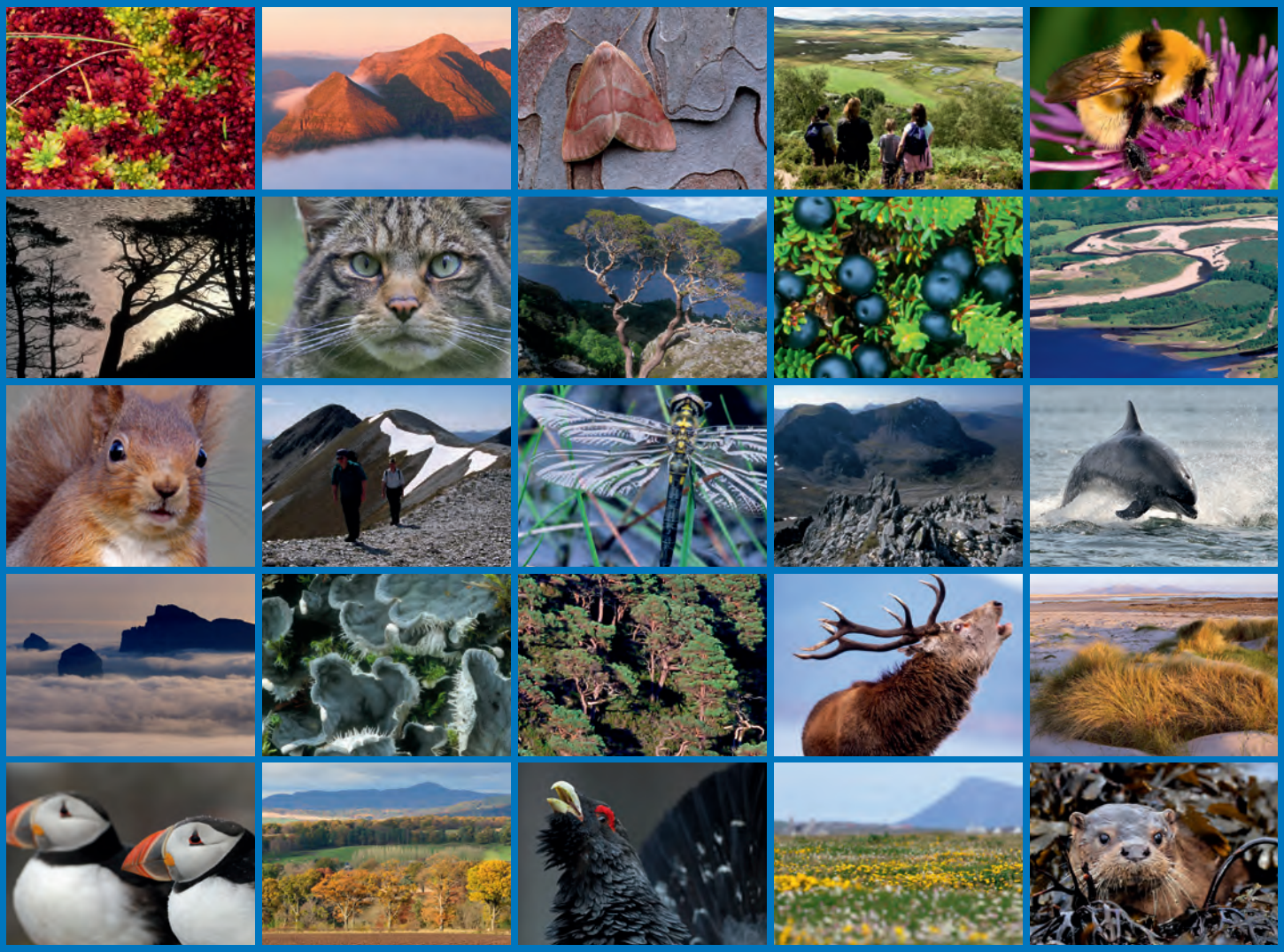
Scottish Natural Heritage
Commissioned Report No. 714

Investigation of Standing Water and Wetland SSSIs thought to be under Diffuse Pollution Pressure: Auchrochar Wetlands



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COMMISSIONED REPORT

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Investigation of Standing Water and Wetland SSSIs thought to be under Diffuse Pollution Pressure: Auchrochar Wetlands

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COMMISSIONED REPORT

Summary

Investigation of Standing Water and Wetland SSSIs thought to be under Diffuse Pollution Pressure: Auchrochar Wetlands

Commissioned Report No. 714
Project No: 13700
Contractor: EnviroCentre Ltd.
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Keywords

Diffuse pollution; SSSIs; wetland; water; soil; samples; recommendation.

