in March to mid-May, where the majority of the surveys were outside of the optimal survey period. Ideally, the water vole surveys should be carried out during the water vole breeding season (May to August) when the animals are most active. However, although water voles are less active in early spring, if they were present within the survey area it would be anticipated that field signs would still be found.

5.4.3 Pre-construction water vole surveys between May and August should be carried out before the start of works, and if no signs are found it can be assumed that water voles are not present within the site. The survey can be limited to the development area and 50m buffer around it.

5.4.4 Requirements and recommendations with regards to water voles and the proposed works on site are discussed in Section 6.

Section 6 - Requirements and Recommendations

6.1 Requirements and Recommendations

6.1.1 Table 6.1 summarises the requirements and recommendations relating to otter, water vole and badger and future developments at the site.

Table 6.1 - Requirements and recommendations

Action Point	Relevant Species	Action	Ownership	Target Date
AP1	**All**	**Further surveys** Project Stage 3 - Options Appraisal will be completed in March 2017 and so it is unlikely that works will commence within 18 months of the mammal survey. Therefore, pre-construction mammal surveys will be required in order to confirm the situation regarding badger, otter and water vole on site has not changed in the interim period.	CH2M Falkirk Council	Prior to works starting
AP2	**Water vole**	**Further surveys** The pre-construction surveys should be carried out during the water vole breeding season (between May and August) within the development area and a 50m buffer.	CH2M Falkirk Council	Prior to works starting
AP3	**Mammal holes**	**Further surveys** A number of large mammal holes that could be used by badger, but where no evidence was identified, are located throughout the development area. Any holes that are within 30m of works will need further survey in order to rule out the use of the holes by badgers. This should involve stick traps and camera traps for at least two weeks in the active season. If the holes are disused, they can be demolished after the survey. If the holes are used by badgers, then no works are permitted within 30m without appropriate licenses being gained from SNH.	CH2M Falkirk Council	Prior to works starting
AP4	**Otter**	**Further surveys** [Redacted] **Licence application** [Redacted]	CH2M Falkirk Council	Prior to works starting
AP5	**Badger**	**Licence application** No works are permitted within 30m of badger sett(s), without appropriate licenses being gained from SNH.	CH2M Falkirk Council	Prior to works starting

AP6	**All**	**Pollution prevention** All equipment must be washed at least 10m away from the water courses. Drip trays must be used during refuelling of mobile plant and placed under all static plant. All re-fuelling must be undertaken at least 10m from the water courses. A spill kit must be kept near to fuel and oil storage areas and any minor spills must be cleaned up as soon as possible.	CH2M Falkirk Council	During works
AP7	**All**	**Excavations** All deep holes and excavations greater than 1m deep should be covered whilst unattended so as to prevent animals falling in. Where this is not possible these areas should be fenced off to prevent accidental entry by animals. Excavations and holes less than 1m deep should be covered at night, or planks should be used, placed within these areas, in order to provide a means of escape.	CH2M Falkirk Council	During works
AP8	**All**	**Pipework** Pipework and the like, if stored in the open, should be capped during storage so as to prevent it being used by animals.	CH2M Falkirk Council	During works
AP9	**All**	**Rubbish** Construction rubbish should regularly be removed from site, and chemical containers should not be left open on site. Materials kept in the open on site should be stored within a fenced off area to prevent accessibility by animals.	CH2M Falkirk Council	During works
AP10	**Otter**	**Lighting** Any artificial/security lighting used during and after construction works should be installed in such a manner as to avoid illuminating the burn or its banks. This is to avoid deterring otters from using this stretch of the water course.	CH2M Falkirk Council	During and post works
AP11	**All**	**Encountering protected species on site** If evidence of otter, water vole or badger are discovered at any time during activities, then stop the work immediately and seek advice from Echoes Ecology Ltd and/or Scottish Natural Heritage.	CH2M Falkirk Council	During works

Section 7 - References

Chanin, P. (2003). **Ecology of the European Otter.** Conserving Natura 2000 Rivers Ecology Series No. 10. English Nature, Peterborough.

Clark, M. (1994). **Badgers.** Whittet Books, London.

Forestry Commission (1995). **Forestry Practice Guide 9 - Forest Operations and Badgers Setts.** Forestry Practice Division, Edinburgh.

Harris, S. and Yalden, D. W. (Eds). (2008), **Mammals of the British Isles: Handbook, 4th Edition.** The Mammal Society

Roper, E. (2009). **An Otter Surveyors Handbook (Draft for Peer Review).** Atkins Ecology.

Scottish Badgers (2005). **Badger Awareness Manual.** Scottish Badgers.

Scottish Natural Heritage (1997). **Badgers.** Scottish Natural Heritage, Perth.

Scottish Natural Heritage (2001). **Badgers and Development.** Scottish Natural Heritage, Perth.

Scottish Natural Heritage (2008). **Otters and Development. Scottish Wildlife Series.** Scottish Natural Heritage, Perth.

Scottish Natural Heritage (2014). **Licensing Guidance.** Scottish Natural Heritage. Accessed at http://www.snh.gov.uk/docs/A1391121.pdf on 23rd September 2014**.**

Strachan, R., Moorhouse, T. and Gelling, M. (2011). **Water Vole Conservation Handbook, 3rd edition.** The Wildlife Conservation Research Unit

Appendix I: Site Plan

Figure I.1: Current site plan

Appendix II: Otters, Badgers and Water Vole in the UK

II.1 Otters in the UK

II.1.1 The Eurasian otter (*Lutra lutra*) is found throughout the UK with an estimated 90% of the population residing in Scotland (Scottish Natural Heritage, 2008).

II.1.2 Otters are the largest members of the Mustelid family in the UK (Roper, 2009) with a full grown male otter approximately 1 metre (m) in length and weighing on average 9 kilograms (kg). The female otter is slightly smaller (Scottish Natural Heritage, 2008). A female otter is known as a bitch, a male otter is a dog and the young are referred to as cubs (Roper, 2009). In the UK otters can be roughly separated into two main groups, freshwater and coastal (Scottish Natural Heritage, 2008), although seasonal variations in prey availability can blur this divide with coastal otters moving inland to feed and vice versa.

II.1.3 Otters are largely solitary animals, with the sexes living separately. When groups of otters are observed these are likely to be family groups (mother and cubs). They are highly territorial and will frequently mark out territory boundaries and features within territories using spraints (droppings) and urine (Roper, 2009). On average a female otter territory will extend along a 20 kilometre (km) stretch of a watercourse, with a male otter holding around a 32km stretch (Scottish Natural Heritage, 2008). Territory size can be much smaller or much larger depending on habitat quality, and territories on the coast tend to be much smaller than those inland (M. Findlay, pers. comm.).

II.1.4 An otter requires three main resources: fresh water, resting places and prey (Roper, 2009), and the abundance of these resources dictates the quality and in turn the size of territory an individual otter will require. Ideally an otter's territory contains a number of different habitat types thus enabling the animal to utilise a variety of different food resources depending on the season (Roper, 2009).

II.1.5 Otters require a number of resting places within their territories and there are two types: underground holts and above ground couches (Scottish Natural Heritage, 2008). Holts may be within holes and cavities in riverbanks, amongst riparian root structures, in dense vegetation, within existing animal burrows or in caves and rocks, although otters will dig their own holts too (Roper, 2009). Natal holts, where young are born, are usually more difficult to detect due to their location in more elusive spots, often some distance from water (Chanin, 2003) and the fact that, unlike other resting places, natal holts are not generally marked using spraints. Couches may be constructed from vegetation, or may simply be a depression on the ground, such as beneath an overhanging river bank.

II.1.6 Other otter signs include footprints, paths, slides (pathways down banks into water), sign heaps (piles of loose substrate with urine or spraints deposited on top), grooming hollows and feeding remains (e.g. fish heads and bones, frog spawn) (Roper, 2009).

II.1.7 Otters are carnivorous, eating mainly fish; eels form a large part of the diet. They supplement this diet with amphibians and occasionally birds and mammals dependent on seasonal availability (Scottish Natural Heritage, 2008). Coastal otters forage close to the shore and eat bottom-dwelling fish and crustaceans (Scottish Natural Heritage, 2008).

II.1.8 Freshwater otters have no specific breeding season and may reproduce at any time of the year (Roper, 2009), while coastal otters tend to breed in the summer. A female otter can have one litter a year, normally of one to three cubs although the average is two (Scottish Natural Heritage, 2008). Cubs are born in natal holts and stay below ground for around two months. At this point females move their cubs around various breeding holts in their territory, which is thought to aid in familiarising them with the surrounding habitat. The cubs normally remain with their mother for eight months, and stay in the natal territory for upwards of one year (M. Findlay, pers. comm.).

II.2 Badgers in the UK

II.2.1 Badgers (*Meles meles*) are widely distributed throughout the UK, with a Scottish population of around 25,000 (Scottish Natural Heritage, 2001). They live in social groups known as clans. These groups are composed of a dominant male (boar) and female (sow), the current year's cubs, the previous year's cubs and often a number of subordinate adult relatives, both male and female. The average clan size is between four and six adults (Scottish Natural Heritage, 2001).

II.2.2 Badgers live in an underground system of tunnels and chambers known as a sett. Tunnels are distinguished by being wider than they are tall. Each clan uses different types of sett within its territory. These sett types vary in level of usage. There are four types of sett:

- The main sett is the most active sett in the territory and is easily recognised, having a large number of entrance holes (on average 12) that are well used, with well-worn paths leading to and from the sett and between entrance holes. Often there will be signs of recent usage, for example, freshly dug soil and bedding at the entrance to holes. Normally a clan will only have one main sett in their territory and as such they are good indicators as to the density of clans within an area.
- The annexe setts are normally within 150 metres (m) of the main sett and are connected to the main setts with well-worn paths. Normally they have around eight entrance holes.
- Subsidiary setts are at least 50m from the main sett, normally have four entrance holes and are not continuously active. For this reason there are often no obvious paths connecting these setts to other setts within the clan territory.
- Outlier setts are often found a distance from the main sett and consist of one to two entrance holes. Often these holes are taken over by rabbits and foxes. Outlier setts are more often found where clan territories are in close proximity to human developments with the associated increased levels of disturbance. These setts are used as a refuge if the badger feels threatened (Scottish Badgers, 2005).

II.2.3 Badger clans each have a territory that can vary in size from 20 to 50 hectares (ha) in rich habitat to 300ha in poorer habitats (Scottish Natural Heritage, 1997), although in lower density areas in Scotland, territory size can be around 180ha (Clark, 1994). The main factors that influence territory size are the availability of suitable sett sites and food resources.

II.2.4 Badgers use scent marking and communal latrines to define territory boundaries. Latrines are often found near the main sett and territory boundaries, normally close to linear features such as field margins, walls and fence lines. Latrines are composed of a number of shallow, uncovered holes (dung pits) filled with droppings. Urine is also an important marker (Scottish Natural Heritage, 1997).

II.2.5 Badgers are opportunistic omnivores and have a wide diet influenced by local food availability. In general, earthworms make up around 50% of their diet. The remainder of the diet consists of insects, small mammals (voles, moles, mice, young rabbits, and hedgehogs), birds and their eggs, bulbs, nuts, fruit, cereals, fungi and carrion (Clark, 1994). Snuffle holes, where the badger has dug into the ground in search of worms and tubers, are often visible in areas of foraging.

II.2.6 Badgers are predominantly nocturnal. They emerge from their setts prior to dusk from May to August and after dark during the rest of the year. They are less active from November to February and may enter a state of torpor during periods of extreme cold utilising stored fat reserves (Scottish Natural Heritage, 1997).

II.2.7 Badgers predominantly mate between February and May, and July and September, though they can mate during any month (Clark, 1994). Female badgers exhibit delayed implantation of the embryo until late December or early January. Gestation lasts six to eight weeks and cubs are normally born in February. A female has one litter a year and can produce up to six cubs, although the average is two. The young emerge from the sett around late April or early May and begin foraging with their parents. They are fully weaned at five to six months old (around June/July). Juvenile badgers will remain with the clan until around 18 months old, and may stay longer. Males are more inclined to disperse than females and this normally occurs in the autumn of the year after they were born.

II.3 Water Voles in the UK

II.3.1 Water voles (*Arvicola amphibius*) are a member of the Cricetidae family of the Order Rodentia. From the tip of the head to the base of the tail the males measure an average of 188 millimetres (mm) and weigh on average 219 grams (g). Females are slightly smaller in comparison measuring an average of 181mm and weighing 196g (Harris and Yalden, 2008). Their coat colour ranges from reddish to dark brown and is extremely dense, trapping air to aid insulation whilst in the water (Harris and Yalden, 2008).

II.3.2 Harris and Yalden (2008) describe the water vole as having gone through 'the most rapid and serious decline of any British wild mammal during the 20th century' and although widespread throughout the UK, is now found in only 6% of previous known sites (Harris and Yalden, 2008).

II.3.3 A number of reasons are given for the decline in the water vole population. Firstly, is predation by an introduced species, the American mink (*Mustela vison*). The mink, an escapee from fur farms during the 1950's and 1960's, is now widespread throughout the UK. It has been observed that where mink are present water vole populations become extinct as their re-colonisation rate is lower than the predation rate (Harris and Yalden, 2008). In contrast, levels of predation by other mammals including otter, stoat and fox, and avian predators do not have a negative effect on population size. Other reasons for population decline include habitat loss and degradation (Strachan *et al*., 2011) and the indirect persecution through rat poisoning within urban areas (Harris and Yalden, 2008).

II.3.4 Water voles live in colonies, though each member of a colony will inhabit distinct territories. Females in particular are highly territorial, only sharing their territory with non-breeding female off-spring. Males will share their territory with other males and have home ranges that overlap with a number of female territories (Strachan *et al*., 2011).

II.3.5 In the UK water voles tend to inhabit linear habitat (e.g. rivers, streams), and territory size is normally measured in length (Strachan *et al*., 2011). They are generally found in habitat that has dense vegetation both in the watercourse and on the bank as this provides food and shelter (Strachan *et al*., 2011). They prefer slow moving watercourses, over a metre in depth, with banks containing a soft substrate to enable easy burrowing (Strachan *et al*., 2011).

II.3.6 Water voles are predominantly herbivorous, eating the stems and leaves of riparian vegetation. They will supplement their diet with small molluscs and crayfish, especially pregnant females (Strachan *et al*., 2011). A sign of water vole activity is feeding stations along runways. Within these areas neat piles of vegetation cut at a 45 degree angle are found (Harris and Yalden, 2008).

II.3.7 Water voles inhabit residential burrows, nest chambers, bolt holes and food storage chambers all connected by a network of tunnels. Nest chambers occur at various heights within steep areas of bank including under the waterline, and are lined with grass. They are also known to weave nests at the base of sedges and reeds in areas when the water table is high (Strachan *et al*., 2011).

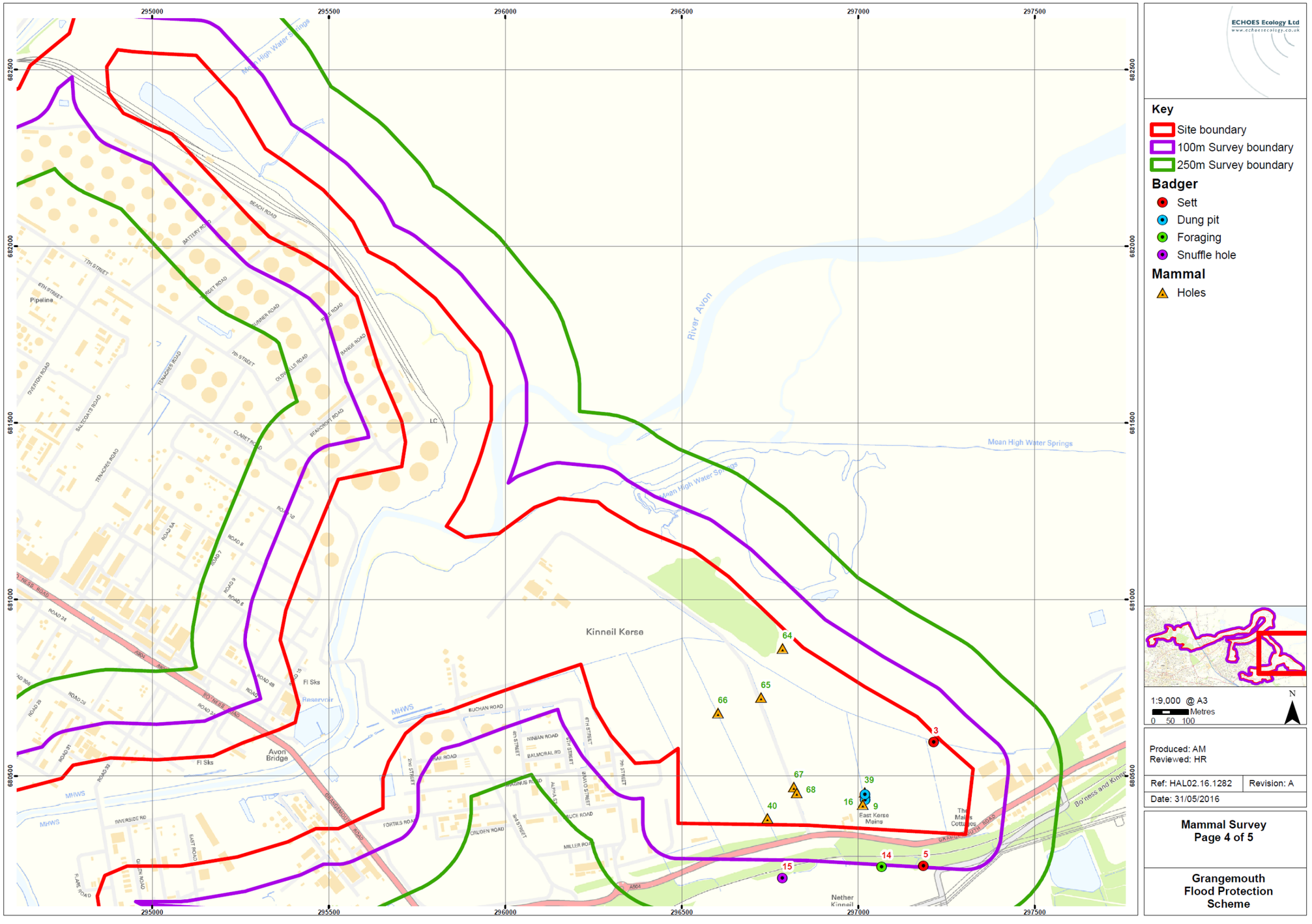
II.3.8 Water vole territory size is influenced by the availability of food resources. Males tend to have larger range sizes, overlapping with a number of female territories. Both males and females scent mark at latrines to demarcate territories (Harris and Yalden, 2008).