Background

SNH contracted EnviroCentre to look at a number of Sites of Special Scientific Interest across Scotland thought to be adversely affected by diffuse pollution. EnviroCentre was asked to carry out a number of tasks to help SNH understand better whether sites are being affected by diffuse pollution and if so, what activities might be contributing to this pressure and how SNH could improve the condition of the sites.

If sites are identified as being affected by diffuse pollution, SNH hope that the results of this report will inform their work with managers of the sites to improve their conditions.

Main findings

- The analytical data supported claims of elevated nutrient status from agricultural improvements to the surrounding land. It should be noted that the sampling assessment was undertaken as a single visit and the limited scoped dataset and a lack of historical data constrained the ability to draw accurate conclusions to fully inform current site conditions.
- The desk study and site walkover identified potential existing and historical land use practices within the catchment that could adversely affect water quality and soil nutrient status. This included long-term changes to the nutrient status of the site resulting from diffuse agricultural sources, management practices and alteration to natural drainage routes within the catchment.
- A series of recommendations are proposed to seek to confirm the inflow of nutrients to the site. It is considered that this additional information will help further the understanding of the perceived changes taking place at the site.

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Table of Contents **Page**

Acknowledgements

EnviroCentre Ltd would like to thank the SNH Operations staff for their time and assistance in providing access to the site files held at the local office, providing landowner contact details, and in aiding the preliminary understanding of the site to assist with the health and safety evaluation prior to the initial visit.

Thanks are also extended to the site landowners for affording access to the site to enable the agreed scope of work to be undertaken.

1. INTRODUCTION

EnviroCentre Ltd was contracted by Scottish Natural Heritage (SNH) in August 2012 to deliver the 'Investigation of Standing Water and Wetland SSSIs under diffuse pollution pressure' project. The data collected from the project will be used to inform management decisions on wetland and standing water Sites of Special Scientific Interest (SSSI).

1.1 Site Location

Auchrochar Wetlands is located 2.5 kilometres (1.5 miles) east of Stranraer. The site is accessed from an unnamed road off the A75(T). See Figure 1.1 in Annex 1.

1.2 Site Description

Auchrochar Wetlands is a Site of Special Scientific Interest (SSSI) designated for a basin fen feature. It is one of the least disturbed areas of swamp and fen vegetation in Wigtownshire (SNH, 2010a). The site comprises an area of 24.42 hectares, lies at an altitude of 9 metres AOD, and has been designated since 1988.

The site is bounded by the A75 trunk road to the north, open farmland comprising improved pasture to the west and south and woodland and a gravel pit to the east. An accessible man-made causeway runs east-west through the site and at the far end of the site there is a bridge over the central drain which affords access to the southern half of the site.

The habitat is of recent origin, being developed since 1942 from farmland on the site of a loch first drained in 1860. The south east side of the site is on slightly higher ground and the site comprises a standing area of open water. The open water varies considerably in extent over a given year and according to SNH site visit reports (SNH, 2010c) appears to be increasing yearly as the former drainage deteriorates.

The swamp and fen vegetation supports a large breeding population of sedge warbler (*Acrocephalus schoenobaenus*) and there is a diverse bird population of both breeding and wintering species characteristic of wetland. The site is used regularly as a hunting area for a number of raptors (SNH, 2010a). During winter months the site is prone to flooding and as a result hosts large numbers of waterfowl, particularly Common Teal (*Anas crecca*). Recreational wildfowl shooting takes place on the site (SNH, 2010b).

The underlying bedrock of the site is Loch Ryan Formation Sandstone, overlain with superficial peat deposits. Glacial-fluvial deposits comprising gravels, sands and silt are evident on the higher ground in the south eastern part of the site (SNH, 2010c).

Note - The condition monitoring form (SNH, 2010c) states that the citation for the SSSI is incorrect in that the site was first drained in the 1860s and not, as stated, the 1960s (see section 1.4).

1.3 Site Hydrology

A catchment area of 2.25km^2 drains to the wetland, with an annual average rainfall of 1080mm (Centre for Ecology and Hydrology, 2009). The main inflows to the site are field drains and overland flow from adjacent farmland. An area of ponded water is present to the centre of the site. A small unnamed watercourse forms the main outflow from the site, flowing to the north west along the southern boundary of the A75(T), before entering a culvert under the road and joining the Bishop Burn.

The original site drainage is understood to have comprised a herringbone formation system (SNH, 2010b).

1.4 Site History

The site was once a shallow loch, drained prior to the Second World War - possibly in the 1860s - and comprised a culvert running to the Bishop Burn. The drained ground was cultivated, with grazing land on the southern compartment and vegetation cut for thatch on the northern compartment and there are also records of peat cutting having taken place, but during the Second World War the pattern changed. Firstly, due to the collapse of a culvert and secondly, due to the interruption of the existing drainage pattern through the installation of a water supply to a nearby hospital, which crossed the site. A sewage filtration plant was also constructed in the north east end (date unknown) (SNH, 2010c).

Prior to notification in 1988, the A75(T) was widened and the estate owners reported they were having difficulties with water levels on the site. As a result, extensive swamp and open water features dominated the site (SNH, 2010c).

It is noted that historical (1984) mapping highlights that the open water bodies on the southern compartment of the site (*i.e.* south of the causeway) appear to have receded and comprise mainly swamp vegetation (SNH, 2010c).

1.5 Recent Site Management Practices

Outwith the information contained in the Site Management Statement (SNH, 2010b) there has been limited information available regarding previous or existing management practices.

The owner manages the land as part of a shooting enterprise. This mainly concentrates on wildfowl, however, pest and predator control takes place throughout the year. Some cutting of vegetation around shooting butts also takes place. There is occasional vehicle use on the central causeway and some ditch maintenance is reported to have been carried out by the site owner to help with drainage issues (SNH, 2010b). It is also reported that over the last 60 years, the site has become increasingly wet (SNH, 2010c).

It is understood that there is no management agreement in place for the site at present.

2. METHODOLOGY

The following sections outline the approach undertaken to fulfil the scope of works established by SNH in the Statement of Requirements (SOR).

2.1 Pre-site Attendance Desk Study

Before the initial site visit was undertaken the local SNH officer was contacted and a meeting held at the corresponding local office to discuss the local understanding of the site and review SNH records. Access to non-publically available data held by other regulators, including SEPA, was not available.

The meeting was also used to provide an insight into any health and safety constraints not readily apparent from the site maps.

Landowners of the site were notified of the planned site visit a week before the proposed visiting date. This allowed landowners the opportunity to ask any questions and also gave EnviroCentre staff a chance to gain a greater understanding of the workings of the site and the site surrounds.

2.2 Site Attendance

The site was accessed and samples collected over a one day period – termed Visit 1. A follow up visit to the wider catchment was undertaken once the analytical data was available and appraised in context with the information obtained from the desk based exercise. Table 2.1 below shows site conditions on the day of each visit.

Table 2.1: Site Conditions

Auchrochar Wetlands	Date of Visit	Weather Conditions	Grid References
Visit 1	26 October 2012	Dry, cold and sunny	NX 094605
Visit 2	19 February 2013	Clear, cold and sunny	NX 094605

2.3 Sampling Approach

SNH had determined the preferred locations for the collection of soil and water samples – as detailed in Figure 2.1 in Annex 1. EnviroCentre was not involved in determining these locations and had not assessed the suitability to access such before Visit 1. Due to certain access restrictions the locations of samples that EnviroCentre collected had to be changed and are as detailed in Figure 2.2 in Annex 1. Changes to locations were kept to a minimum and are generally not deemed to have a significant impact on the sampling or conclusions.

All sampling methods were carried out by trained personnel. Photographs of each sampling location were taken (see Figure 2.3 in Annex 1) and grid references for each location recorded.

2.4 Sample Equipment

The following sample kit was used to undertake site field work:

- Handheld GPS to record specific grid references;
- Handheld soil augers;
- Plastic bailers;
- Sample bottles (all sample bottles were written on to record locations, date and time); and

- Personal Protection Equipment (PPE - in line with the requirements of the site specific health & safety risk assessment).