II.3.9 The water vole breeding season is March to October. During this time demarcation of territories by females using latrines is more pronounced (Strachan *et al*., 2011). Gestation lasts 20 to 30 days and females are polyoestrous with the ability to produce up to five litters a year, although the average is three. Litter size can range from one to six young. Young are weaned at around 22 days and leave the nest when mother has her next litter (Harris and Yalden, 2008). Most offspring move away from the maternal territory by the autumn of the year of their birth (Harris and Yalden, 2008).

Appendix III: Mammal Survey Map

[Redacted]

Figure III.4 - Mammal survey map, page 4



Appendix IV: Photographs

Figure IV.1 - Outlier sett (No. 1, Table 4.1)

Figure IV.2 - Main sett (No. 2, Table 4.1)

Figure IV.3 - Outlier sett (No. 3, Table 4.1)

Figure IV.4 - Outlier sett (No. 4, Table 4.1)

Figure IV.5 - Main sett (No. 5, Table 4.1)

[Redacted]

[Redacted]

[Redacted]

GRANGEMOUTH FLOOD ALLEVIATION SCHEME

Ornithology Survey Report 2015-2017

Prepared by:	Rafe Dewar
Authorised by:	Prof Bob Furness
Date:	22nd August 2017
Tel:	0141 342 5404
Email:	rafe.dewar@macarthurgreen.com
Web:	www.macarthurgreen.com
Address:	95 South Woodside Road | Glasgow | G20 6NT

Document Quality Record.

Version	Status	Person Responsible	Date
1	Draft	Rafe Dewar	18/08/2017
2	Reviewed	Prof Bob Furness	19/08/2017
3	Updated	Rafe Dewar	22/08/2017
4	Internal Approval		
5	Final Revision		

CH2M and MacArthur Green have prepared this report in accordance with the scope and instructions of Falkirk Council, our client, for their sole and specific use. Any other persons or organisations who use any information contained herein do so at their own risk.

CONTENTS

LIST OF TABLES

EXECUTIVE SUMMARY

Falkirk Council is developing flood risk management measures for the Grangemouth area. Works as part of the Grangemouth Flood Protection Scheme (FPS) are likely to be carried out on the shoreline of the Forth Estuary, within the tidal reaches of the River Carron, Grange Burn and River Avon, and upstream reaches. It is anticipated that an Environmental Impact Assessment (EIA) will be required, and that the Competent Authority will be required to complete a Habitats Regulations Appraisal (HRA) due to the proximity of the schemes to the Firth of Forth Special Protection Area (SPA).

Falkirk Council engaged Halcrow Group Ltd (part of the CH2M family of companies) to provide the engineering and environmental related services for the development of the FPS. They commissioned a series of ornithology surveys of the Forth Estuary between Dunmore and Blackness which were carried out from August 2015 to April 2017, for the purposes of assessing the potential effects of the proposed Grangemouth FPS on ornithological receptors in the area. The aims of the surveys, carried out by MacArthur Green, were to observe and record the following:

- Abundance and spatial distribution of target species at different stages of the tidal cycle;
- Temporal distribution and abundance of target species between years, seasons, months, and time of day;
- Behaviour of birds at different stages of the tidal cycle (e.g. feeding, roosting);
- Baseline human activity levels and types of activity within the survey area;
- Any evidence of anthropogenic or other disturbance within the survey area, and reactions of birds to such disturbance; and
- Breeding bird distribution and abundance (to be reported separately).

This report provides a summary of the work undertaken and results obtained from the two non-breeding seasons (2015-16 and 2016-17), and 2016 breeding season.

A total of 87 target species were recorded during the survey period. Of these, 25 are SPA qualifying interests (out of a total of 27 SPA qualifying interests). Species recorded, and reference populations within the context of the Firth of Forth, are shown in Table 3-1.

Monthly peak counts for each target species are presented for each of the 16 sectors surveyed between Dunmore and Blackness Castle. Potentially important counts at an SPA, estuary and national level have been highlighted, and a discussion provided for each sector's bird assemblage, focussing on key populations and distribution, particularly those at high tide.

Seven species were recorded in numbers within a particular sector reaching importance within a national context: shelduck, dunlin, redshank, bar-tailed godwit, black-tailed godwit, greenshank and red-breasted merganser. Additionally, other species such as curlew, lapwing, pink-footed goose and Sandwich tern were recorded within sectors in populations significant within an SPA context, and further non-SPA species were also found in numbers of estuary level importance.

Distribution of species was relatively consistent between years. Largest numbers of roosting waders were recorded between December and March, with particularly high numbers in January 2017 in Sectors 9 to 11. The key roost sites identified within the survey area appear to be in the vicinity of Grangemouth Port and Petrochemical works (Sectors 6-11) where despite there being high levels of background noise and activities, access to the foreshore is limited, disturbance is infrequent, and man-made and natural structures are suitable for high tide roost locations. Particularly important roost locations identified are:

- Adjacent to the downstream side of the Kincardine Bridge in Sector 3;
- The breakwater adjacent to Grangemouth Port in Sector 6;
- The sheltered bay adjacent to Grangemouth Petrochemical works in Sector 9;
- Mudflats and creeks at the mouth of the River Avon (Sector 10);
- The lagoon at Kinneil (Sector 11); and
- The sheltered bay adjacent to Kinneil Island (Sector 12).

Large areas of mudflats exist adjacent at Skinflats and Kinneil which are also used by large numbers of birds for roosting and feeding at certain parts of the tidal cycle. Any incursions relating to the FPS works close to the foreshore at higher tides in these areas are likely to result in disturbance to numbers of birds that are important at an SPA/ estuary level.

Upstream, in Sectors 1-5, numbers of birds are generally lower, despite infrequent human activity. Roosting locations are more limited and the extent of mudflat is smaller, although inland fields provide roost and feeding opportunities for species such as pink-footed goose, curlew and lapwing. Because of low levels of baseline activity, it was observable that a greater proportion of human activities in these Sectors result in disturbance to birds present, particularly when close to the shore at high tide.

Downstream between Bo'ness and Blackness Castle human activity is frequent and likely to have already influenced bird distribution and behaviour. Birds are present in smaller numbers than further upstream (although gulls and ducks that roost further offshore can be numerous), but are potentially more tolerant of human activities. Disturbance events were still observable when birds were forced closer to the coastal path towards high tide. Coastal works are therefore likely to prevent high tide usage in local areas.

Small numbers of SPA species were recorded through the breeding season across the survey area. In a number of cases, birds present were non-breeders, with the Firth of Forth being outside of the breeding range of such species (e.g. godwits, dunlin). In other examples (e.g. curlew, lapwing, redshank, shelduck), a mixture of non-breeders and a small number of breeding birds may have been present, with breeding habitat within the survey area limited. The larger mudflats appear to be favoured by birds during the breeding season.

1 INTRODUCTION

1.1 Purpose

Falkirk Council is developing flood risk management measures for the Grangemouth area. Works as part of the Grangemouth Flood Protection Scheme (FPS) are likely to be carried out on the shoreline of the Forth Estuary, within the tidal reaches of the River Carron, Grange Burn and River Avon, and upstream.

It is anticipated that an Environmental Impact Assessment (EIA) will be required, and that the Competent Authority will be required to complete a Habitats Regulations Appraisal (HRA) due to the proximity of the schemes to the Firth of Forth Special Protection Area (SPA).

The FPS is currently going through an appraisal of options, with the selection of a preferred solution and submission of the EIA Scoping Report anticipated by late 2017/early 2018. The options currently under consideration include direct defences (flood walls and embankments), upstream flood storage areas, property level protection and a tidal barrier in the Grange Burn.

A detailed consideration of option selection will be necessary, to establish the likely mitigation required and implications for the HRA (SPA / Ramsar) and Conservation Act (Site of Special Scientific Interest, SSSI) consenting processes, with the aim to avoid likely significant effects upon the sites or the qualifying features thereof and adverse effects on their integrity.

Submission of the application for consent is planned for summer 2019, with construction starting 2021, taking 5-10 years to complete.

Falkirk Council engaged Halcrow Group Ltd (part of the CH2M family of companies) to provide the engineering and environmental related services for the development of the FPS. They commissioned a series of ornithology surveys of the Forth Estuary between Dunmore and Blackness (Figure 1) which began in August 2015 (carried out by MacArthur Green), for the purposes of assessing the potential effects of the proposed Grangemouth FPS on ornithological receptors in the area. Falkirk Council requested that the study area was expanded to include a wider area than the immediate surrounds of the Grangemouth Flood Alleviation Scheme due to other potential flood risk management activities or developments in the estuary. Much of the required survey area forms part of the Firth of Forth SPA, Ramsar site and Site of Special Scientific Interest (SSSI) which supports a variety of species' populations of European importance during the migratory and winter periods.

This report provides a summary of the bird survey work undertaken from August 2015 to April 2017, and associated results. It follows on from the interim report on survey work carried out during winter 2015-16, published by MacArthur Green in September 2016[1].

1.2 Aims of Surveys

The proximity of the schemes to the Firth of Forth SPA means they have the potential to have a significant impact on the qualifying features of the SPA (and SSSI and Ramsar site), as well as other

[1] MacArthur Green (2016). Grangemouth Flood Alleviation Scheme: Ornithology Survey Report: Winter 2015-16.

"target species", which for the purposes of this study, are considered to be the same wetland/estuarine species that are included in the British Trust for Ornithology's (BTO) Wetland Birds Survey (WeBS) annual reports[2]. Also included are raptor species that may cause disturbance and influence the distribution and abundance of other target species.

The data collected during the survey programme will be used to inform an EIA and HRA. The aims of the surveys are to observe and record the following:

- Abundance and spatial distribution of target species at different stages of the tidal cycle;
- Temporal distribution and abundance of target species between years, seasons, months, and time of day;
- Behaviour of birds at different stages of the tidal cycle (e.g. feeding, roosting);
- Baseline human activity levels and types of activity within the survey area;
- Any evidence of anthropogenic or other disturbance within the survey area, and reactions of birds to such disturbance; and
- Breeding bird distribution and abundance.

The data collected will be used to establish the potential significance of effects on SPA qualifying interests and other species, as well as inform decisions about the timing, nature and extent of construction activities, including any mitigation measures that may be required. This report provides a summary of results from the surveys, and does not make any assessment of potential impacts at this preliminary stage.

1.3 Firth of Forth SPA, Ramsar and SSSI

The Firth of Forth SPA is a complex of estuarine and coastal habitats stretching from Alloa in the west to the coasts of Fife and East Lothian in the east. The site includes extensive areas of invertebrate-rich intertidal mudflats, rocky shores, saltmarsh, lagoons and sand dunes.

The qualifying features of the SPA are listed below.

Wintering populations (1993/94-97/98 winter peak means) of Habitats Directive Annex 1 species:

- Red-throated diver;
- Slavonian grebe;
- Golden plover; and,
- Bar-tailed godwit.

Wintering populations of migratory species:

- Pink-footed goose;
- Shelduck;

[2] https://www.bto.org/volunteer-surveys/webs/publications/webs-annual-report

- Knot;
- Redshank; and,
- Turnstone.

A passage population of:

- Sandwich tern.

A wintering waterfowl assemblage (1992/93-96/97 winter peak mean of 95,000 waterfowl) of European importance including:

- Great crested grebe;
- Cormorant;
- Scaup;
- Eider;
- Long-tailed duck;
- Common scoter;
- Velvet scoter;
- Goldeneye;
- Red-breasted merganser;
- Oystercatcher;
- Ringed plover;
- Grey plover;
- Dunlin;
- Curlew;
- Wigeon;
- Mallard; and,
- Lapwing.

In addition to the above list, the overlapping Firth of Forth Site of Special Scientific Interest (SSSI) lists breeding eider, ringed plover and shelduck as notified interests.

The Firth of Forth Ramsar site citation lists pink-footed goose, shelduck, redshank, turnstone, Slavonian grebe, goldeneye, knot and bar-tailed godwit as qualifying species.

2 METHODOLOGY

Detailed survey methodology was previously presented in the *Grangemouth Flood Alleviation Scheme: Ornithology Survey Desk Study and Proposed Scope* report, prepared by MacArthur Green and CH2M in April 2015, and agreed with SNH.

2.1 Survey Area

To achieve the survey aims detailed above, a series of surveys of target species has been carried out at specified locations covering:

- The upper shore and intertidal area of the Firth of Forth SPA between Dunmore and Blackness;
- The tidal ranges of the Carron and Avon Rivers and the Grange Burn (where access allows);
- Any suitable terrestrial habitat adjacent to the SPA between Dunmore and Blackness which may at times be used by estuarine birds; and
- The estuary and intertidal/foreshore between Bo'ness harbour and Carriden which, whilst not part of the SPA or SSSI, comprises part of the available habitat for the SPA qualifying species in the area.

The survey area extent is shown in Figure 1. A total of 16 vantage points have been used, each covering a "sector". This sectorial approach is similar to that used for WeBS core count and low-tide count schemes within the Forth Estuary, but provides a more detailed overview by plotting distribution of birds within each sector. The survey area overlaps with six of these existing WeBS core count sectors, and around 12 of the WeBS low-tide count sectors.

2.2 Survey Methodology

2.2.1 Wintering and migration surveys

The surveys involve a programme of monthly counts from 16 individual sectors within the study area. The foreshore and adjacent inland area are checked for birds, for the purposes of:

- estimating flock sizes (for obtaining peak counts within each sector);
- assessing behaviour (e.g. whether birds use the site for feeding and/or roosting);
- obtaining information on local distribution of birds through the tidal cycle;
- recording baseline human activity levels; and
- recording any disturbance events, either human or otherwise (e.g. raptors).

It is anticipated that the impacts of the proposed development are generally likely to be limited to birds that utilise the upper shore, since there will be no loss of lower shore habitat. The distance between upper shore and lower shore, particularly at low tide, also means that disturbance impacts are unlikely on birds on the lower shore.

The primary focus of the surveys is to record presence and activity of SPA species, although non-SPA species of conservation concern are also recorded, unless the level of activity prevents the surveyor from accurately recording SPA species. If so, this is noted by the surveyor.

It is not necessary to conduct all surveys simultaneously on a pre-designated date, as is the case for the WeBS core count scheme[3], on which the methods for these surveys were based. Instead, similar to the WeBS low-tide count scheme, the main purpose of the surveys is to investigate local distribution and abundance, and not necessarily to determine overall population sizes within the whole survey area. An example provided in the WeBS low-tide count methodology is that if a sector is important for birds at low water, it does not matter if a flock of dunlin recorded there was also recorded elsewhere - the outcome is that it is established that both areas are important.

Each survey lasts for six hours, enabling a range of tidal states to be surveyed. Emphasis has been placed on covering the period around high tide, in order to establish roost (or feeding) distribution closest to the shoreline, when birds may be at their most sensitive to disturbance.

- The survey effectively comprises six independent hourly counts. The observer surveys from a predefined vantage point, recording the location and abundance of target species utilising the upper shore, intertidal and adjacent inland habitat. Notes are made on survey sheets of species, flock size, behaviour (feeding, roosting, loafing or movements), time recorded, time birds left sector (if applicable) and any other relevant information.
- The location of individual birds or flocks is recorded on field maps to provide accurate distribution. Flock ID on the map can be cross-referenced with an associated record in the survey sheets. Three distribution maps are used for each survey: one at high tide, and two spaced evenly throughout the remainder of the survey.
- Generally, birds that fly through the sector and do utilise the area are not recorded, as they will not be subject to disturbance pressures or habitat loss. However, species such as Sandwich tern which do not tend to land, but may forage within the Sector are recorded when in flight.
- Any disturbance displacement distances and directions are noted, and (where apparent) possible return times once disturbance has ceased.
- Baseline activity levels, by humans, traffic, boats or other sources such as raptors are also recorded using a combination of spot counts and total activity tallies.
- In some sectors it was considered to be beneficial to move a short distance from vantage points during the survey so that obscured areas within the sector can be viewed, only if it can be ensured that such movements do not cause disturbance to birds within the sector.
- Weather conditions (wind speed using the Beaufort scale, cloud cover estimated as eighths or oktas of the sky, visibility and temperature) are recorded. Weather conditions can affect the ease of carrying out any bird monitoring, and conditions of fog, rain or strong winds can

[3] https://www.bto.org/volunteer-surveys/webs/taking-part/core-counts-methods

make the counting of birds on distant mudflats particularly difficult. Such adverse conditions are therefore avoided wherever possible.

- During surveys, surveyors should behave as inconspicuously as possible to minimise disturbance, for example by not breaking the horizon.
- If a flock leaves the sector between counts, the time of this event is noted in the appropriate column.
- If a flock arrives and leaves the sector between hourly counts, it should still be included in the appropriate hourly count.

Examples of survey sheets are shown in Appendix 1.

2.2.2 Breeding season surveys

Surveys during the breeding season (May to July 2016) involved a combination of walkovers and short vantage point surveys along the upper shore and suitable inland habitat[4], within each sector. The aim of the surveys was to record any breeding evidence of target species (primarily SPA or SSSI qualifying interests). Non-breeding target species were also recorded during each survey.

2.3 Survey Programme

Survey effort (hours per sector per month) is shown in Table 2-1 and Table 2-2. Hours lost to poor visibility have been excluded from survey effort.

Table 2-1 Grangemouth survey effort – August 2015 to April 2016.

Sector	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	TOTAL
1	6	6	6	6	6	6	6	6	6	54
2	6	6	6	6	6	6	6	5	6	53
3	6	6	6	6	6	6	6	6	6	54
4	6	6	6	6	6	6	6	6	6	54
5	6	6	6	6	6	6	6	6	6	54
6	6	6	6	6	6	6	6	12	0	48
7	6	6	6	6	6	6	6	6	6	54
8	6	6	6	6	6	6	6	6	6	54
9	6	6	6	6	6	6	6	6	6	54
10	6	6	3.5	6	6	6	6	12	0	51.5
11	6	6	5	6	6	6	6	6	6	53
12	6	6	6	6	6	6	6	0	6	48
13	6	6	6	6	6	6	6	6	6	54
14	6	6	6	5.5	6	6	6	6	6	53.5
15	6	6	6	5.5	6	6	6	6	6	53.5
16	6	6	6	5.5	6	6	6	6	6	53.5

[4] The definition of "suitable inland habitat" for this purpose is flexible and dependent on site-specific characteristics, but in general can be considered to be habitat potentially utilised by SPA species, within approximately 250m of the shoreline. In practice this buffer distance is not fixed and may be more, or less, depending on habitat type, visibility and access at a particular location.

Table 2-2 Grangemouth survey effort – August 2016 to April 2017.