All samples were given unique identification names and packaged in cool boxes with ice packs so as to keep samples at appropriate temperatures prior to being despatched to a United Kingdom Accreditation Service (UKAS) accredited laboratory for analysis.

2.5 Health and Safety

Site specific risk assessments were carried out before attending site. The assessment was based on information obtained from the meeting with the local officer and from EnviroCentre's extensive experience of undertaking previous work of this nature.

The risk assessment, which was carried by staff attending the site visit, included details of the landowner, nearest emergency services and identified risks and proposed means of mitigation. Field operatives notified EnviroCentre head office when entering and leaving site and wore the following appropriate PPE at all times:

- Warm and waterproof clothing;
- Waders;
- Waterproof footwear; and
- Hi-vis vest.

Biosecurity measures were implemented when entering and leaving site. Boots and equipment were washed when leaving site so as not to cross contaminate subsequent sites.

2.6 Water Samples

Surface water samples were collected from strategic locations within the surface water courses on site. Collections were made from inflows, standing water areas and outflows, to give a rounder picture of what is happening to the whole watercourse.

Groundwater samples were collected using plastic bailers from slotted pipes installed with hand augered holes where soil samples were originally collected. The sampling methodology employed a geosock membrane for coarse filtration so as to minimise samples being heavily loaded with suspended solids and organic material.

Samples underwent initial on-site field tests using an OTT Quanta Handheld probe for the following parameters:

- pH;
- Temperature;
- Electrical Conductivity (EC);
- Dissolved Oxygen (DO);
- Oxidation-Reduction Potential (ORP); and
- Salinity.

The water samples were submitted for the following analyses to a UKAS accredited laboratory:

- Total calcium (Ca) and magnesium (Mg) and sodium (Na);
- N Species – total nitrogen, nitrate and ammonium;
- P Species – orthophosphate and total phosphorus; and
- Total Iron.

Dissolved and ferrous iron analyses were scheduled in but could not be undertaken by the laboratory due to insufficient sample. This data would have supported interpretation of results if available but is not considered critical for determining the presence or potential sources of diffuse pollution.

2.7 Soil Samples

Soil samples were collected from specific locations on site by hand augering holes into the ground. The soil samples were collected at two depths:

- The rooting zone; and
- A depth of approximately one metre below the rooting zone.

  NB - In the corresponding results tables the samples are differentiated by the suffix 'A' for the rooting zone; and 'B' for below the rooting zone.

Soil samples were analysed for the following suite:

- Moisture Content;
- Extractable nitrogen and phosphorus;
- Total nitrogen and phosphorus; and
- Total calcium (Ca); magnesium (Mg) and potassium (K).

Bulk density analysis was scheduled in but could not be undertaken by the laboratory due to insufficient sample. Total sodium (Na) and total organic carbon (TOC) were not scheduled in properly and analyses were not undertaken. The lack of this data is not considered to affect interpretation of results in terms of determining the presence and potential sources of diffuse pollution.

2.8 Field Observations

On accessing the site for the first visit, and the wider catchment for the second visit the following field observations were noted:

- Geo-referenced photograph locations of surrounding land-use (see Figure 2.4 in Annex 1);
- Adjacent land use;
- Identified and potential pollution sources; and
- Atypical or unusual site features (*e.g.* fly tipping, vandalism, *etc*.).

In addition, mapping of the immediate surrounding catchment was completed following the second site visit (see Figure 2.5 in Annex 1). This process utilised the Flood Estimation Handbook (Centre for Ecology and Hydrology (CEH), 2009) catchments and Land Cover data (Land Cover Map 2007) to populate GIS mapping. The output was used to aid the interpretation of results and further inform the study conclusions.

3. STUDY LIMITATIONS

The scope of the commissioned study presented a series of limitations which should be borne in mind when reviewing this report. These are outlined below:

- Sampling was undertaken on a single visit. Whilst this afforded consistency for the samples collected, the weather conditions preceding and at the time of the visit may have directly influenced the observations made and the analytical results obtained.

- For the same reasons outlined above, access to certain parts of the site may have been restricted and limited access to the predetermined sampling location.