Sector	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	TOTAL
1	6	6	6	6	6	6	6	6	6	54
2	6	6	6	6	6	6	6	6	6	54
3	6	6	6	6	6	6	6	6	6	54
4	6	6	6	6	6	6	6	6	6	54
5	6	6	6	6	6	6	6	6	6	54
6	6	6	6	6	6	6	6	12	0	54
7	6	6	6	6	6	6	6	6	6	54
8	6	6	6	6	6	6	6	6	6	54
9	6	6	6	6	6	6	6	6	6	54
10	6	6	6	6	6	6	6	6	6	54
11	6	6	6	6	6	6	6	6	6	54
12	6	6	6	6	6	6	6	6	6	54
13	6	6	6	6	6	6	6	6	6	54
14	6	6	6	6	6	6	6	6	6	54
15	6	6	6	6	6	6	6	6	6	54
16	6	6	6	6	6	6	6	6	6	54

Table 2-3 Grangemouth survey effort – May to Jul 2016.

Visit	Month	Dates
1	May	19-21
2	June	17,18,20
3	July	21-22

2.4 Survey Limitations

2.4.1 Survey Gaps

Because of the complex nature of the estuarine habitat to be surveyed, and the human activities along the shoreline and access restrictions, coverage is less than 100% across the survey area. The following bullet points list the gaps in coverage and explain the reasons behind such omissions (refer to Figure 1 for survey sector coverage).

- Sector 5: some inland pools are not observable from one static vantage point covering the River Carron and immediate inland area. These pools have however been covered during surveys. Most birds that fly to and from these pools and the shore are observable by surveyors from the vantage point.
- Sector 6: the northwest part of Grangemouth docks is inaccessible for security reasons, as it forms part of the BP oil terminal. Although not observable from the vantage point within sector 6, it is viewable, albeit from a distance from sector 4.
- Sector 7: the northernmost part of Grangemouth port is only partially viewable due to no access at the BP oil terminal.

- Sector 9: Accessibility from the INEOS refinery at Grangemouth is very limited at a perimeter fence gate, and there is no access to the area of reclaimed land to the north.
- Between Sectors 11 and 12: there is a small inlet in a wooded area where no extensive vantage point coverage is possible. High tide roost habitat is limited here but the area is walked prior to and after surveys of sectors 11 and 12.
- Between Sectors 12 and 13: follows the John Muir Coastal Path – the sector is gently curved with woodland to path edge, making a suitable vantage point difficult to locate. High tide roost habitat is very limited. It is walked prior to and after survey of sectors 12 and 13.
- Between Sectors 13 and 14: follows the John Muir Coastal Path – sector is gently curved with industrial buildings inland. No suitable vantage point exists. High tide roost habitat is very limited. It is walked prior to and after survey of sectors 13 and 14.
- Between Sectors 14 and 15: gently curved sector within woodland – no suitable vantage point, but habitat suggests high tide roost habitat is very limited. It is walked prior to and after survey of sectors 14 and 15.

Overall, these constraints were minor, and we consider that they had very little impact on the collection of survey data. Therefore, the data are considered to be fully representative of the situation throughout the study area as a whole.

2.4.2 Survey Effort

Where possible, surveys comprised a standard length six hour survey, to cover most phases of the tidal cycle. In a small number of cases during the first winter period (see Table 2-1) valid survey hours were less due to periods of poor visibility. Despite the loss of some survey time, at least four hourly counts were made during each survey in 2015-16, and so overall results are unlikely to be significantly affected by the reduction due to adverse weather conditions, particularly as full survey coverage was achieved in 2016-17.

No survey was conducted in Sector 12 in March 2016. Whilst it is unlikely that this will influence results, survey results in March 2017 have provide increased confidence of results obtained for this sector.

2.4.3 Changes in Recording Style

The methodology employed at the start of the survey programme was agreed with SNH prior to commencement. A review of the suitability and ease of recording took place in October 2015, and some refinements to recording style were made, commencing November 2015 (methods of survey, and human activity level recording remained unchanged). Results obtained from August to October 2015 were subsequently converted into the format of the updated style, to allow consistency of analysis. Thus the change in survey style does not pose a limitation to analysis or assessment.

The key changes were:

- Instead of constant counts and recording of movements and behaviours through the six hour survey period, a series of six separate hourly counts are made to estimate total numbers per species within the sector at different tidal states.
- Three separate distribution maps are produced per six hour survey, instead of one map that is continuously added to. One of these distribution maps is completed at high tide, and the other two are spread through the remainder of the survey to cover different tidal states. The information in each map (e.g. Flock ID #, species) corresponds with the associated hourly count information, e.g. if a map is produced in hour 4, then it ties-in with the records for count 4.
- Movements of birds within sectors are no longer recorded, but instead should be picked up by the three distribution maps. The exceptions to this are when flocks leave/enter the sector, where it is important to know directionality. Birds' reactions to any disturbance event continue to be noted throughout the six hour period, whether they remain within the sector or leave the sector.

For the second winter period from August 2016 onwards, an electronic GIS mobile data capture system (on a tablet) was used by each surveyor to record information on birds, background activity, disturbance and weather, using forms and maps with similar content to paper versions used previously. Surveyors were able to plot bird distribution via a series of points on an hourly basis using this technology (i.e. six hourly counts with six distribution maps).

2.4.4 Breeding Bird Surveys

During the breeding season, no surveys were undertaken within Sector 9 (Grangemouth refinery). Access is very limited at a perimeter fence gate, and there is no access to the area of reclaimed land to the north. Visibility is also limited during summer months because of the high *Phragmites* reeds in front of the access point, so that surveys during the breeding season were impractical.

2.5 Analysis Methodology

The methods of analysis have been designed to highlight particular locations within the survey area which host important numbers of target species within the context of the SPA and Firth of Forth as a whole, and where birds may be sensitive to disturbance, for example because of high tide roosts or because background levels of human activity are currently low. The following information is provided:

1. **Species present:** a list of all species recorded during surveys, their conservation status, wider reference populations and whether a WeBS alert exists due to a decline in numbers. The BTO WeBS Alerts system provides a method of identifying changes in numbers of waterbirds at a variety of spatial and temporal scales. Species that have undergone major changes in numbers are flagged, by the issuing of an Alert.
2. **Monthly sector peak counts** for each species, equating to the total abundance at any point during an hourly count over the six hour monthly survey period. This may involve the summation of counts of more than one flock, as long as the flock ID number is not referenced more than once within the hour (i.e. to avoid double counting).

3. **Important sector peak counts** have been highlighted in Sector summary tables when they exceed the following criteria:
    a. >10% of its associated cited SPA population (highlighted green in Sector tables);
    b. >10% of its associated 5 year mean for the Firth of Forth WeBS core counts (highlighted blue);
    c. 10% of its associated cited SPA population and 5 year mean for the Firth of Forth WeBS core counts (highlighted orange);
    d. Over the threshold for national importance (GB population) in the WeBS core counts report (highlighted red).
4. **Distribution of SPA species within the survey area.** Figures show spatial distribution of birds of each SPA species and whether birds are using the sector for roosting, feeding or loafing. The relative flock size of each species is represented by appropriately sized dots on the figure.
5. **Distribution of high tide roosts for SPA species**. Figures show distribution of roosting SPA species at high tide. The relative flock size of each species is represented by appropriately sized dots on the figure.
6. **Background human activity levels**. To assess the risk of disturbance, the relative levels of current human background activity were quantified, to identify potentially sensitive areas, and where areas of ongoing disturbance may already exist.

    The overall human activity level was represented by an index that is a simple average of those produced per survey, corrected for sector length (e.g. X events[5] per hour per km).

7. **Disturbance events:** any human, or other (e.g. raptor presence) activity that elicits a response from birds (increased vigilance, calling, movement along the shore, or taking flight) is noted by the surveyor, and source and reactions described. These are summarised qualitatively.

3 RESULTS

3.1 Wintering and Migration Surveys: Species Present

A total of 87 target species were recorded during the wintering and migration surveys. Of these, 25 are SPA qualifying interests (out of a total of 27 SPA qualifying interests, with long-tailed duck and velvet scoter absent). Seven species were recorded in numbers within a particular sector reaching importance within a national context: shelduck, dunlin, redshank, bar-tailed godwit, black-tailed godwit, greenshank and red-breasted merganser. Species and their reference populations within the context of the Firth of Forth are shown in Table 3-1.

For the Firth of Forth SPA (surveyed in 2009/10), WeBS Alerts were triggered for 17 out of the 26 species assessed[6]. Declines of between 25% and 50% trigger Medium Alerts (amber) and declines of

[5] Events are for example, a single person, a group of people or a vehicle appearing within the Sector.

greater than 50% trigger High Alerts (red). For three of the species recorded during surveys (goldeneye, red-breasted merganser and golden plover), comparison of site trends with broad scale trends suggests that the declines underpinning Alerts status may be driven by site-specific pressures, rather than broader population patterns.

[6] http://app.bto.org/webs-reporting/?tab=alerts

Table 3-1 Target species recorded during wintering and migration surveys

Species	SPA Qualifying Interest	WeBS Core Count GB Threshold	Cited SPA population (individuals)	Forth Estuary Complex WeBS core count[7]		2009/10 WeBS Alert (SPA) and period of concern
				5 year average	Month of peak count	
Arctic skua		-	-	-	-	-
Arctic tern		-	-	19	Sep	-
Barnacle goose		580	-	301	Oct	-
Barn owl		-	-	-	-	-
Bar-tailed godwit	✓	380	1,974	1,341	Jan	ST, MT, MC
Black-headed gull		22,000	-	3,412	Sep	-
Black-tailed godwit		430	-	636	Oct	-
Black-throated diver		6	-	4	Apr	-
Brent goose		-		10	Sep	-
Buzzard		-	-	-	-	-
Canada goose		-	-	300	Aug	-
Common gull		7,000		941	Oct	-
Common sandpiper		1	-	16	Jul	-
Common scoter	✓	1,000	2,880	2,130	Apr	ST, MT, SC
Common tern		-	-	543	May	-
Coot		1,800	-	15	Feb	-
Cormorant	✓	350	682	496	Sep	MT (ST, LT, SC medium)
Curlew	✓	1,400	1,928	3,132	Feb	-
Curlew sandpiper		-	-	6	Sep	-
Dunlin	✓	3,500	9,514	5,302	Dec	MT, SC (ST, medium)

[7] Frost, T.M., Austin, G.E., Calbrade, N.A., Holt, C.A., Mellan, H.J., Hearn, R.D., Stroud, D.A., Wotton, S.R. and Balmer, D.E. 2016. Waterbirds in the UK 2014/15: The Wetland Bird Survey. BTO/RSPB/JNCC. Thetford. http://www.bto.org/volunteer-surveys/webs/publications/webs-annual-report

Species	SPA Qualifying Interest	WeBS Core Count GB Threshold	Cited SPA population (individuals)	Forth Estuary Complex WeBS core count[7]		2009/10 WeBS Alert (SPA) and period of concern
				5 year average	Month of peak count	
Eider	✓	550	9,400	4,787	Jan	MT, SC
Feral/hybrid goose		-	-	-	-	
Fulmar		-	-	-	-	
Gadwall		250	-	12	Mar	-
Gannet		-	-	-	-	-
Glaucous gull		-	-	-	-	-
Golden plover	✓	4,000	2,949	1,419	Oct	ST,MT,SC
Goldeneye	✓	200	3,004	1,794	Jan	MT, LT, SC
Goosander		120	-	200	Aug	-
Great black-backed gull		760	-	414	Oct	-
Great crested grebe	✓	190	720	87	Sep	ST,MT,LT,SC
Green sandpiper		9	-	1	-	-
Greenshank		6	-	47	Dec	-
Green-winged teal		4	-	1	-	-
Grey heron		610	-	86	Oct	-
Grey plover	✓	430	724	278	Feb	MT, SC (ST, medium)
Greylag goose		850	-	1,993	Sep	-
Herring gull		7,300	-	2,820	Jan	-
Kestrel		-	-	-	-	-
Kingfisher		-	-	2	Nov	-
Kittiwake		-	-	127	May	-
Knot	✓	3,200	9,258	4,405	Jan	MT, SC (ST, LT medium)
Lapwing	✓	6,200	4,148	2,711	Oct	MT, SC (ST, medium)
Lesser black-backed gull		1,200	-	490	Aug	-
Little auk		-	-	-	-	-

Species	SPA Qualifying Interest	WeBS Core Count GB Threshold	Cited SPA population (individuals)	Forth Estuary Complex WeBS core count[7]		2009/10 WeBS Alert (SPA) and period of concern
				5 year average	Month of peak count	
Little egret		45	-	5	Feb	-
Little grebe		160	-	18	Jan	-
Little gull		-	-	11	Aug	-
Little stint		1	-	1	Aug	-
Mallard	✓	6,800	2,564	1,397	Dec	MT,LT,SC
Marsh harrier		-	-	-	-	-
Mediterranean gull		18	-	1	Oct	-
Merlin		-	-	-	-	-
Moorhen		3,200	-	23	Nov	-
Mute swan		740	-	200	Jul	-
Oystercatcher	✓	3,200	7,846	6,425	Nov	-
Peregrine		-	-	-	-	-
Pink-footed goose	✓	3,600	10,852	17,204	Oct	-
Pintail		290	-	111	Jan	-
Pochard		380	-	3	Jan	-
Purple sandpiper		130	-	118	Nov	-
Razorbill		-	-	-	-	-
Red-breasted merganser	✓	84	670	299	Dec	MT, LT, SC (ST amber)
Red-necked grebe		1	-	6	Aug	-
Redshank	✓	1,200	4,341	3,816	Oct	-
Red-throated diver	✓	170	90	53	Oct	-
Ringed plover	✓	340	328	503	Dec	-
Rock pipit		-	-	-	-	-
Ruff		8	-	14	Aug	-
Sanderling		160	-	353	Mar	-
Sandwich tern	✓	-	1,617	1,254	Aug	-

Species	SPA Qualifying Interest	WeBS Core Count GB Threshold	Cited SPA population (individuals)	Forth Estuary Complex WeBS core count[7]		2009/10 WeBS Alert (SPA) and period of concern
				5 year average	Month of peak count	
Scaup	✓	52	437	13	Oct	MT, LT (SC amber)
Shag		1,100	-	395	Oct	-
Shelduck	✓	610	4,509	3,577	Oct	-
Short-eared owl		-	-	-	-	-
Shoveler		180	-	8	Jan	-
Slavonian grebe	✓	11	84	36	Mar	-
Snipe		10,000		92	Oct	-
Sparrowhawk		-	-	-	-	-
Spotted redshank		1	-	1	Dec	-
Teal		2,100	-	3,077	Dec	-
Tufted duck		1,100	-	26	Mar	-
Turnstone	✓	480	860	694	Nov	-
Water rail		-	-	2	Feb	-
Whimbrel		1	-	26	Jul	-
Whooper swan		110	-	34	Nov	-
Wigeon	✓	4,400	2,139	1,905	Jan	ST, SC
Wood sandpiper		-	-	1	-	-

WeBS Alerts: ST: short-term (5 years) MT: medium-term (10 years) LT: long-term (up to 25 years) AT: all-time SC: since classification.

3.2 Monthly Sector Peak Counts

3.2.1 Sector 1: Dunmore

The monthly peak counts for each species recorded within Sector 1 are shown in Table 3-2. The top line for each species (pink) represents the peak counts during the 2015-16 period, and the second line (white) represents the 2016-17 period. Highlighted are counts that are seen to represent aggregations of potential importance within a regional (in this case the Forth Estuary) or national (based on WeBS GB threshold populations of importance) context (see Table 3-1 for reference values[8]). The key for this, and all other subsequent sector tables is:

	>10% of WeBS 5-year mean peak count but not achieving any of the other criteria
	>10% of cited SPA population but not >10% of WeBS count and not of national importance
	>10% of WeBS count and cited SPA population
	Above WeBS GB threshold population for national importance

Table 3-2. Sector 1 species monthly peak counts, 2015/16 and 2016/17

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Barnacle goose			20			46			
Bar-tailed godwit			1	1		1	17		
	1								
Black-headed gull	170	300	230	200		1			
	116		89	54	33	9	12	4	
Black-tailed godwit				1			210	17	
		4		20		6	65	23	2
Black-throated diver						1			
Buzzard	1								
Canada goose		345	120						
Common gull	2		50	15					7
						5	11		
Common sandpiper	1								
	2								
Common tern	17								
	2								
Cormorant	11	1	10	24					
	2		4	4	5	1	4	7	2
Curlew	105	4	70	140	270	240	188	108	1
	34	168		3	93	8	36	44	3
Dunlin	26				25		16		
		2							

[8] Note that values exceeding thresholds have only been highlighted where 5 year average for Forth Estuary WeBS count, or Firth of Forth SPA citation population is greater than 10 birds, or where WeBS Core Count GB threshold is greater than one bird.

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Gannet			1			1			
Goldeneye						35			
					1				
Golden plover			1	2					
Great black-backed gull			5	3					
	2		1			2		2	
Greenshank				1					
Grey heron	15	5	10	10					3
	6	30	1	9	8	16	3	2	
Grey plover			8						
Greylag goose		370	60	1					
Herring gull	8	5,000	80	35					8
	29		66	2	7	4	1	10	
Kestrel	1		1	1		1			
		1			1				
Kittiwake						1			
Lapwing	4	200	180	270					1
					98				
Lesser black-backed gull	1		40	8					
			1						
Little auk						3			
Little egret		1		2					
		3	2	2	2	5		3	
Mallard	82	17	65	25		60	35	26	8
	13	25	150	51	58	39	35	28	6
Marsh harrier				1					
Merlin				1					
Mute swan									
					1				
Oystercatcher						35		4	
	25						27	6	10
Peregrine				2					
Pink-footed goose		3,000	640	450					
								233	
Pintail									
				12					
Red-breasted merganser			1	7		16			
				4	8	2	2	4	

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Redshank	14	33	13	40	50		80	12	2
	4	4	2	3	65	11	37	64	3
Ringed plover									
									6
Sandwich tern	2								
Shag						1			
Shelduck	6	4	8	18			6	15	
		1	1	4	12	11	9	2	6
Short-eared owl									
	1								
Snipe		1							
Sparrowhawk	1		2						
Spotted redshank			1				1	1	
Teal	6	11	80	30	50	15	170	55	
		18	14	78	35	35	137	13	2
Tufted duck			2						
Whimbrel	2								
									7
Wigeon		20	100	40	90		200	74	
			1	71	38	95	62	136	19
TOTAL COUNTS 2015-16	475	9,312	1,799	1,328	485	457	923	312	30
TOTAL COUNTS 2016-17	237	256	332	317	465	249	441	581	66

Target species found in nationally-important numbers:

- None.

SPA qualifying interests found in potentially important numbers:

- Curlew, pink-footed goose.

Other target species not in the previous two lists but found in potentially important numbers in relation to the Forth Estuary:

- Barnacle goose, black-tailed godwit, Canada goose, common sandpiper, grey heron, greylag goose, herring gull, lapwing, little egret, mallard, pintail, whimbrel and wigeon.

Section 1 is within an area of relatively undisturbed arable farmland between Dunmore and Airth. The river edge comprises an earth bund to protect fields from flooding, with partially-exposed marshland on the estuary side.

In general, peak monthly counts for most of the 46 target species in Sector 1 were relatively low in comparison with their overall 5-year peak mean population for the Forth Estuary, or cited SPA population, where applicable. Pink-footed goose and curlew were the only SPA qualifying interests with peak monthly counts >10% of the cited populations.

Curlews were recorded feeding and roosting, including at high tide, throughout the non-breeding survey period, albeit in higher numbers in 2015-16. A count of 3,000 pink-footed geese was obtained in September 2015. Birds were feeding on an adjacent field alongside a flock of Canada geese, and there was a lot of movement to and from the flock during the survey. In 2015-16, pink-footed geese were present during the autumn migration period, but were absent during subsequent months, whereas the only record in 2016-17 was during the spring migration period.

A number of species' counts did exceed 10% of current 5-year peak mean estuary populations, and the Sector does appear to be relatively important for geese, likely because of the adjacent agricultural land, which is relatively undisturbed, and can be used for feeding and roosting. Other notable aggregations included black-tailed godwits in February 2016 and 2017, approximately 5,000 herring gulls in September 2015, 270 lapwings in November 2015, and 200 wigeons in February 2016.

3.2.2 Sector 2: Airth

The monthly peak counts for each species recorded within Sector 2 are shown in Table 3-3.

Table 3-3. Sector 2 species monthly peak counts, 2015/16 and 2016/17

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Arctic tern	1								
Bar-tailed godwit								10	
		4		2		1			
Black-headed gull	20	2,500	53		5		76		
	167	120	590	560	766	1	1		
Black-tailed godwit			2						
		1	43	2	30	2			8
Canada goose		236	27						
		20							
Common gull			1		3		6	1	1
		75		240		2	3	1	19
Common tern	3								
Common sandpiper	2		1						1
Cormorant	3	5	2		4		5		
	6	3	5	8	8	2	8	6	1
Curlew	13	233	5	27	47	240	18	22	2
	36	60	20	184	98	124	56	5	78
Dunlin									
				54	10				
Goldeneye						2	2		
					1				
Goosander					4				
Great black-backed gull	2		1		1		1		
	2	3	1	7	2	1	2	2	

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Greenshank			1						
	1		1						
Grey heron	1	4					1		1
	2	1	1	5	2		1	2	1
Greylag goose		292	2						
	103	200			33				
Herring gull	10	3,000	41		2		7	2	16
	163	1,700	41	130	9	2	17	2	20
Kestrel						1			
				1					
Lapwing			15						
					20				
Lesser black-backed gull									3
			2	15	2				4
Little egret				2			1		
								2	
Mallard		2				2	4	2	3
	10	2	2	7	17	3	2	2	22
Mediterranean gull									
				1					
Oystercatcher	2		5	32	15	2	6	2	50
		11		14	32	13	8	1	110
Peregrine									2
			2						
Pink-footed goose	3	50				53	3	8	
		4	4	2	610	1	1	12	17
Pintail									
		1							
Red-breasted merganser			1			2			
			3	9	2		4	1	4
Redshank			3	41	13	14	7	44	1
	1	2	27	65	144	67	45	65	14
Ringed plover									
									1
Shelduck	25	28	14	14	4		8	21	15
		4	5	35	7	17	10	7	34
Spotted redshank			1						
Teal		1	13	9		3	18	54	
	2	20	18	80	170	143	91	45	7
Whimbrel									4
		1							
Wigeon				20		3	9	19	
		12		78	6	66	40	28	33
TOTAL COUNTS 2015-16	82	6,351	188	145	98	322	172	185	99
TOTAL COUNTS 2016-17	496	2,244	765	1,499	1,969	445	289	181	373

Target species found in nationally-important numbers:

- None.

SPA qualifying interests found in potentially important numbers:

- Curlew.

Other target species not in the previous two lists but found in potentially important numbers in relation to the Forth Estuary:

- Black-headed gull, Canada goose, common gull, common sandpiper, greylag goose, herring gull, little egret, whimbrel.

Sector two comprises low-lying farmland similar to Sector 1, and peak monthly counts for most of the target species in Sector 2 were again relatively low, and the number of species recorded (36) was also relatively low. Curlew was the only SPA qualifying interest with peak monthly counts >10% of the cited population, in September and January 2015. Curlews used the Sector both for feeding, and as a high tide roost.

Herring gull and black-headed gull were recorded in relatively high numbers in autumn, and the Sector is also used intermittently by greylag and Canada geese, particularly in autumn (pink-footed geese were also present in numbers in December 2016). By contrast, the Sector appears to be unimportant for waders, with little habitat suitable for high tide roosts. Many gulls and oystercatchers were observed on the exposed mud bank in the middle of the Forth, outside of the sector, at lower tides, but did not remain within this Sector as tide rose.

3.2.3 Sector 3: RSPB Skinflats

The monthly peak counts for each species recorded within Sector 3 are shown in Table 3-4.

Table 3-4. Sector 3 species monthly peak counts, 2015/16 and 2016/17

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Barnacle goose		17							
			1						
Bar-tailed godwit	5						8		
		47							
Black-headed gull	110		30	15			248	3	1
		116	100	340	55	129	116	10	
Black-tailed godwit			4					1	
	1			152	7	3			
Black-throated diver						1			
Buzzard						1			
Common gull			4	6			34	6	
		71	5	90	42	20	6	7	
Common tern	10								
Coot						1			
Cormorant		1	1	2					1

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
		3	4	4	2	1	1		
Curlew	86	234	34	100	306	340	248	12	25
	180	45	133	178	96	7	44	266	11
Dunlin	10	110	16	120					3
		15	2	660	48	1			
Eider									
								2	4
Gadwall								3	
Gannet			3						
		4							
Golden plover				1		14			
			7		5				
Goldeneye				2		1			
				2	2				
Goosander	20								
	17								
Great black-backed gull	2			2					
		4	1	4		1	2	4	2
Great crested grebe						1			
					1	1			
Greenshank	5	1	1						
	1	1		1					
Grey heron	12		1	4		6	1		1
		7	2	5	3	4	1	2	1
Grey plover		23	10						
				8					
Greylag goose		1							
	360	1							
Herring gull	6	80	16	6			28	2	4
		21	2	100	5	7	11	11	7
Kestrel									
				1					
Kingfisher		1							
		1	1						
Knot	8			5					
				2					
Lapwing			7		3	1			2
		5		77				3	4
Lesser black-backed gull	6								
		1		15				2	1
Little egret	2	2		1			1	1	
		1						1	
Mallard	49	2		10		1		2	2
	10	4		4	5	18	13	26	16
Merlin						1			
Mute swan				3					

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
		2							
Oystercatcher	16	33	23	70	42	170	10	31	100
	30	2		76	120	40	60	83	62
Peregrine									
							1		
Pink-footed goose			120	200		350		76	9
			2,700	6	39	1		1,268	366
Pintail									1
		11	3	42	1	4	1		
Pochard									
	5								
Red-breasted merganser		4	2	11		3	17	14	
	10		1	11	15	4	2	2	4
Redshank	35	175	2	230		110		2	11
		3	84	723	89			1	16
Red-throated diver						1			
Ringed plover								2	14
Sandwich tern									
	3								
Scaup									
								2	1
Shelduck	148	280	104	16	4	80	5	31	9
	200	59	21	43	9	30	47	44	72
Snipe									
				3					
Teal	49	8	39	125	236	470	121	120	
	6	10	200	105	47	210	195	148	88
Tufted duck		1						1	
	1								1
Whimbrel	1								1
		1	4						
Whooper swan									
				2					
Wigeon		100	62	50		1		3	
		18	17	94	75	35	35	34	16
TOTAL COUNTS 2015-16	570	1,073	479	979	591	1,553	721	310	184
TOTAL COUNTS 2016-17	834	453	3,288	2,748	666	516	535	1,916	672

Target species found in nationally-important numbers:

- None.

SPA qualifying interests found in potentially important numbers:

- Curlew, pink-footed goose, redshank.

Other target species not in the previous two lists but found in potentially important numbers in relation to the Forth Estuary:

- Black-tailed godwit, dunlin, gadwall, goosander, greenshank, grey heron, greylag goose, little egret, pintail, pochard, scaup, teal and whimbrel.

A total of 52 species were recorded within Sector 3. Flock sizes were generally relatively low throughout the winter, although curlew, pink-footed goose and redshank were recorded in important numbers compared to their SPA populations. Curlews used the sector for feeding, and a high tide roost. Dunlin and redshank were also regularly present but numbers of most other waders were low. Teal was consistently present, with numbers exceeding 10% of the estuary population in January 2016, at lowering tide.

It was observed on at least one occasion that as the tide rose, geese moved into fields, and ducks and waders moved to Sector 4, or some flew up river. When the mud was not fully covered at high tide, some birds were able to stay on shore.

3.2.4 Sector 4: Skinflats Bay

The monthly peak counts for each species recorded within Sector 4 are shown in Table 3-5.

Table 3-5. Sector 4 species monthly peak counts, 2015/16 and 2016/17

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Barnacle goose			3						
Barn owl									
						1			
Bar-tailed godwit		6				1			
		4	55	3	45	12			
Black-headed gull		4,000		6		200	78		3
		30	260	300	100	330	100	360	
Black-tailed godwit		2	5						
	12	6	12	147	33				
Buzzard		1							
Canada goose									
									4
Common gull		1,500		1		20	11	23	9
		10	160	76	35	35	2	139	
Common tern									
		19							
Coot		45							
Cormorant			17	7				10	1
		12					8		8
Curlew	132	470	115	190	110	200	182	295	42
	188	330	240	76	574	496	35	100	57
Dunlin	5	10	30			100			4
	4	670	1,500	770	6,440	90		720	
Gannet		1	4						

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Golden plover		8							
		8	230				7		
Goosander	15	18		6					
	4	7							1
Great black-backed gull		20		3					1
		6	20	15	5	6		4	5
Greenshank									
				1					
Grey heron		25	1	1			1		
		2		1				1	
Grey plover						5	1		
					9	6		6	
Herring gull		2,500	93	5		75	1	3	85
		25	19	134	30	45	60	34	9
Kestrel		1							
Knot									
		30	240	82					
Lapwing		10			5	50			3
		75	370		168				2
Lesser black-backed gull		300				2			3
			45	35	5	25		15	1
Little egret									
					2	4			
Mallard		15	4	8		8		2	2
	6		4		4	4			
Mute swan				3					
Oystercatcher	170	15	47	2	30	50	82	10	67
	44	220	170	8	75	15	40	213	139
Pink-footed goose			70	28				600	
		22	2				8	96	790
Pintail						74		2	
		30	64	124	35	123	50	220	53
Red-breasted merganser		10						2	
		18		6				22	
Redshank	30	330	45	126		80	46	302	16
	50	300	490	1,008	1,100	70	6	524	187
Sandwich tern		2							
Scaup									
		2		14				6	
Shelduck	449	2,140	580	69	25	45	25	474	38
	1,460	480	370	78	138	246	90	311	283
Short-eared owl									1

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Shoveler									
			2						
Sparrowhawk		3							
Teal		20				20	48	256	30
		16	140	250	340	36		58	74
Tufted duck									
		1							
Whooper swan							4		
Wigeon		5	54					13	
		30	45	2	16	12			4
TOTAL COUNTS 2015-16	801	11,457	1,068	455	170	930	479	1,992	305
TOTAL COUNTS 2016-17	1,768	2,353	4,438	3,130	9,154	1,556	406	2,829	1,617

Target species found in nationally-important numbers:

- Shelduck and dunlin.

SPA qualifying interests found in potentially important numbers:

- Shelduck, curlew, redshank.

Other target species not in the previous two lists but found in potentially important numbers in relation to the Forth Estuary:

- Black headed gull, black-tailed godwit, common gull, golden plover, grey heron, herring gull, lapwing, lesser black-backed gull, little egret, pintail, scaup, teal and whooper swan.

Sector 4 comprises a large mudflat bay area, with adjacent agricultural land which is relatively undisturbed. A total of 43 species were recorded in Sector 4 during winter months. In year 1, numbers were particularly high during the September 2015 survey when nationally-important numbers of shelduck were recorded, alongside large gull flocks, important at an estuary level. The Sector appears to be important for shelduck through the autumn, with high peak counts in August to October in both years. Counts were highest during lower tidal states when individuals were recorded feeding extensively across the mudlfats. It was repeatedly observed that shelducks moved in large numbers from Sector 4 to Sectors 3 and 5 as the tide rose, so they could continue feeding for longer by moving to where the incoming tide proceeded more slowly, and occurred at a later time. Curlews were also recorded feeding extensively across the mudflats throughout winter months.

In December 2015, it was noted that curlews and oystercatchers were spread widely across mudflats at low tide at dawn. After sunrise, most curlews headed to arable land (winter cereal) to roost for 1-2 hours. Some curlews and oystercatchers remained on mudflats until near high tide. No high tide roosts were observed within the sector, and generally there were few birds at high tide, with some shelducks on water.

During year 2 there were increased numbers of dunlin, reaching national importance in December 2016. Birds were mainly recorded feeding within the Sector, throughout the tidal cycle. This was

also the situation for redshank which was recorded throughout the winter, and pintails were commonly present on the water in important numbers in relation to the estuary population.

3.2.5 Sector 5: River Carron

The monthly peak counts for each species recorded within Sector 5 are shown in Table 3-6.

Table 3-6. Sector 5 species monthly peak counts, 2015/16 and 2016/17

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Bar-tailed godwit		15		3		1			
	1	31			3				
Black-headed gull	718	400	200		20		150		20
		150	75	700	2,300	2,200	30	120	
Black-tailed godwit	380	17	1	4		1			9
	2		34		33		3	7	24
Buzzard	3	3	1	1					
			3					2	
Canada goose	29	18		24	22	24			
		9							
Common gull	13	1,100	300	5	40	5	20		6
		18	15	95	120	120	6	29	2
Common sandpiper	8	1							
	1								
Common scoter				1					
Common tern	12								
Coot	9	6		18	20	5	30		4
	5	9	21	24	26	18	1	7	12
Cormorant	1	60	10	2		6	2		1
		1							
Curlew	57	370	270	216	10	150	48	32	1
	88	10	88	69	178	88	101	66	24
Curlew sandpiper		1							
Dunlin	1	280	85	730		240	1		
	32					55			
Eider			1						
Gadwall					8		2		
Gannet		1	3						
Golden plover	26		1	2					
	1								
Goldeneye		4	1	6	6	8	14		1
						2			
Goosander		3	1	12		3	2		2
	37		5						

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Great black-backed gull		15	10						20
					2	8			2
Great crested grebe				1		1			
									1
Green sandpiper	2								
	1								
Greenshank	4						1	1	
					1			1	1
Greylag goose	42		66	16		16			1
Grey heron		45	5	2	2	2			1
		1					4	1	2
Grey plover		1	64			8			
	1								
Greylag goose									
				1			1	2	
Herring gull	77	1,600	180				6		10
		37	12	50	55	60	2	53	6
Kestrel		1	1	1		1			
	1		1	1	1			2	
Kingfisher		1		1					
Kittiwake				27					
Knot		2							
	1								
Lapwing	200	360	130	6			6		
	188	171			310	8			
Lesser black-backed gull	25	160	60		2				40
		6	6	4	27	25		38	2
Little grebe	3								
	2		4	6	4	2		3	
Little stint		1							
Mallard	58	6	1		25	20	44		4
	11		5	22	8	40	13	6	6
Mediterranean gull		1		1					
Moorhen	10	4	2	25	3	1	6		1
	4	1	13	8	12	8		5	6
Mute swan	7	8	6	33	75	29	16		5
	9	4	27	27	56	22	4	10	7
Oystercatcher	80	8	65		15	18			6
	106	3	1						
Peregrine		1							
Pink-footed goose			341				600	70	
				1,370			180	111	

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Pintail				37	11	22			
				1					
Pochard							1		2
Red-breasted merganser	22	18	13	1		35	2		
						1	1	3	
Red-necked grebe						1			
Redshank	11	190	35	460	20	870	106	40	42
	310	3	6	28	72	45	1	60	12
Red-throated diver			1						
Ringed plover		1							
Ruff	5								
Sandwich tern		17							
Scaup			1						
Shag						60			
Shelduck	26	2,880	1,100	140	90	60	1	5	56
	740	8		8	8	17	2	2	2
Shoveler			6		2				3
	2		2						
Snipe			1	3					
	3								
Sparrowhawk		1	1	2		1			
			2						
Teal	53	340	80	71	55	65	250	55	35
	6	26	124	133	91	127	30	109	19
Tufted duck	2	2	6		15	8	18		12
	3		1	9	11	33	7	36	47
Water rail			1	1					
	1							1	2
Whooper swan				6	5		4		
				5	4				
Wigeon	5		24	56	45	25	80	30	
	1	1	160	90	77	52	14	27	
Wood sandpiper		1							
TOTAL COUNTS 2015-16	1,889	7,943	3,074	1,914	491	1,686	1,410	233	282
TOTAL COUNTS 2016-17	1,557	489	605	2,651	3,399	2,931	400	701	177

Target species found in nationally-important numbers:

- Shelduck

SPA qualifying interests found in potentially important numbers:

- Shelduck, curlew, redshank and pink-footed gooses.

Other target species not in the previous two lists but found in potentially important numbers in relation to the Forth Estuary:

- Black headed gull, black-tailed godwit, common gull, common sandpiper, coot, cormorant, dunlin, gadwall, goosander, grey heron, golden plover, herring gull, kittiwake, lapwing, lesser black-backed gull, moorhen, mute swan, pintail, red-breasted merganser, ruff, shag, shoveler, teal, tufted duck, whooper swan.

Sector 5 takes in a variety of habitats, including the tidal stretch of the River Carron, inland lagoons, and where the Carron meets the Forth. As such, a large number of species (65) were recorded. As reported for Sector 4, shelduck was recorded in particularly high numbers in autumn, and it is likely that birds move between these sectors, avoiding the rising tide to maximise time feeding. Numbers of shelducks reduced within the Sector as winter progressed.

Curlew was present throughout the survey period, although numbers were highest between September and November in year 1, with the Sector being used for feeding and roosting through the tidal cycle. Redshank numbers reached potential importance within an estuary and SPA context in November and January 2016 but not 2017, with birds recorded feeding and roosting through the tidal cycle, although birds did depart in January on the incoming tide.

A number of other target species were recorded in potentially important peak counts, including gulls, pintail and teal. Pink-footed goose were recorded in large numbers in November 2016, feeding inland at high tide.