- Sampling comprised a single set of samples from each of the pre-determined locations. Repeat or continuous sampling over an extended (seasonal) period would be preferred to enable a greater dataset to be collected. This would present a more representative assessment of the site and allow for seasonal/climatic variations.

- The dataset provides a 'snapshot' of the site condition. Due to the limited availability of historical data (see section 1.4) there is very limited scope for comparisons to be made with previous records or allowance for assessment of seasonal or climatic factors.

- The scope of work did not include the assessment of rainfall within the catchment, measure loch levels or the inflow(s)/outflow(s) of associated watercourses.

- The limited dataset does not allow for any statistical analysis of the results to be undertaken. No adjustment has been made for anomalous results or to determine trends over time.

- The sampling methodology used to obtain groundwater samples (obtained from a circa. 1m depth coupled with geosock membrane for coarse filtration) typically results in these samples being heavily loaded with suspended solids and organic material meaning that the samples appear 'dirty' to the naked eye. To avoid interference with the laboratory analytical instrumentation and erroneous results, on receipt at the laboratory these are processed on a x10 dilution. It is this dilution process which explains why some of the results are reported as a less than value rather than the equivalent level of detection of 'clean' samples. The same dilution approach is applied to heavy silted surface water samples.

- The weather conditions prior to and during the site visit should be taken into consideration when reviewing the results. According to the Met Office (n.d.) the seasonal rainfall totals for summer, autumn and winter 2012 in western Scotland were 144%, 104% and 128% respectively of the annual average rainfall levels for the period 1981-2010. This should be taken into consideration when reviewing the results as it could result in bias when compared with years where average rainfall levels were recorded. The higher rainfall will directly influence runoff, dilution and catchment water levels/throughput which have not been assessed.

- Due to limitations in the mapping data used to compile the Flood Estimation Handbook (FEH) catchment boundary, the area defined in the Annex 1 maps does not necessarily present a fully accurate reflection of the hydrological catchment for the site. Whilst this affords a valuable tool for the purposes of this study, the mapped boundary should be viewed as an indicative guide only and be subjected to detailed verification to be considered definitive.

4. ANALYTICAL DATA

The following tables show the results obtained from the initial site visit (Visit 1) in which samples from the pre-determined locations (or as close to as practically possible) were collected. Where the pre-determined locations were not accessible comparable alternative locations with the same habitat features were sampled.

Table figures in red indicate relative atypical (*e.g.* high or low values) or anomalous results or observations relative to the collected dataset or which would typically be expected from a site of this nature. These are discussed further in section 6.2.

4.1 Water Quality Field Data

The following data was collected by a suitably qualified operative using the methods outlined in section 2.

Table 4.1: Water Quality Field Data and Observations

Sample ID	Nat. Grid Reference		Temp (°C)	pH	Salinity (psu)	DO (%)	DO (ppm)	ORP (mV)	EC (mS/cm)	Comments
AW01	NX 094070	60541	10.76	7.88	0.12	100.3	11.81	211	0.261	Surface water - very slightly cloudy with some very minor suspended solids; no odour
AW02	NX 098600	60400	10.25	7.30	0.16	45.9	4.55	227	0.336	Groundwater - dark cloudy brown with very fine brown suspended solids; no odour
AW03	NX 096280	60469	9.75	7.48	0.16	63.0	6.67	185	0.346	Groundwater - dark cloudy brown with fine brown suspended solids; no odour
AW04	NX 097580	60257	10.31	7.24	0.24	53.4	5.83	177	0.503	Surface water - very slightly discoloured; moderate flow very fine suspended solids; no odour
AW05	NX 097500	60214	10.22	7.31	0.10	76.1	8.48	183	0.214	Surface outfall - slightly cloudy with very fine suspended solids; no odour
AW06	NX 096160	60254	10.24	7.74	0.50	85.9	8.53	176	1.029	Surface water - light green/brown colouration; strong effluent (farm) odour (uphill from wetland); mixed size suspended solids; slow flow
AW07	NX 091060	60644	5.20	7.24	0.21	52.1	6.22	94	0.455	Surface water - clear with small green pond weed on surface no obvious flow; no odour
AW08	NX 091060	60500	4.60	7.35	0.07	18.0	2.20	91	0.157	Groundwater - dark cloudy brown; no odour
AW09	NX 089540	60300	5.35	7.17	0.08	48.2	6.05	128	0.171	Surface water - cloudy, light brown/green pond weed; weed on surface; no obvious flow; no odour
AW10	NX 089540	60300	6.27	6.31	0.06	35.0	4.27	179	0.125	Groundwater - dark cloudy brown; no odour

4.2 Laboratory Results

The data in the following tables was collected by a suitably qualified operative using the methods outlined in section 2.