A potentially important roost site in Sector 5 is the two freshwater pools inland from the shore north of the River Carron. These pools provide a roosting site for geese, ducks and shorebirds but can be subject to human disturbance, including shooting activity.

3.2.6 Sector 6: Grangemouth Port

The monthly peak counts for each species recorded within Sector 6 are shown in Table 3-7.

Table 3-7. Sector 6 species monthly peak counts, 2015/16 and 2016/17

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Black-headed gull			8				42	6	14
	52	70	32	40	2	6	15	15	
Black-tailed godwit	43	2							
		6			4				
Common gull									
		20	2	25	2			1	
Common sandpiper	10								
		6							
Common tern	4								2
Cormorant	7	8	14	2			6	1	1

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
	6	60	9	12	4	2	6	7	8
Curlew	39	24	10	86	13	9	16	6	4
	37	80	17	35	105	5	1	2	7
Curlew sandpiper									
		2							
Dunlin	109				650	800	2,800	100	4
	1,020	235	20	3,300	1,200	100	100	720	17
Eider									
						2			5
Glaucous gull									
							1		
Golden plover									
				6					
Goldeneye									
				2					
Goosander	20						2		
	8	35	6	3	2	1			
Great black-backed gull			4				1	1	3
	5	40	7	14	8	7	13	7	12
Green sandpiper									
Greenshank		1	1	1					
				1					
Grey heron			6				1		
	8	14	5	10	9	6		2	
Herring gull	3	21	11				95	46	
	260	370	49	60	48	388	291	120	48
Kingfisher									
			1						
Knot			85						
					1				
Lapwing	76	92	160	195	61	150	40		
			20	314	450	110	100	2	
Lesser black-backed gull			1				3	9	
	18	15	6	26			1	4	13
Mallard				13				4	1
		18	6	31	11	7	3	1	1
Oystercatcher	21	3	20	14	2		7	11	11
	15	12	20	38	25	24	36	13	10
Peregrine		1							
Pink-footed goose				13					
									95
Pintail				5	18	96	111	122	
		2		35	8	19	40	2	
Red-breasted merganser			3			2		2	
				4	4		2	1	
Redshank	477	365	420	530	500	440	1,200	400	15

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
	499	570	730	1,515	1,050	1,185	710	944	321
Ringed plover	7								
	8	6		8					
Shelduck	750	363	380	270	43	72	51	21	26
	488	570	125	175	15	55	25	15	4
Spotted redshank									
					1				
Teal	3	3	24	103	83	194	80	47	
		24	4	60	26	83	65	67	
Turnstone									
	3	1		4	1	1	3	1	2
Whimbrel	1								
		2	1		1				
Wigeon	2		1	5	150	75	2		
		45		58	24	27	30	20	
TOTAL COUNTS 2015-16	1,572	883	1,148	1,237	1,520	1,838	4,457	776	81
TOTAL COUNTS 2016-17	2,427	2,203	1,060	5,776	3,001	2,028	1,442	1,944	543

Target species found in nationally-important numbers:

- Redshank, shelduck.

SPA qualifying interests found in potentially important numbers:

- Dunlin, redshank, shelduck and lapwing.

Other target species not in the previous two lists but found in potentially important numbers in relation to the Forth Estuary:

- Common sandpiper, cormorant, curlew sandpiper, goosander, grey heron, herring gull, pintail.

In Sector 6, the breakwater alongside Grangemouth Port provides a roosting and feeding opportunity for a number of species, in particular redshank and dunlin, which were recorded in high numbers during the winter in both years. Other wader species such as lapwing, curlew and oystercatcher also frequent the area in large numbers. Peak counts often occur just before high tide, as large high tides limit the amount of roosting habitat available.

The Sector is also widely used by shelduck, particularly for feeding extensively across the mudflats upstream of the breakwater in Skinflats Bay in autumn.

Redshanks usually roost at high tide behind the breakwater and upstream along the River Carron, and feed along the tideline across mudflats behind the breakwater. Shelduck, teal and curlew are also abundant at high tide roosting/feeding along the tideline. Birds move to mudflats within the sector to feed as tide recedes, widely within Skinflats Bay. Curlews and shelducks feed widespread across the outer mudflats at low tide.

3.2.7 Sector 7: Grangemouth Port Locks

The monthly peak counts for each species recorded within Sector 7 are shown in Table 3-8.

Table 3-8. Sector 7 species monthly peak counts, 2015/16 and 2016/17

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Bar-tailed godwit									
		69	4						
Black-headed gull				6	13	50	11	19	300
	42	130	77	60	141	145	48	2	2
Black-tailed godwit	15	3		113					
		14	6		11				
Common gull						54	6		
		15	6	40		1	1		
Common sandpiper	1	40							
Common tern	12								
	8								
Coot									
				34				1	
Cormorant	7		4		2	2	2	3	1
	12	12	9	8	4	5	3	4	4
Curlew	39	6	68		16	54	1	9	7
	11	230	140	108	16	1	1	2	7
Curlew sandpiper									
			1						
Dunlin	27	180		180	1				
	35	500	110	2,300		9	7	1	
Eider									
				3					1
Goldeneye									
				3					
Goosander									
		8							
Great crested grebe						2			
	1	6	4	13					
Great black-backed gull				2					2
	4	28	5	4	1				1
Green sandpiper		2							
Greenshank		2							
Grey heron	1					3		1	
		4	6	2	2				
Herring gull						8	1	14	58
	15	15	8	19	2	2	1	1	10
Kestrel			1	1					
			1						
Kingfisher				1		1			

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
			1	2					
Knot								42	
	1	20							
Lesser black-backed gull									
	6	6	19	6					
Little egret						1		1	
Mallard		21	8		17	80	9	6	
	8	160	45	14	36	8	16		4
Moorhen									
								1	
Oystercatcher	5		41	15	44	66	2	12	12
	4	170	70	160	8		1	6	96
Pink-footed goose									
			1						
Pintail						70		2	
				22	17				
Purple sandpiper	2								
Red-breasted merganser		22	7		2	5	6		
	6	36	28	20	4	5	2	11	2
Redshank	121	186	88	259	71	400	41	371	
	74	540	410	553	338	137	233	49	
Red-throated diver									
				2					
Ringed plover									
	2								
Sanderling		18							
Sandwich tern	4								
		4							
Scaup									
		2							
Shag									
			1						
Shelduck	631	144	232	10	24	27	2	4	9
	178	230	360	48	52	5	3	4	64
Snipe			3			11		5	
		1	1					1	
Sparrowhawk	2								
						1			
Spotted redshank									
				1			1	1	
Teal	20	22	75	136	370	300	25	28	34
		410	140	94	130	1	36	13	103
Turnstone									
								1	
Water rail									

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
		1	2		1				1
Whimbrel	1								
							1		
Wigeon	21		4		70	6	1		10
			30	22	8				
TOTAL COUNTS 2015-16	959	646	531	723	630	1140	107	517	433
TOTAL COUNTS 2016-17	407	2611	1485	3538	771	320	354	98	295

Target species found in nationally-important numbers:

- Shelduck.

SPA qualifying interests found in potentially important numbers:

- Curlew, dunlin, redshank, shelduck.

Other target species not in the previous two lists but found in potentially important numbers in relation to the Forth Estuary:

- Black-tailed godwit, common sandpiper, coot, great-crested grebe, green sandpiper, kingfisher, mallard, pintail, red-breasted merganser, scaup, snipe, teal.

This Sector comprises a relatively small area of habitat beside the mid-estuary side of Grangemouth Port, and where the Grange Burn flows into the Forth. Two small lagoons are present.

The Sector provides little habitat for high tide roosting, but in August 2015 over 600 shelducks were recorded roosting on the water. Increased numbers of waders (curlew, dunlin and redshank being recorded in important numbers) were recorded in year 2. The area of reclaimed land to the southwest provides early feeding opportunity for curlew, oystercatcher and shelduck on mudflats soon after high tide. During lower tidal states mudflats are exposed, and this provides feeding opportunities for redshank and teal in particular, which exit high tide roosts along the Grange Burn (Sector 8) as the tide recedes.

Large numbers of birds feeding on mudflats become more concentrated around the area to the south east of Grange Burn as tide rises. Redshanks and teals move into Grange Burn as tide rises above mudflats. Teals feed right up to the bankside south of the east jetty before high tide.

3.2.8 Sector 8: Grange Burn

The monthly peak counts for each species recorded within Sector 8 are shown in Table 3-9.

Table 3-9. Sector 8 species monthly peak counts, 2015/16 and 2016/17

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Bar-tailed godwit	1								
Black-headed gull	6	8		4					2
	5	19	14					1	
Black-tailed godwit				47					
	3		7						

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Common gull		1							
Common sandpiper	3								
Cormorant			1	3	1		1	1	
				1					
Curlew	28	9	17	131			1	2	1
	3		10	12	3		1	1	2
Dunlin	2	18		27	2			1	
	12	2	6	10	1	10	65	8	
Goosander									
			1						
Great black-backed gull				1					
Greenshank							1		
Grey heron	5	5		15			1		2
	13	3	4	1		1		1	
Herring gull	3			7				1	1
	1	2						9	2
Kestrel	1								
Kingfisher			1						
		1	2						
Knot				530					
				7					
Lapwing	1	3							
									1
Lesser black-backed gull									2
	1								
Mallard	12	29	6	65	11		4		
	21	98	38	10	4	6	8	3	1
Oystercatcher	1			14					5
								1	2
Pintail									
				2					
Red-breasted merganser		6		1					
	3								
Redshank	161	88	135	189	235	75	149	210	6
	206	994	160	134	128	209	280	245	107
Ringed plover									
		2	4						
Shelduck	126	11	5	104	1	1	6	4	12
	39	9	18	2	1	1	8	4	7
Sparrowhawk					1				
Spotted redshank									
			1			1			

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Teal	129	89	103	337	532	63	68	25	19
	8	45	118	92	59	105	108	70	67
Whimbrel									
			7						
Wigeon	2		9		5	15	12	4	
			33	33	15		21	29	
TOTAL COUNTS 2015-16	481	267	277	1,475	788	154	243	248	50
TOTAL COUNTS 2016-17	315	1,175	423	304	211	333	491	372	189

Target species found in nationally-important numbers:

- None.

SPA qualifying interests found in potentially important numbers:

- Redshank.

Other target species not in the previous two lists but found in potentially important numbers in relation to the Forth Estuary:

- Common sandpiper, grey heron, kingfisher, knot, teal, whimbrel.

Sector 8 follows the length of the tidal stretch of Grange Burn, between Grangemouth Port and reclaimed land at the refinery, to where it meets the Forth Estuary.

Redshanks roost on the mud bank within the river and feed in shallow water downstream, reaching SPA importance in flock size in September 2016. Teals mainly feed in shallow water next to the bridge, and roost at high tide. Redshanks roost in revealed creeks at lower tide. Some redshanks and teals leave before low tide to feed in Forth Estuary. Redshanks and teals likely roost in relatively large numbers along Grange Burn during the night.

3.2.9 Sector 9: Grangemouth Refinery

The monthly peak counts for each species recorded within Sector 9 are shown in Table 3-10.

Table 3-10. Sector 9 species monthly peak counts, 2015/16 and 2016/17

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Bar-tailed godwit							14	12	9
	14	7	73	110	117	480	244	68	
Black-headed gull	50						62	91	20
		35	21	490	50	400	260	130	
Black-tailed godwit	5	1		20	50	45			
	32	8	2		26	467	10	44	
Common gull									4
				35	60	600	28	60	
Cormorant				3					
		6		2			3		
Curlew	239	300	385	290	165	210	271	198	64
	275	370	360	755	345	244	500	153	100
Curlew sandpiper									

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
	15								
Dunlin	80	220	472		400	2,500			
	330	260	640	5,660	5,700	11,000	870	3,730	
Gannet		5							
Golden plover			140			12			
			94	73		49			
Goldeneye									
		8						1	
Goosander									
	12								
Great black-backed gull				6			2		2
	1	6	3	5	4	10	5	8	
Great crested grebe				5					
	28	20	3	5	6	2	6	4	3
Greenshank							4		
Grey heron				1					
		2	2	2		2			
Grey plover									
				2					
Herring gull							2	12	12
		45	5	85	45	400	35	28	4
Kingfisher									
			1				1		1
Knot		1		326		1,500	250	550	
	80		172	845	2	3,600	12	33	
Lapwing	20		10	55					
	34		4			55			
Lesser black-backed gull								2	2
				40		100	8	24	8
Little stint									
	1								
Mallard	41	65	16	23		2	20	3	2
	115	18	14	10	26	25	36	4	4
Mute swan				2					
Oystercatcher	27	230	342	41	115	360	230	265	139
	290	35	630	460	379	44	590	384	262
Peregrine	1	1							
Pintail		2	14	17	4	11	3		58
	30	34	13	17	68	112	189	191	74
Red-breasted merganser									
	15	25	5	5	5	6	6	9	6
Redshank	75	44	34	170	280	175	187	303	165
	540	220	109	630	480	600	398	259	13
Ringed plover	12		18						

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
	250		2	37		78	22		
Ruff									
	1								
Sanderling		1	2						
Sandwich tern									
	5								
Scaup									
		3			1	15	4		30
Shelduck	400	560	355	292	90	39	18	59	26
	1,400	396	160	352	388	210	230	214	280
Shoveler									
		1							
Spotted redshank	2								
	1								
Teal	18	144	350	350	250	70	69	17	201
	110	270	450	75	270	138	310	22	198
Whimbrel									
	2								
Wigeon			2	16	20	9	27		
	10	53	18	6	25	110	45	66	
TOTAL COUNTS 2015-16	970	1,574	2,140	1,617	1,374	4,933	1,159	1,512	704
TOTAL COUNTS 2016-17	3,591	1,822	2,781	9,701	7,997	18,747	3,812	5,432	983

Target species found in nationally-important numbers:

- Bar-tailed godwit, black-tailed godwit, dunlin, knot, shelduck.

SPA qualifying interests found in potentially important numbers:

- Bar-tailed godwit, curlew, dunlin, knot, redshank, ringed plover, shelduck.

Other target species not in the previous two lists but found in potentially important numbers in relation to the Forth Estuary:

- Black-headed gull, common gull, curlew sandpiper, great crested grebe, herring gull, lesser black-backed gull, oystercatcher, pintail, scaup, teal.

This Sector borders the Grangemouth petrochemical works, and very limited access is available to the foreshore. Upstream is an undisturbed area of wooded reclaimed land, and in the middle of the sector an outflow of heated water provides feeding and roosting opportunities for many birds.

At mid to high tide the sheltered, western part of the Sector is used as a roost by curlew, lapwing, golden plover, dunlin, shelduck, knot, redshank and black tailed godwit. Curlew numbers appear to be consistently important within an estuary context. In general, numbers of waders were higher in year 2, reaching national significance for bar-tailed godwit, black-tailed godwit, dunlin and knot. January 2017 counts were particularly high, with birds roosting at high tide.

Shelducks feed in large numbers and move from low tide to around the hot water outflow and mallards and oystercatchers also congregate around the outflow. Dunlins and redshanks also feed along the tideline.

Many birds were observed heading southeast out of the sector after high tide. Dunlins generally only feed in the sector and leave before high tide.

3.2.10 Sector 10: Kinneil Kerse

The monthly peak counts for each species recorded within Sector 10 are shown in Table 3-11.

Table 3-11. Sector 10 species monthly peak counts, 2015/16 and 2016/17

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Bar-tailed godwit					75	80	270	360	2
		15	20	76	43	360	340	47	31
Black-headed gull	448	250	258		150	180			350
		175	680	2,000	400	4,000	240	240	118
Black-tailed godwit	38		17	60	2	1	70	80	20
	560		32	403	384	660	728	702	1,242
Common gull					4				
			4	240	50	2,000	500	30	15
Common sandpiper	3								
	1	1							
Cormorant		2			2	5			1
		6		3	3		4	6	3
Curlew	84	1	10	13	10	60	290	210	6
	110	24	45	105	102	490	76	43	245
Dunlin	5	150		415	650	200	9,000	6,300	80
	140	150	120	760	8,000	9,200	7,450	1,310	95
Eider									
			5			2			
Gannet									
			2						
Golden plover			185	39	25	4	34		
			230	112		44			
Goldeneye						7			
			1		1	23	19		
Goosander	10								2
		1	8			1	4		
Great black-backed gull			3						2
		3	6	6	6	12	8	3	
Great crested grebe					1	1			6
		1	6	6	8	4			4
Greenshank								2	
	3		2	2	1		2		1
Grey heron					1	2			
		4	3	1	4		1	1	
Grey plover									

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
							1		
Herring gull	17	150	80						50
		120	25	200	50	270	65	65	35
Kingfisher									
		1	2	2					
Knot	3		325		220	30	1,900	1,300	20
	1		30	170	270	7,300	1,100	578	74
Lapwing	180	550	284	75	280	480	268	76	6
	55	26	255	424	333	430	37		
Lesser black-backed gull	7		5						15
		2	12	28	15	70	30	15	8
Little egret									
	1								
Mallard	23	37	188		30	30	20	20	8
	15	23	16	35	45	65	23	9	12
Oystercatcher	64	3	2	67		85	380	490	8
	60	4	12	118	66	120	66	176	378
Pintail					2				22
					28	98	97	66	54
Red-breasted merganser		2		1					7
			16	4	6	10	6	7	6
Redshank	490	1,050	591	381	270	250	460	435	350
	880	640	260	160	576	560	1,000	555	1,240
Ringed plover	15			30	1	19	17	6	
			45		9				
Ruff									
		1							
Sanderling			18						
Scaup								3	6
			9			22	3	21	28
Shelduck	330	21	555	12	2	40	80	175	20
	4,735	350	248	234	236	490	290	178	260
Shoveler									
									1
Snipe									
			2						
Teal	30	30	45	85	80	150	240	470	120
	32	22	225	590	598	1,120	670	405	468
Whimbrel									
	2			8				56	
Whooper swan									
					7				
Wigeon			20	24	8	20	170	135	25
		6	44	80	134	660	78	151	3
TOTAL COUNTS 2015-16	1,747	2,246	2,586	1,202	1,813	1,644	13,199	10,064	1,126
TOTAL COUNTS 206-17	6,595	1,575	2,365	5,767	11,375	28,011	12,838	4,662	4,321

Target species found in nationally-important numbers:

- Black-tailed godwit, dunlin, knot, redshank, shelduck.

SPA qualifying interests found in potentially important numbers:

- Bar-tailed godwit, curlew, dunlin, knot, lapwing, redshank, shelduck, wigeon.

Other target species not in the previous two lists but found in potentially important numbers in relation to the Forth Estuary:

- Black-headed gull, common gull, common sandpiper, golden plover, kingfisher, lesser black-backed gull, mallard, pintail, scaup, teal, whimbrel, whooper swan.

Sector 10 covers the mudflats around Kinneil Kerse and the Grangemouth Petrochemical works, where the River Avon meets the Forth. The area appears to be important for waders, particularly black-tailed godwit, dunlin, knot and redshank. Peak counts were recorded between December and March, particularly in year 2. As with Sector 9, there was a very high count in January 2017, although unlike in Sector 9 which was predominantly a high tide roost, birds in Sector 10 were present feeding and roosting in large numbers through the tidal cycle.

Shelduck was recorded in large numbers in October 2015, and in nationally-important numbers in August 2016.

As the tide rises, many birds move towards Sector 9 which still has exposed mudflats. Limited mudflats remain exposed in the river channel.

Teal use the bay at the mouth of the river around high tide to continue feeding (some roosting). As the tide starts receding they drift down the river channel and out of the sector.

3.2.11 Sector 11: Kinneil Reserve

The monthly peak counts for each species recorded within Sector 11 are shown in Table 3-12.

Table 3-12. Sector 11 species monthly peak counts, 2015/16 and 2016/17

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Bar-tailed godwit				1	178	230	30	48	2
		630	130		276	410	402	77	170
Black-headed gull	700		40	200	100				150
	657	200	270	119	260	450	173	200	1
Black-tailed godwit	400	1,000	102	470	460	670	300	32	144
	635	1,120	900	374	980	897	340	877	220
Black-throated diver									
						1			
Buzzard				1	3				
		2		1					
Canada goose					6				
Common gull	12			170	20				
		45	50		80	60		25	

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Common sandpiper									
		2							
Common scoter									
					1				
Common tern	3								
	8								
Cormorant	6		7	40					
	2	6	4	1					1
Curlew	139	42	20	85	15	150	170	200	2
	96	70	320	122	430	363	17	46	4
Dunlin	2	13	400	2,600	5,800	5,000	9,000		2
	6	660	1,400	208	9,000	4,650	600	2,640	50
Eider			2		2				
			2			2		22	
Gannet									
		1							
Golden plover			100	210	68	60			
		18	436		15	83			
Goldeneye			1	15	4				
						2			
Goosander				4	1	1			
		18	10						
Great black-backed gull	1		7	35	8				
	8	6	6	2	4	2		2	2
Great crested grebe	1		15	28	17	1			
		30	18	16	12	7		18	
Greenshank	6	3	2	2		1			1
		6	5	1	2	2	3	4	1
Green-winged teal									1
Grey heron	16	7	1	15	8				
		12	6	1	3	7	1		1
Herring gull	20		15	150	30				5
	138	570	71	46	65	578	101	8	38
Kestrel				1	1	1			
Kingfisher				1					
						1			
Knot	30		180	260	380	1,000	2,200	260	
	1	100	540	276	530	3,370	500	930	150
Lapwing	430	350	150	330	190	750			
	57	244	370		548	648	10		1
Lesser black-backed gull	6			50	15				3
	42	40	24		6	15		15	2
Little egret		1	1						
Mallard									

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
	2	20	15	39	40	36	3	34	2
Mediterranean gull									
Moorhen	5			1	1				
	1								
Mute swan									
						2			
Oystercatcher	30	3	12	80	12	80	50	220	14
	14	6	270	213	260	180	10	104	103
Pink-footed goose				8					
Pintail						100		44	
								88	43
Red-breasted merganser	30	2	15	130	55	1			2
	4	60	36	9	10	6	1	14	
Redshank	200	730	450	835	600	660	1,000		200
	65	460	920	626	1,200	390	110	768	330
Red-throated diver					5	1			
								1	
Ringed plover		48	30	12				8	
		7							
Sandwich tern	15								
Scaup									
						14		18	7
Shelduck	536	642	150	280	170	200	50	247	90
	406	760	1,040	349	570	648	363	444	67
Short-eared owl						1			
Shoveler									
		2							
Snipe			1		4				
					1	8			
Spotted redshank									1
					1				
Teal	28	190	90	240	90	100	50	208	45
	17	80	210	133	670	600	700	961	136
Turnstone	2	1		12					
Water rail									
		1							
Wigeon			1	35	35		40	80	
		22	168		26		28	10	
Wood sandpiper	1								
TOTAL COUNTS 2015-16	2,635	3,044	1,818	6,351	8,328	9,008	12,900	1,347	664
TOTAL COUNTS 2016-17	2,143	5,186	7,195	2,486	14,940	13,431	3,352	7,306	1,327

Target species found in nationally-important numbers:

- Bar-tailed godwit, black-tailed godwit, dunlin, greenshank, knot, red-breasted merganser, redshank, shelduck.

SPA qualifying interests found in potentially important numbers:

- Bar-tailed godwit, curlew, dunlin, golden plover, knot, lapwing, redshank, red-breasted merganser, ringed plover, shelduck.

Other target species not in the previous two lists but found in potentially important numbers in relation to the Forth Estuary:

- Black-headed gull, common gull, common sandpiper, great crested grebe, grey heron, herring gull, lesser black-backed gull, moorhen, pintail, scaup, teal.

Sector 11 comprises the Kinneil Local Nature Reserve, and reclaimed land of a former colliery site. Extensive mudflats exist along the Forth and an inland lagoon is present, which is an important roost for a variety of species, including dunlin, redshank, golden plover, black-tailed godwit, and knot. Numbers recorded within the Sector were particularly high between December and February in both years, with a number of wader species reaching national importance. As with Sectors 9 and 10, January 2017 provided highest numbers of roosting waders recorded in the Sector, at high tide. Numbers of black-tailed godwit, lapwing, knot, redshank and shelduck were consistently high through the winter period.

3.2.12 Sector 12: Bo'ness

The monthly peak counts for each species recorded within Sector 12 are shown in Table 3-13. Note that no survey was undertaken in March 2016.

Table 3-13. Sector 12 species monthly peak counts, 2015/16 and 2016/17

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Arctic skua			4						
Bar-tailed godwit			75	68	55		50		
	84	150	78			15			
Black-headed gull	100	68		8	40	50	20		45
		96	66	27	224	90	260		
Black-tailed godwit	180	2	610						
	588		6	14		12			1
Common gull				46	15	40	55		1
		2	15	26		10	6		
Common tern	30								
	15								
Cormorant		1		2	1				
		1						1	
Curlew	35	28	50	12	12	50	70		1
	32	13	23	61	2	77	6	5	3
Dunlin				12	50	30	500		

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
	5	14	305	2		6			
Eider			6						5
	5							6	2
Gannet			2						
Goldeneye					5		5		
			1			2	5		
Goosander			6						
			4						
Great black-backed gull		2		1	2	1			
		3	4	1	2	3	5	3	
Great crested grebe			1			1			
			8				3	1	
Grey heron									
		2	2	5	1	4			
Greylag goose			1						
Grey plover	2								
Herring gull	13	2		4	20	12	15		12
		12	35	15	6	40	15	12	17
Kingfisher									
			2						
Knot			71	101	120		50		
	55		8						
Lapwing	90	3	12						
	10	155							
Lesser black-backed gull							6		6
		9	8						5
Mallard	19	29	30	6	5	20	10		4
	10	4	10	14			3	2	2
Mute swan									
			1			2			
Oystercatcher	6	2		120	150	130	115		26
	10	12	44	60	201	122	33	61	53
Pink-footed goose			50						
Red-breasted merganser	50	4	90	6	6	5			
	5	47	33			9	11	6	3
Redshank	94	79		283	65	20	122		40
	28	200	68	60	96	94	36	22	17
Ringed plover									
	4			1					
Sandwich tern	75	26							
	39							1	
Scaup			2						
Shelduck	80	229		5	8	10	16		12

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
	33	47	36	1	19	52	48	78	7
Teal				81	10	60	50		2
	4	5	25	139	6	19	16	1	4
Turnstone				2		8	1		2
	1	2		1	1	2	1	6	7
Whimbrel									
		1						1	
Wigeon									
							6		
TOTAL COUNTS 2015-16	774	475	1,010	757	564	437	1,085	-	156
TOTAL COUNTS 2016-17	928	775	782	427	558	559	454	206	121

Target species found in nationally-important numbers:

- Black-tailed godwit, red-breasted merganser.

SPA qualifying interests found in potentially important numbers:

- Red-breasted merganser.

Other target species not in the previous two lists but found in potentially important numbers in relation to the Forth Estuary:

- Bar-tailed godwit, kingfisher, scaup.

In contrast to the adjacent Sector 12, this Sector is close to Bo'ness town and the John Muir coastal path, meaning that human activities are relatively frequent, and suitable roosting (and feeding) habitats are limited. This may be reflected in the relatively low peak monthly counts within Sector 12, with the exception of high counts of black-tailed godwits in October 2015 and August 2016. Large numbers of red-breasted merganser were also recorded offshore in October 2015, likely to be distant from possible disturbance. Birds were recorded feeding and loafing on mudflats close to Kinneil Island.

Birds were observed moving up the foreshore on the tide, then roosting on the point of Kinneil Island.

3.2.13 Sector 13: Grangepans

The monthly peak counts for each species recorded within Sector 13 are shown in Table 3-14.

Table 3-14. Sector 13 species monthly peak counts, 2015/16 and 2016/17

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Bar-tailed godwit									
	76				9	1			
Black-headed gull			150	12	60	90	65	10	4
	9	111	233	66	126	318	115		
Black-tailed godwit	2	49	4						
		144	41	3		3	1		
Common gull			30	1	10	6	8	3	1
		6	24	10	1	111	25		

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Cormorant		1	60						
	1		1		2	1	3		
Curlew	4	7	10	1	1	6	1	1	
	3	15	10	4		5	14	10	1
Dunlin			5	25	21	500			
		88	18	238	5		1		
Eider	5		5					3	
		6					16		2
Gannet									
		1							
Goldeneye			12				7		
							2		
Goosander									
		1							
Great black-backed gull			14		2	3	1	1	
		4	5	2	3	1	4		
Great crested grebe			1			1			
		2	2			5			
Grey heron	1	1	12						
				2					
Herring gull	10	12	80	2	6	6	15	5	4
	2		6	8	4	3	20	4	24
Knot						40			
		4	1						
Lesser black-backed gull			25					2	4
		2	12				6		
Mallard	16	21	10	12	18	3	30	5	
	3	4	4	14	2	7		3	1
Oystercatcher	1		6	3	7	1	4	5	
		4			1	10	14	11	2
Red-breasted merganser		2	90	11	8	10	3		
			6		11	7	16	5	3
Red-necked grebe			1						
Redshank	220	221	8	92	65	30	60	21	14
	40	81	70	78	54	39	57	20	
Red-throated diver									
		1							
Ringed plover			4						
Sandwich tern		2							
	6								3
Scaup							5		
Shelduck	7	61	15	12				3	6
	27	55	12		1	5	80	6	2
Slavonian grebe			1						

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Teal			10				24		
				19	3				
Turnstone	3			9	36	11	14	8	
		15	3	6	6	2	2		
TOTAL COUNTS 2015-16	269	377	553	180	234	707	237	67	33
TOTAL COUNTS 2016-17	167	544	448	450	228	518	376	59	38

Target species found in nationally-important numbers:

- Red-breasted merganser.

SPA qualifying interests found in potentially important numbers:

- Red-breasted merganser.

Other target species not in the previous two lists but found in potentially important numbers in relation to the Forth Estuary:

- Black-tailed godwit, common gull, cormorant, grey heron, scaup.

Sector 13 is characterised by its proximity to industrial sites at Grangepans, and also the John Muir coastal path. The coastline is heavily modified, and few opportunities for extensive feeding or roosting exist within the Sector. This is reflected in the relatively low peak counts recorded for all species, with the exception of red-breasted merganser which can be found further offshore on the water. The Sector appears to be used by feeding redshank, dunlin and shelduck. Some redshanks were recorded roosting, but as the tide rises, the area for roosting is likely to be too close to the coastal path, which is used regularly by walkers and their dogs. Very little activity at high tide occurs except for species such as red-breasted merganser and mallard on the water.

3.2.14 Sector 14: Carriden

The monthly peak counts for each species recorded within Sector 14 are shown in Table 3-15.

Table 3-15. Sector 14 species monthly peak counts, 2015/16 and 2016/17

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Arctic skua									
			2						
Arctic tern									
	1								
Bar-tailed godwit									
		12							
Black-headed gull	120				40		31		6
		65	125	56		87	78		35
Black-tailed godwit	2	9	181		1				
			102						
Brent goose									
				2					
Common gull	1						15		5
			14	170		20	18		30
Common scoter						1			

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Common tern	2								
	18								
Cormorant	1								
				1			2		
Curlew	9	36		2	12	40	11	8	
	28	8	33	10	18	21	14	15	6
Dunlin			405		27	4			
			98		21				
Eider						6	2		
							6		
Goldeneye						3			
Great black-backed gull	2								
			4	2		1	3		3
Great crested grebe						1			
							5		
Grey heron							2		
				3					
Herring gull	420	212			30		11		
		80	40	151		9	46		76
Knot									
	1		13						
Lesser black-backed gull					5		4		
		3	10			2	24		27
Mallard	3	3			6	12	5		
	12	7	26	40		3	2		3
Oystercatcher	2	33	1	6	11	60	10	15	
	12	3	5	22	10	21	21	1	9
Pink-footed goose						1			
Red-breasted merganser	14		31	1	6	1	1		
					10		8		
Red-necked grebe						1			
Redshank	2		7	60	65	55	23		
	38	6	52	20	33	30	28		19
Ringed plover	5					26	1	1	
	8			1					
Sandwich tern	600	160							
	1	97							
Scaup				1					
Shelduck	30	106	176	58	65	12	21	21	
	38	91	120	72	19	24	43	16	4
Teal						90			
			70	93					
Tufted duck									

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
	1								
Turnstone					9				
	1		8	2		1		7	
Whimbrel			1						
		3				1			
Wigeon			75	250	39	55	4	22	
			182	89	83	20			
TOTAL COUNTS 2015-16	1,213	559	877	378	316	368	141	67	11
TOTAL COUNTS 2016-17	159	375	904	734	194	240	298	39	212

Target species found in nationally-important numbers:

- None.

SPA qualifying interests found in potentially important numbers:

- Sandwich tern, wigeon.

Other target species not in the previous two lists but found in potentially important numbers in relation to the Forth Estuary:

- Black-tailed godwit, Brent goose, common gull, herring gull, whimbrel.

This Sector is partially in close proximity to industrial areas and the John Muir coastal walk, but further downstream the habitat becomes more wooded. Numbers of waders recorded were generally low, reflecting the lack of roosting and feeding opportunities within the Sector, and probably also the level of human activity and adjacent terrestrial habitat.

A large Sandwich tern roost was recorded in August 2015, across an exposed sandbank in the middle of the bay, but was not present in autumn 2016. Large numbers of herring gulls roosted in the area. Wigeon are also common in the Sector, reaching importance within an SPA context in November 2015.

3.2.15 Sector 15: Stacks

The monthly peak counts for each species recorded within Sector 15 are shown in Table 3-16.

Table 3-16. Sector 15 species monthly peak counts, 2015/16 and 2016/17

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Bar-tailed godwit					1				
		8	4						
Black-headed gull	28	117	452	11	15		13		
		470	38			240	45	8	2
Black-tailed godwit			71						
		65	3		1	12			
Buzzard						1			
Common gull		4	2		4		5		
		78	15			34	15		
Common scoter						1			

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Common tern	17								
Cormorant	1		2	1	1		1		
Curlew	20	66	46	73	132	220	6	110	1
	31	12	6	4	114	222	19	96	
Dunlin						1			
						50			
Eider	3					6	3		2
		22						2	
Feral/hybrid goose									
				1					
Fulmar									
	1								
Great black-backed gull	1		1	2	3		2		
		7	4	1	2	4	3		1
Great crested grebe					2	2	1		3
	1	4		2	1	6	16		
Grey heron	1		5				1		1
	1	3		1					
Greylag goose									
		65							
Herring gull	15		386		1		2		3
	180	860	18	2	49	66	8	9	10
Kittiwake						1			
Knot									
						45			
Lapwing						4			
				1		16			
Lesser black-backed gull		1	1						
		30				5	12		
Little gull									
						20			
Mallard				4		1	4		2
		5	4		2	4	2	4	
Oystercatcher	9	8	3	2	21	25	3		
	3	8	12	4	4	36	24	15	3
Pink-footed goose			19			66			
			1						
Razorbill									
				1					
Red-breasted merganser	5			17	4	13	1		2
	2	16		5	6	6	14	1	
Red-necked grebe						1			
Redshank	1		1		23	29	13	6	

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
	23	68		8	8	18	37	2	
Red-throated diver						1			
Sandwich tern	7					1			
	4	38							
Scaup				1					
Shelduck	19	4	83	38	40	73	21	17	2
	33	105	24	19		59	33	4	10
Slavonian grebe						1			
Teal									
	4				26	6			
Turnstone									
						3			
Whimbrel				70					
Whooper swan						12			
Wigeon						45		12	
		40	18	6	27	46			
TOTAL COUNTS 2015-16	127	200	1,072	219	247	504	76	145	16
TOTAL COUNTS 2016-17	283	1,904	147	55	240	898	228	141	26

Target species found in nationally-important numbers:

- None.

SPA qualifying interests found in potentially important numbers:

- Curlew.

Other target species not in the previous two lists but found in potentially important numbers in relation to the Forth Estuary:

- Black-headed gull, black-tailed godwit, great crested grebe, herring gull, little gull, whimbrel, whooper swan.

Sector 15 lies adjacent to the John Muir coastal path, and the shoreline has been modified to allow for the recent upgrade and construction of this. It is bordered by improved agricultural fields. Numbers of all species were generally low with only curlew consistently recorded in relatively larger numbers, reaching SPA importance in January 2016 and 2017. Large numbers of herring gulls, black-headed gulls and black-tailed godwits were recorded feeding in October 2015 and September 2016, following the tide, before moving away in batches as the tide rose. Little roosting habitat exists at high tide.

3.2.16 Sector 16: Blackness

The monthly peak counts for each species recorded within Sector 16 are shown in Table 3-17.