Table 4.2: Water Samples – Laboratory Analysis

Sample ID	Nat. Grid Reference		Sample Type+	Total Ca (mg/l)	Total Mg (mg/l)	Total Na (mg/l)	Total Fe (mg/l)	Amm N (mg/l)	Nitrate as N (mg/l)	Phosphate as P (mg/l)	Total P (mg/l)	Total N as N (mg/l)
AW01	NX 094070	60541	SW (OW)	12	8	23	0.27	0.04	<0.2	<0.01	<0.1	<1
AW02	NX 098600	60400	GW	26	11	20	2.29	0.80	0.7	0.09	0.2	5
AW03	NX 096280	60469	GW	27	12	27	4.38	1.20	0.5	<0.01	0.7	14
AW04	NX 097580	60257	SW (OW)	35	19	15	0.10	0.01	7.0	0.07	0.1	<1
AW05	NX 097500	60214	SW (I)	17	4	8	0.37	0.02	0.8	0.51	0.6	6
AW06	NX 096160	60254	SW (I)	58	22	44	1.77	29.20	8.6	10.90	21.2	78
AW07	NX 091060	60644	SW (O)	34	18	16	0.71	0.01	4.6	0.05	0.7	2
AW08	NX 091060	60500	GW	26	11	11	11.30	0.04	0.5	0.11	1.3	13
AW09	NX 089540	60300	SW (I)	19	5	8	1.58	0.11	0.5	0.05	0.2	5
AW10	NX 089540	60300	GW	38	9	7	17.10	0.90	<0.2	<0.01	1.6	34

+ Surface water samples are designated either inflow (I), outflow (O) or open water (OW)
Red figures denote samples that exceed Typical Ranges

Table 4.3: Soil Samples – Laboratory Analysis

Sample ID	Nat. Grid Reference		Soil Type	Extractable N (mg/Kg)	Total Ca (mg/Kg)	Total Mg (mg/Kg)	Total P (mg/Kg)	Total K (mg/Kg)	Tot Moisture * 105°C (%)	Total N (mg/Kg)	Nitrate (mg/l)	Nitrogen (%)	Extractable P (mg/l)
AW02A	NX 09800	60400	High organic dark coloured wet sludge	1.3	9730	4540	854	1200	85.1	<1.5	<0.2	1.82	<2.0
AW02B	NX 09800	60400	High organic dark coloured wet sludge	<0.5	14500	4950	425	364	74.7	<0.7	<0.2	1.96	<2.0
AW03A	NX 09628	60469	High organic dark coloured wet sludge	0.6	10100	2170	863	494	94.5	<0.8	<0.2	2.31	3.33
AW03B	NX 09628	60469	High organic dark coloured wet sludge	3.8	17700	2550	347	129	73.4	<4.0	<0.2	0.14	7.52
AW08A	NX 09200	60500	High organic with some gravels	0.7	11300	1640	456	387	62.3	1.4	0.7	1.28	2.83
AW08B	NX 09200	60500	High organic with some gravels	1.8	2180	2450	271	808	36.6	<2.0	<0.2	0.14	7.52
AW10A	NX 09300	60300	High organic with some gravels	1.1	5660	1850	793	612	67.5	<1.3	<0.2	1.78	<2.0
AW10B	NX 09300	60300	High organic with some gravels	0.7	12100	3110	416	1120	66.7	<0.9	<0.2	1.80	<2.0

** Soil types are field observations*
*** Total Moisture = Water content*
*A/B suffix: **A** = Rooting Zone and **B** = Below Root Zone*
Red figures denote samples that are above typical ranges for the observed dataset.

5. SITE OBSERVATIONS

To enhance the understanding of Auchrochar Wetlands and the surrounding area, preliminary research was undertaken and complemented with a second site walkover to further understand the landforms, drainage configurations, potential environmental sensitivities and possible diffuse pollution sources influencing the site.