Table 3-17. Sector 16 species monthly peak counts, 2015/16 and 2016/17

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Arctic skua									
		1							
Bar-tailed godwit									
		14					1		
Black-headed gull	270		75	25	40	80	35	4	25
	31	460	140	31	215	340	18	12	1
Black-tailed godwit									2
		14	22		1				
Brent goose									
				2					
Common gull	70		75	6	20	13	25	39	6
	14	230	35	10	282	35	4	22	
Common scoter									
		1							
Common tern									
	6								
Cormorant	14		4	2		1			1
	2	8	3		1			1	
Curlew	160	60	70	80	130	2	20	37	2
	8	30	34	2	74	106	1	51	
Dunlin	3		2		206				
		44	2	24	33		2		
Eider	10						3	13	5
		10						2	
Goldeneye									1
Goosander									
		4							
Great black-backed gull				1	3	2	2	1	2
		6	2	1	3	3	1		
Great crested grebe	10		4		1	1	1		7
			2			8			
Greylag goose			1						
		40							
Grey heron			4						
		1			1	1			
Herring gull	82	7	170	10	6	6	15	14	12
	180	570	20	3	4	180	3	11	11
Knot					1				
Lesser black-backed gull									
		28	6			6	1	2	2
Mallard				2			4	2	
							3		
Mute swan									
			1						
Oystercatcher	29	7	25	10	30	20	18	5	3
	5	12	34	3	8	16	11	15	

Species	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Pink-footed goose			15						
Red-breasted merganser			20	7	5	2		2	6
		36	10	1	2	15			
Redshank	32		70	9	75	30	22	5	21
	42	76	110	40	32	103	32	60	23
Red-throated diver									
		14							
Ringed plover	1								
Sandwich tern	4								
	2								
Shelduck	16	1	50	75	89	35	15	4	6
	1	45	34	7	5	36	5		3
Snipe									
			1						
Teal									
		2	4			2			
Turnstone									
	1								
Whimbrel									
					28	122			
Whooper swan			2						
Wigeon			40	110	35	63	4	8	2
		14	94	86	60	88	2		
TOTAL COUNTS 2015-16	704	15	627	337	641	255	164	134	101
TOTAL COUNTS 2016-17	289	1,720	554	210	749	1,061	84	176	40

Target species found in nationally-important numbers:

- None.

SPA qualifying interests found in potentially important numbers:

- Red-throated diver.

Other target species not in the previous two lists but found in potentially important numbers in relation to the Forth Estuary:

- Black-headed gull, Brent goose, common gull, great crested grebe, herring gull, red-breasted merganser, whimbrel.

Sector 16 is adjacent to Blackness village, pier and castle, as well as the John Muir coastal path, and so human activity is relatively high. Species such as redshank, oystercatcher and shelduck were regularly recorded but in small numbers. Relatively large numbers of red-throated divers were present on the water in September 2016, and notable feeding whimbrel flocks were present in December and January 2017.

3.3 Distribution and Behaviour of SPA species within the survey area

This section summarises the spatial distributions and associated behaviours of all birds, and specific key species (SPA qualifying interests and any other species found in nationally-important numbers – see Section 3.2) recorded during surveys, particularly in relation to high tide.

It should be noted that in relation to distribution Figures 1.1 to 12.2, the change in data capture from paper to digital (see Section 2.4.3) meant that more records were collected from August 2016 onwards compared to the first non-breeding season, as hourly distribution maps, instead of bi-hourly maps were collated. The larger number of records in 2016-17 therefore should be attributed to increased data collection rather than any obvious increase in numbers of birds within each Sector. The main purpose of the figures was to record the distribution of birds (and flock size) rather than frequency of records within each Sector.

3.3.1 General bird distributions

Figures 1.1 and 1.2 show the distribution of all species recorded roosting at high tide. In general there are key roosting locations where a number of wader species aggregate in large flock sizes. These are:

- Adjacent to the downstream side of the Kincardine Bridge in Sector 3;
- The breakwater adjacent to Grangemouth Port in Sector 6;
- The sheltered bay adjacent to Grangemouth Petrochemical works in Sector 9;
- Mudflats and creeks at the mouth of the River Avon (Sector 10);
- The lagoon at Kinneil (Sector 11); and
- The sheltered bay adjacent to Kinneil Island (Sector 12).

In other Sectors, particularly downstream in Sectors 13-16, numbers of roosting birds are lower, although large aggregations of ducks are commonly present on the water at high tide. Further upstream in Sectors 1-5, large aggregations of gulls are common.

It was evident that distribution of birds was relatively similar in year 1 (2015-16) and year 2 (2016-17).

3.3.2 Bar-tailed godwit

Bar-tailed godwits were recorded mainly in Sectors 9-12, although were recorded in smaller numbers in the sectors further upstream (Figures 2.1 and 2.2). The main roosting areas were in the sheltered bay at the Grangemouth petrochemical works, along the mouth of the River Avon, and in the lagoon at Kinneil in Sector 11 (Figure 2.1). Birds were also recorded roosting in Skinflats Bay (including onshore lagoons in Sector 5) and at Kinneil Island in Sector 12.

3.3.3 Black-tailed godwit

Black-tailed godwits were recorded in nearly all sectors, but were observed roosting in highest numbers within the lagoon at Kinneil in Sector 11, in the sheltered bay in Sector 9, in Skinflats Bay in Sector 5, as well as feeding along the shore in most other sectors (Figures 3.1 and 3.2, and 12.1 and

12.2). Birds were recorded roosting upstream in Sectors 1 and 2 in 2016-17. They were also observed feeding far out on mudflats at lower tides.

3.3.4 Curlew

Curlew was recorded feeding and roosting in large numbers throughout the survey area, being regularly recorded in all sectors. High tide roosts were encountered across all sectors from Dunmore, downstream to Bo'ness, in both years (Figures 4.1 and 4.2). No regular high tide roosts were observed in Sectors 13-16 in year 1, although there were small numbers present in year 2. Birds fed extensively on the mudflats around Skinflats, near the Kincardine Bridge, and near Grangemouth petrochemical works in Sector 9 (Figures 12.1 and 12.2). Birds also fed further downstream in all other sectors.

3.3.5 Dunlin

Dunlin distribution was largely restricted to Sectors between the Kincardine Bridge and Bo'ness. Highest numbers were recorded along the breakwater in Sector 6, in the sheltered bay in Sector 9, at the mouth of the River Avon in Sector 10 and in the Kinneil lagoon in Sector 11, and at Kinneil Island in Sector 12, where birds roosted at high tide (Figures 5.1 and 5.2). Birds also fed extensively across mudflats in Sectors 4, 9 and 11 in particular (Figures 12.1 and 12.2).

3.3.6 Golden plover

Golden plover distribution within the survey area was mainly restricted to a small number of locations – within Skinfats Bay (Sectors 5 and 6), in the sheltered bay in Sector 9 (Grangemouth petrochemical works), in the mouth of the River Avon (Sector 10) and in the lagoon in Sector 11 (Kinneil) where birds roosted at high tide (Figures 6.1 and 6.2). There were no records further downstream, and few, sporadic observations in Sectors 1-4.

3.3.7 Knot

Knot was mainly recorded within Sectors that have large areas of mudflats, particularly between Grangemouth Port (Sector 7) and Bo'ness (Sector 12). Birds were recorded roosting on mudflats near the shore (e.g. within the sheltered bay in Sector 9), and also within the lagoon in Sector 11, in particularly high numbers (Figures 7.1 and 7.2). The species was largely absent from other sectors downstream of Sector 11 and upstream of Sector 4.

3.3.8 Pink-footed goose

Pink-footed goose was recorded mainly in the upstream parts of the survey area, within Sectors 1-5, characterised by agricultural land use and lower human activity rates. They used the survey area both for feeding (e.g. on fields in Sectors 1-3, Figure 12.1), and roosting (on the mud in Skinflats Bay and within the adjacent lagoon (Sectors 4 and 5), and at high tide on marsh beside the Kincardine Bridge in Sector 3 (Figures 8.1 and 8.2).

3.3.9 Red-breasted merganser

Large numbers of red-breasted mergansers were recorded in a number of sectors, but in most cases birds were loafing, roosting or feeding on the water at a distance from the shore. Figure 9.1 shows that in year 1, roosting birds were often recorded in Sectors 13 and 15 towards Blackness, and in

general were more common in the downstream half of the site. In year 2 (Figure 9.2), there was a wider distribution, with larger numbers of birds recorded at high tide between Sectors 7 and 11 in particular.

3.3.10 Redshank

Redshank was distributed widely across the survey area, being recorded in all sectors in both survey years. Largest flock sizes were recorded around Grangemouth port and petrochemical works, particularly along the breakwater at Sector 6, along the sheltered bay in Sector 9, at the mouth of the River Avon in Sector 10, and in the lagoon at Kinneil in Sector 11 (Figures 10.1 and 10.2). These locations formed important high tide roost sites for the species. Birds did also frequent sheltered bays further downstream, albeit in lower numbers.

3.3.11 Shelduck

Shelduck was distributed widely across the survey area, being recorded feeding and roosting in all Sectors (Figures 11.1 and 11.2). Particularly high numbers were recorded feeding within Skinflats Bay (Sector 4/5) and across the mudflats at Kinneil (Sector 11) (Figures 12.1 and 12.2). Large numbers of roosting birds were recorded around Grangemouth Port and petrochemical works (Sectors 7 and 9) and on the mudflats at Kinneil (Sectors 10 and 11). Birds were recorded roosting in most Sectors, mainly on land, but occasionally also on the water, depending on the availability of roost sites, for example in Sectors furthest downstream where suitable habitat is most limited.

3.3.12 Sandwich tern

Sandwich terns were recorded roosting in August and September 2015 in Sectors 11-14, with highest numbers along a sandbank in Sector 14 (all birds left before high tide). Birds were also recorded occasionally in flight, and feeding in low numbers further up and downstream during the autumn migration period.

In year 2, birds were recorded roosting again in August and September, within Sectors 9, 12 and 14 (five, four and 12 birds respectively). Birds were recorded feeding within Sectors 12-14 in August.

3.4 Baseline Human Activity Levels

Human activities observed or heard within the sector during surveys were noted on the Activity survey sheet (Appendix 1) in year 1, and in a similar electronic form using mobile data capture in year 2. Human activities were categorised into various types, and the numbers of "events" (e.g. number of dog walkers, cars or industrial/farm machinery) were tallied at the end of the survey. The total numbers of activities across all surveys can then be averaged to produce an overall baseline activity index for each sector, based on hourly rates of activity per km (Table 3-18). The main human activities recorded within each sector are also listed.

Table 3-18 Baseline Activity Levels

Sector ID	Name	Length	Overall Baseline Activity Index*		Main Human Activities
			2015-16	2016-17	
1	Dunmore	1.86 km	0.25	0.67	Gas guns, walkers

Sector ID	Name	Length	Overall Baseline Activity Index*		Main Human Activities
			2015-16	2016-17	
2	Airth	1.95 km	0.19	0.53	Farm vehicles, walkers, dogs
3	RSPB Skinflats	1.85 km	0.31	0.12	Farm vehicles, walkers, dogs
4	Skinflats Bay	1.73 km	0.24	1.13	Gas guns, walkers, dogs
5	River Carron	3.35 km	0.36	0.08	Walkers, dogs
6†	Grangemouth Port	1.75 km	0.14	0.07	Vehicles, industry
7	Grangemouth Port Locks	0.65 km	0.54	0.71	Ships, boats
8†	Grange Burn	1.20 km	0.58	1.05	Vehicles, industry
9	Grangemouth Refinery	1.35 km	2.79	0.00	Industry personnel, machinery
10	Kinneil Kerse	2.10 km	0.57	0.12	Walkers, dogs
11	Kinneil Reserve	2.45 km	0.62	0.36	Walkers, dogs
12	Bo'ness	1.87 km	4.73	1.91	Walkers, dogs
13	Grangepans	1.25 km	4.85	0.90	Walkers, dogs
14	Carriden	1.40 km	1.99	0.44	Walkers, dogs
15	Stacks	1.21 km	5.21	3.69	Walkers, dogs
16	Blackness	1.06 km	7.16	5.24	Walkers, dogs

* measured as average number of total activities per km per hour

† Index does not include frequent traffic movement along port roads adjacent to sector. Surveyors were unable to estimate number of movements per hour due to large numbers present, which would have distracted from survey. This regular activity did not appear to have any effect on bird distribution.

Results show a large range of baseline activity levels, with some sectors having little human activity (a number of surveys having no noted activities) and others where there is regular activity throughout the day. In general it is apparent that the survey area can be broadly split into three separate areas:

- Dunmore to River Carron (Sectors 1-5): characterised by low activity rates, particularly furthest upstream. Human activity mainly consists of walkers, sometimes with dogs. Occasional farming activities take place, and at times regular audible bird deterrents in the form of gas guns are deployed in fields close to the survey area.
- Grangemouth Port and Petrochemical Works (Sectors 6-9): characterised by regular, sometimes intensive activity, either vehicle movements along shore roads (not specifically counted by surveyors due to high frequency), or industry activity – personnel or machinery, within restricted areas away from the shore. Some shipping activity also occurs. During year 1, construction activities were consistent beside Sector 9, but this work was completed by year 2, hence the difference in activity rates.
- Kinneil to Blackness (Sectors 10-16): characterised by walkers and sometimes dogs and cyclists. Activity levels vary, and are likely to be related to ease of access (e.g. Bo'ness and Blackness sectors have relatively high activity rates, reflective of proximity to settlements and car parking). Activity is generally restricted to the John Muir Coastal Path.

Baseline activity levels are likely to provide an indication of the sensitivity of birds present within a particular sector, in relation to any potential construction work associated with the project. If work for example were to take place in Sectors 1-3, it is possible that birds may exhibit greater disturbance reactions, since such activity would be a significant change from baseline activity levels.

Other sectors such as those alongside built-up areas may host birds that are more tolerant of human activities (or birds are already distributed away from disturbance), and so are less likely to be significantly affected by increased levels of activity.

3.5 Disturbance Events

Disturbance events are considered to be those events that result in a change in behaviour and/or distribution and abundance of birds within a sector. Only a small number of baseline human activity levels outlined in Section 3.4 may result in observable disturbance to birds, as in many circumstances birds may have already adapted their behaviour to avoid human activity, are habituated to the presence of humans, or are at sufficient distance from the disturbance source (e.g. feeding on the lower shore).

Table 3-19 and Table 3-20 provide a summary of disturbance events recorded during surveys from August 2015 to April 2017. This includes any predator presence within each sector, which may also lead to disturbance (gannet appears to elicit a threat response by shorebirds so has been included as a "predator").

	Sector														
Disturbance Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Boat						5	2					1			
Dog walker		3		1	1					9	6	3	5	6	14
Farm machinery	1	1		1											
Farm vehicle	1			1											
Helicopter/aeroplane	1		1	1	1									1	
Industry machinery	1					1	3	2			2				
Industry personnel					1		1				2				1
Predator	2	1					1	1	1		1		1	1	1
Surveyor presence	4	3	3		1		2	2		1	2	1			1
Unknown	2				1		1					1		2	2
Walker		2			1					1	5	2	1	5	4
Wildfowling	1	2	3		1	1									
Total	**13**	**12**	**7**	**4**	**7**	**7**	**10**	**5**	**1**	**11**	**18**	**8**	**7**	**15**	**23**

Table 3-19. Disturbance Events during the 2015/16 Non-breeding Season

Sector	Date	Disturbance Event	Predator presence
1	25/08/2015	Diggers at 1100 dumping soil onto flood defence W of VP. Disturbed all waders out of area 1 and gulls from 1 to 2. Herons disturbed but returned to 1	Buzzard Kestrel
1	25/08/2015	Buzzard over saltmarsh briefly disturbed waders and moved gulls from mud to water.	Peregrine
1	28/09/2015	Farmer drove through field and flushed geese (1025). Settle on mid-channel mud.	Sparrowhawk Marsh harrier Merlin Gannet
2	25/08/2015	1102 - dogs heard barking quickly followed by curlew alarm calling. No sign of any of them	Kestrel Peregrine
3	-	-	Buzzard Merlin Gannet Sparrowhawk
4	25/11/2015	1112 - Light aircraft flew over, shelduck moved within zone, returned at 1117. 1232 - manoeuvres disturbed around 125 pink footed geese in fields behind VP	Buzzard Kestrel
4	27/04/2016	Tractor works in field south of VP throughout survey. Presumably activity forced lapwings from field to saltmarsh/mudflats	Sparrowhawk Gannet Short-eared owl
5	16/02/2016	Pink-footed goose disturbed by wildfowler during hour 3	Buzzard Kestrel Peregrine Sparrowhawk Gannet
6	25/08/2015	1109 - Speedboat. Most shelduck disturbed to other side of bay. Half of redshank on bank disturbed - 1117 boat back - no disturbance	Peregrine
6	28/04/2016	at 0950 loud bang, flushed most of gulls off breakwater/mud and out of sector	
7	16/09/2015	Uncontrolled roe deer fawns - playing, flushing redshank and dunlin off ponds but resettled.	Kestrel
7	21/10/2015	Hammering by workmen - disturbed c.30 feeding shelduck - took off and left sector	Sparrowhawk

Sector	Date	Disturbance Event	Predator presence
7	08/01/2016	Industrial noise may have disturbed curlew at 12:20	
8	22/02/2016	Siren alarm test at 1145, some birds disturbed. Most settled quickly.	Kestrel Sparrowhawk
9	24/09/2015	birds disturbed by gannets, buzzard and peregrine	Buzzard Peregrine Gannet
10	-	-	-
11	27/08/2015	0810 - man walking along track disturbed 80 lapwings and 50 shelduck.	Buzzard Kestrel Short-eared owl
11	27/08/2015	Two sets of people walking 2 dogs. First set disturbed 30 redshanks. Second set disturbed 20 redshanks.	
11	23/09/2015	Dogs with walkers, flushed around 50 feeding shelduck in south-east corner of sector	
12	27/08/2015	Sandwich terns flushed off roost due to steam train whistle and smoke at 10.50. Flew around bay.	Gannet
12	10/09/2015	1145: Dog walker flushed all birds at roost and high tide mark. Curlew and redshank flew off.	-
12	24/12/2015	In 1300-1320 period 2 people walked out on to the West Pier, disturbed roosting Oystercatcher and gulls. Oystercatcher flew and some landed at West end of sector, rest continued off west.	
12	22/01/2016	One walker in hour 6 disturbed roosting waders etc at West end of sector, birds resettled again.	
12	22/02/2016	In hour 4 people on piers at East end of the sector preventing the waders from roosting/ settling there.	
13	13/09/2015	3 boys on beach flushed redshank 1248	
13	24/11/2015	Pedestrian moved slightly off path, new roost area - disturbed some redshank at 1130.	-
14	10/12/2015	Pedestrian disturbed redshank - moved within sector - quickly resumed feeding. At higher tide disturbance resulted in redshank leaving sector	-
14	10/12/2015	Dog walker on path - made redshank take flight and shelduck walk further offshore	
15	10/11/2015	two persons walking on beach and a couple with dog – disturbed mallard flock offshore	Buzzard
15	13/10/2015	Two small children on bikes disturbed gulls off strand but not out of zone.	
15	17/02/2016	Two men searching along strand line, birds moved offshore to '14'. 1120 another man walking along shore, birds all off.	
16	31/08/2015	1200 - 2 yachtsman digging mooring into shore. Disturbed 6 black headed gulls, 20 metres down beach. 1400 - 160 curlew pushed off shore by human disturbance.	-

Sector	Date	Disturbance Event	Predator presence
16	31/08/2015	1210 - loose dog only disturbed 10 black headed gulls. 1255 - loose dog scared 50 gulls. 1315 - dog and two walkers scare 100 gulls all redshanks and about 10 oystercatchers. 1410 - 2 dogs running loose, scared last few gulls off shore.	
16	31/03/2016	Dog on the beach, most birds moved out	

Table 3-20. Disturbance Events during the 2016/17 Non-breeding Season

Sector	Date	Source	Description/ Species affected	Predator presence
1	13/10/2016	Unknown	Mallard	Short-eared owl
	23/11/2016	Surveyor presence	Wigeon, mallard	Kestrel
		Unknown	Curlew	
	23/11/2016	Seal	common seal surfaced just off sector, put up a lot of gulls who had been floating nearby.	
	23/11/2016	Helicopter	Low flying helicopter approached from south and crossed forth, following pylons. Many birds in sector took flight from bank, most returned and landed mostly on water	
	27/01/2017	Surveyor presence	Little egret	
	24/02/2017	Surveyor presence	Grey heron, mallard, teal	
	23/03/2017	Surveyor presence	Mallard, teal, wigeon	
		Gas gun	Pink-footed goose, oystercatcher	
		Wildfowling shots	Pink-footed goose, wigeon	
2	09/08/2016	Person	Jogger put up gulls and curlews along roadside	Peregrine
	10/10/2016	Dog walker	Dog with man on bund, gulls up.	Kestrel
		Dog walker	Man and dog walking through saltmarsh, birds moved off exit gulls.	
	12/12/2016	Person	2 men walked along bund from west, birds moved off a little	
	12/12/2016	Person/Raptor	Rentokill van man flying Eagle near Airth behind VP seen on way out from VP	
	23/01/2017	Surveyor presence	Curlew, teal, wigeon	

Sector	Date	Source	Description/ Species affected	Predator presence
	23/01/2017	Wildfowling	Wildfowler fired two shots as feeding flocks of teal and wigeon. Many birds in sector took flight	
	23/01/2017	Wildfowling	After taking shots, Wildfowler stood up and walked to meet another who had a dog. both walked from sector.	
	10/02/2017	Surveyor presence	Curlew, redshank	
	23/03/2017	Surveyor presence	Curlew, redshank, teal	
	23/03/2017	Gas gun	Number of shots, put off redshanks	
3	23/09/2016	Surveyor presence	Kingfisher	Gannet
	10/10/2016	Wildfowling	Wildfowler taking shots at pink-footed geese as they fly from sector. Continuous, with intervals of around seven minutes during hour	Kestrel Peregrine
	10/10/2016	Wildfowling	Black Labrador retriever occasionally making forays onto edge of sector as shots fired.	
	12/12/2016	Surveyor presence	Redshank	
	12/12/2016	Wildfowling	Gunshot in fields behind vp, put up geese there, put up heron too	
	22/02/2017	Helicopter	Helicopter flew S to N over sector, put up teal	
	22/02/2017	Surveyor presence	Curlew	
4	03/04/2017	Gas gun	Gas gun in arable field behind vp firing all day some disturbance but mostly ignored by birds	Barn owl
	03/04/2017	Dog walker	Man and dog , geese up	
5	20/02/2017	Unknown	Curlew, pink-footed goose	Kestrel
	20/02/2017	Helicopter	Helicopter, put curlew off	Buzzard
	04/04/2017	Dog walkers	Couple with dog off lead cycle track. Note dog walkers on path all morning just out of sight. Little disturbance.	Sparrowhawk
	04/04/2017	Personnel/Machinery	Fencing contractor in a tractor arrived working near lagoons. Birds moved to N end lagoon, workers in hi vis at edge of lagoons lots noise etc. Black-tailed godwit, grey heron, mute swan, tufted duck	
	04/04/2017	Surveyor presence	Redshank	
	04/04/2017	Uncontrolled person	Redshank	
6	03/10/2016	Small yacht	Shelduck	-

Sector	Date	Source	Description/ Species affected	Predator presence
	03/10/2016	Yacht	Small yacht travelled down river on near side of breakwater heading out into forth estuary. Most birds roosting on breakwater moved off, some returned shortly after	
	03/10/2016	Yacht	A second, noisier small yacht followed after first. Birds reacted similarly. This yacht produced a more powerful wake, washing birds off from breakwater	
	09/12/2016	Wildfowling shots	Teal, lapwing	
	09/12/2016	Boat	Small boat headed downstream in channel. Some birds moved out. Turned and headed back the way it came, up channel again	
7	26/08/2016	Boat	Port authority boat surveying mouth of dock; going back and forth across edge of zone, birds avoiding area (except terns)	Kestrel Sparrowhawk
	09/12/2016	Unknown	Red-breasted merganser	
	09/12/2016	Industry machinery	Drain cleaner emptied tank into reed bed. Black-headed gulls and redshank flew off	
	10/01/2017	Surveyor presence	Curlew, redshank	
	08/02/2017	Surveyor presence	Curlew, snipe	
	08/02/2017	Ship	Black-headed gull	
	06/04/2017	Industry machinery	Drain cleaning lorry present a number of times. Shelduck, water rail, cormorant, eider, mallard, teal affected.	
8	25/08/2016	Industry machinery	Excavator working just inside fence at port; birds wary - two shelduck flew	-
	25/08/2016	Predator	Fox moved Wigeon across inlet 1231	
	09/02/2017	Surveyor presence	Redshank	
	06/03/2017	Surveyor presence	Redshank, teal	
10	-	-	-	Gannet
11	08/08/2016	Dog walker	Most birds, all waders, disturbed by dog walker, dog at heel on path on bund	Buzzard
	08/08/2016	Dog walkers	Man & child + 2 dogs off lead along bund path, all gulls up but resettled	Gannet
	24/11/2016	Dog walker	Man and dog off lead -birds all moved away from path. 2nd disturbance 1221-1237 couple and dog off lead walking round lagoon. Birds moved well away for extended time. Black-headed gull, cormorant, grey heron, mallard, redshank, teal	

Sector	Date	Source	Description/ Species affected	Predator presence
	24/11/2016	Surveyor presence	Teal	
	21/02/2017	Dog walker	Woman with two dogs E along path	
	21/02/2017	Dog walker	Dog walker heading W along path, throwing stick for dogs	
	21/02/2017	Dog walker	Two women, 9 dogs	
	07/04/2017	Dog walkers	Family with dog walking W along path, some birds moved further out onto mud	
12	25/08/2016	Industry personnel	Contractors; working on west pier; area disturbed as mud appeared	-
	24/11/2016	Person	Person walked out onto pier, put oystercatcher flock up. Birds crossed bay to join curlew/wildfowl flock at river mouth	
	24/11/2016	Predator	Female sparrowhawk in sector; several curlew took flight	
	24/11/2016	Surveyor presence	Redshank	
	24/11/2016	Industry personnel	Two men in hi vis walked along path by water. Most feeding redshank took flight	
	23/12/2016	Surveyor presence	Oystercatcher, redshank, teal	
	23/12/2016	Industry machinery	Digger working on shore path, birds moved off when it started then settled down again.	
	23/12/2016	Dog walker		
	23/12/2016	Dog walker	Person jogging and loose dogs x2	
	23/12/2016	Dog walker	Woman and two dogs	
	23/12/2016	Dog walker	Woman and dog. Redshank flew off	
	07/04/2017	Dog walker	Flocks of oystercatcher and redshank flushed by dog. Some returned to similar area within minute but a number of oystercatchers left sector to go upstream	
	07/04/2017	Person	Flock of 13 redshank disturbed by walker. Moved to mudflats within sector and continued to forage	
13	29/08/2016	Ship	Wake of chemical oil transporter reached edge of mudflat and put off flock of bar-tailed godwits who were feeding there. Birds left sector	Gannet
	23/12/2016	Unknown	Turnstone	
	23/12/2016	Dog walker	Man in hi vis walking German shepherd, gulls moved to water	
	23/12/2016	Dog walkers	Small group of people with dog on path	
	23/12/2016	Dog walker	Dog walker with 2 dogs	
	25/01/2017	Surveyor presence	Redshank	

Sector	Date	Source	Description/ Species affected	Predator presence
14	25/11/2016	Dog walker	Dog walker on beach, put up roosting birds	Arctic skua
	25/11/2016	Dog walker	Dog walker on beach, birds moved to water	
	25/11/2016	Dog walker	Man and three dogs on beach	
	26/01/2017	Dog walkers	Five people and two dogs on each, put redshank off	
	28/03/2017	Seal	Curlew flushed by grey seal	
15	28/11/2016	Unknown	Grey heron, curlew, oystercatcher, redshank, shelduck, wigeon, great-crested grebe	-
	13/12/2016	Predator	Buzzard low over shore, curlew moved	
	13/12/2016	Dog walkers	4 dogs off lead on path with 2 men, curlew flew off	
	13/12/2016	Person	Curlew flew off	
	24/03/2017	Unknown	Shelduck, curlew	
	24/03/2017	Dog walker	Man and dog off lead walked along shore from NW birds flew off	
	24/03/2017	Person	Person walking on path, curlew flew off	
	24/03/2017	Dog walker	Person walking 3 dogs off lead on path CU up and away	
	24/03/2017	Dog walker	Man and 3 dogs run along path again , all birds off	
	24/04/2017	Blimp	Large blimp in sky over Grangemouth all day	
	24/04/2017	Persons	Couple walking on shore path	
	24/04/2017	Dog walker	Man and dog off lead walking shore path	
16	13/12/2016	Unknown	Wigeon	Arctic skua
	24/03/2017	Surveyor presence	Curlew, redshank	
	24/03/2017	Unknown	Redshank	
	26/08/2016	Dog walker	Dog walker put up black-headed gull flock	
	28/11/2016	Dog walker	Dog walker with two dogs along John Muir way. Wildfowl moved out onto water	
	28/11/2016	Dog walkers	Couple with two dogs on beach, wigeon moved out	
	28/11/2016	Person	Cyclist on John Muir way, wigeon out to water	
	28/11/2016	Dog walker	Dog on beach, chased wigeon into water	
	13/12/2016	Persons	Three people walked out onto pier, put off gulls who were hanging around there	
	13/12/2016	Dog walkers	Two dog walkers on path by beach. Some gulls moved out onto mud.	
	13/12/2016	Dog walker	Man with active dog on beach. Feeding wigeon moved to deeper water	

Sector	Date	Source	Description/ Species affected	Predator presence
	13/12/2016	Persons	Five people on path, wigeon swam out to deeper water	
	13/12/2016	Person	Person walked to end of pier, put gulls off	
	13/12/2016	Dog walkers	Dog walkers with very excited dog onto beach, wigeon moving out	
	13/12/2016	Predator	Two peregrines, one male one female, actively hunting Dunlin in sector.	
	23/02/2017	Dog walker	Dog walker E along path	
	23/02/2017	Uncontrolled dog	Dog wandering around beach	
	23/02/2017	Dog walker	Dog walker W along beach	
	24/03/2017	Dog walkers	Couple with dog chasing ball and any birds.	
	24/04/2017	Dog walker	Man walking dog throwing ball around on beach. Redshanks moved away.	

Results in the above tables show that relative to baseline activity levels outlined in Section 3.4, a higher proportion of disturbance events are more likely to result when human activity occurs in the normally quiet sectors north of the River Carron. In contrast, a relatively small proportion of disturbance events occurred around the Grangemouth Port and Petrochemical works, likely because access to the shore is restricted, and birds may be habituated to most regular industrial activities. Disturbance events did happen along the coastal path Sectors 10-16, commonly when dogs were present, although disturbance rates were low in comparison with the amount of background activity. Most disturbance occurred to birds closest to the path.

3.6 Breeding Season Surveys

A total of 70 species were recorded during the breeding season surveys. Of these, 18 are SPA qualifying interests.

Table 3-21 to Table 3-23 show the results of monthly breeding season surveys in 2016. In each table the total counts of each SPA/SSSI target species within the 16 sectors is shown. Highlighted in orange is the sector within which a probable or confirmed breeding attempt by a particular species was recorded (the value within the highlighted cell does not reflect the number of breeding behaviour observations – in practice only single pairs, or small numbers of pairs are likely to have attempted to breed in each Sector). Breeding evidence was observed for lapwing, redshank, oystercatcher and shelduck.

A full list of all species observed is presented in Appendix 1.

Table 3-21 Breeding Season Results – SPA Species: Visit 1 May 2016

	Sector														
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Bar-tailed godwit									5						
Black-tailed godwit									1	8					
Common tern					7	24	1				15	4			
Cormorant	4	1	3			2									
Curlew			13	6	1		2		1					11	2
Dunlin				55											
Eider														3	
Lapwing			8	6											
Mallard	8	4		3	1	2	1		5	3					
Oystercatcher		4	2	105	1			5	74	15	2		2	1	
Redshank	3		4	1	2										
Shelduck		4	16	35	3	9		6	70	24	2	2		8	
TOTALS	15	13	46	211	15	37	4	11	156	50	19	6	2	23	2

Table 3-22 Breeding Season Results – SPA Species: Visit 2 June 2016

	Sector

Species	1	2	3	4	5	6	7	8	10	11	12	13	14	15	16
Bar-tailed godwit									1	2					
Black-tailed godwit					13										
Common tern	1	10	4		3	69	6						1		
Cormorant				3		2	1				1	2	1		
Curlew		5	5	22	1	1	1		5	1			1	6	
Eider														6	
Great crested grebe					2					1					
Lapwing	1		3	23	15			5	93						
Mallard	13	4		1	22	3	4								
Oystercatcher	2	6	4	14	2		4	3	12	21	2	2		2	
Pink-footed goose		6													
Red-breasted merganser		1								8				1	
Redshank	2		6						20	1					
Ringed plover									1						
Sandwich tern		1											1		
Shelduck		1	11	136	41	51	30	7	23	58	36	4	2	1	
TOTALS	**19**	**34**	**33**	**199**	**99**	**126**	**46**	**15**	**155**	**92**	**39**	**8**	**6**	**16**	**0**

Table 3-23 Breeding Season Results – SPA Species: Visit 3 July 2016

	Sector														
Species	1	2	3	4	5	6	7	8	10	11	12	13	14	15	16
Bar-tailed godwit											95				
Common tern						5						2			
Cormorant	7	1		10		1						1	1		3
Curlew	9	27	52	114		46	262	2	37		5	2	2	15	56
Eider														2	
Goldeneye					1										
Lapwing				4	234				112						
Mallard	30	4	5		4	6									
Oystercatcher		2		10	6	4	11	1	13		1			4	6
Redshank						226	190		299						
Ringed plover									2						
Sandwich tern									3	2		4	1		
Shelduck		1	115	95	33	90	1545	8	590	30	1	27	13	7	
TOTALS	**46**	**35**	**172**	**233**	**278**	**378**	**2008**	**11**	**1056**	**32**	**102**	**36**	**17**	**28**	**65**

In general, peak flock sizes for all SPA species were much smaller during the breeding season compared to both winter periods. It was however evident that SPA species are present throughout the summer period, and this is likely to reflect the presence of non-breeding individuals (e.g. 13 black-tailed godwits in Sector 5 in June), or recently failed or finished breeders (e.g. 299 redshanks in Sector 10 in July). The distribution of records (Figure 13) shows that birds are found widely across the mudlflats in summer, particularly from Sectors 4-11. Usage is also made of the onshore lagoons

in Sectors 5 and 11. Downstream of Sector 11 only a few SPA species were present (mainly shelduck, curlew and oystercatcher), although feeding Sandwich terns were also recorded on a number of occasions.

4 DISCUSSION

4.1 Wintering and Migrating Birds

The key roost sites, and therefore potentially most sensitive locations identified within the survey area appear to be in the vicinity of Grangemouth Port and Petrochemical works, and Kinneil (Sectors 6-11) where despite there being high levels of background noise and activities, human access to the foreshore is limited, disturbance is infrequent, and man-made and natural structures are suitable for high tide roosting. Largest numbers of roosting waders were recorded between December and March, with particularly high numbers in January 2017 in Sectors 9 to 11. Distribution was relatively consistent between years 1 and 2. Particularly important roost locations identified are:

- Adjacent to the downstream side of the Kincardine Bridge in Sector 3;
- The breakwater adjacent to Grangemouth Port in Sector 6;
- The sheltered bay adjacent to Grangemouth Petrochemical works in Sector 9;
- Mudflats and creeks at the mouth of the River Avon (Sector 10);
- The lagoon at Kinneil (Sector 11); and
- The sheltered bay adjacent to Kinneil Island (Sector 12).

Large areas of mudflats exist adjacent at Skinflats and Kinneil which are also used by large numbers of birds for roosting and feeding at certain parts of the tidal cycle. Any incursions relating to the FPS works close to the foreshore at higher tides in these areas are likely to result in disturbance to high numbers of birds, in flock sizes that are important at an SPA/ estuary level.

Upstream in Sectors 1-5 numbers of birds are generally lower, despite infrequent human activity. Roosting locations are more limited and the extent of mudflat is smaller, although inland fields provide roost and feeding opportunities for species such as pink-footed goose, curlew and lapwing. Because of low levels of baseline activity, it was observable that a greater proportion of human activities in these Sectors are likely to result in disturbance to birds present, particularly when close to the shore at high tide.

Downstream between Bo'ness and Blackness Castle human activity is frequent and likely to have already influenced bird distribution and behaviour. Birds are present in smaller numbers than further upstream (although gulls and ducks that roost further offshore can be numerous), but are potentially more tolerant of human activities. Disturbance events were still observable towards high tide, when birds were forced closer to the coastal path. Coastal works are therefore likely to prevent high tide usage in local areas.

4.2 Breeding and Summering Birds

Small numbers of SPA species were recorded through the breeding season across the survey area. In a number of cases, birds present were non-breeders, with the Firth of Forth being outside of the breeding range of such species (e.g. godwits, dunlin). In other examples (e.g. curlew, lapwing, redshank, shelduck), a mixture of non-breeders and a small number of breeding birds may have been present, with breeding habitat within the survey area limited. The large mudflats appear to be favoured by birds during the breeding season.

5 FUTURE REQUIREMENTS

The two year dataset, combined with historic data obtained during the desk-based study (e.g. WeBS count data) and scientific literature available on disturbance, is considered sufficient for a robust assessment of the SPA and estuary populations of birds, to fulfil the requirements of the EIA and HRA processes.

When more detailed plans of the FPS are available, further surveys may be required in areas that are earmarked for possible compensation requirements, due to habitat loss incurred. These should take place monthly throughout the non-breeding season to record presence of SPA species for HRA requirements, and during the breeding season, to record breeding species for EIA requirements.