5.1 Desk Study

The Site Management Statement (SNH, 2010b) records an 'Objective for Management' of enhancing the conditions of the site by maintaining the extent of basin fen habitat; by maintaining the high water table and natural fluctuations including winter flooding of the site; maintaining the extent and quality of reed bed habitat by water level management and reed cutting and scrub management; maintaining the low nutrient water quality by maintaining existing water quality to prevent loss of plants and invertebrates; and maintaining a mosaic of some taller scrub to support the sedge warbler and other breeding bird interested by rotational cutting of scrub on a long-term basis.

According to the latest Site Condition Monitoring assessment the basin fen is in unfavourable declining condition (SNH, 2010c). This assessment indicated that drainage pattern on the site has changed historically and in recent years. The site was drained prior to World War II. The site became wetter after the war due to the collapse of a culvert and interruption of the drainage pattern through the installation of a water supply to a nearby hospital. Widening of the A75 may have also led to higher water levels on the site and further waterlogging has been observed since notification in 1988. However, open water bodies on the southern compartment of the site appear to have receded and comprise mainly swamp vegetation at present.

The Site Condition Monitoring assessment concluded that the site is showing a successional change in vegetation as a result of hydrological changes since notification. The component communities are still present, but in different proportions, with swamp being the main community rather than rushes/tall herb fen. Provided the wetland is retained and scrub encroachment does not increase significantly then the conservation interest of the site would continue, although floristically a reduction in diversity is likely. The exploration of management options including grazing in the drier areas was recommended.

The SCM form (SNH, 2010c) makes reference to the presence of nettles on land adjacent to the site. No further information is detailed but this could be indicative of nutrient enrichment.

5.2 Catchment Walkover

From the second site visit post-receipt of the analytical results, the following observations of the surrounding catchment were made:

- The site was free of litter. No visible pollution sources were observed within the site boundary.
- There is an access track through the middle of the site (the man-made causeway). It was considered that the track is suitable for vehicle access.
- A dairy farm is situated on the south boundary of the site. This comprises a sizeable operational facility.

- To the south and west of the site were grazed fields associated with the adjacent dairy farm. None of the fields were noted to have buffer strips or reduced margins where they border the SSSI site.

- The A75(T) runs along the northern boundary of the site. The configuration and outflow of the associated road drains is not confirmed. These have the potential to contain contaminants and discharge to the site.

- The area of standing water at the site appeared to be significantly less than that which is shown on corresponding Ordnance Survey mapping. This was not quantified during the site visit however it is considered that the actual area of standing water may be masked by the increase/changes in vegetation cover and successional changes which occur as a result from the infilling by silts.

- A small operational quarry is located close to the eastern boundary of the site. It is considered that this could potentially affect the hydrology of the SSSI through excavations altering the groundwater flow patterns and/or site surface water and foul drainage flows.

- A small sewage treatment works is located on the north eastern boundary of the site. The discharge location of which is not confirmed.

- Residential properties exist within close proximity and up gradient of the southern and eastern site boundaries.

- There is evidence of disused building (function and purpose unknown) on the boundary and potentially within the north eastern corner of the site.

5.3 Summary

The following table provides a summary of the key site features which were observed during the site visits or identified in the desk study undertaken as part of the initial works.

Table 5.1: Summary of key observations

Activities	Observations
Fencing	Northern boundary that abuts the A75(T) is fenced. The standard and completeness of the fencing was not assessed as part of the site visit.
Fishing	Not applicable.
Grazing	Site is not currently grazed however the majority of the surrounding catchment is used by cattle from the neighbouring dairy farm.
Monitoring	A Site Condition Monitoring assessment was undertaken at the site. No previous water quality monitoring records were reviewed during the desk study.
Public Access	An access track passes through the centre of the site and is suitable for access by 4x4 vehicles.
Shooting	Site managed as part of a shooting enterprise focusing on wildfowl.
Point Pollution Sources	None observed within the SSSI boundary. Highway drainage from the A75(T) could possibly enter site. Potential discharge from dairy farm on the southern boundary of the site. Sewage treatment works to the north east with unknown discharge point.

Properties in Catchment	Several residential properties are located within close proximity of the site and all typically up gradient of the site. Those of note include Inchparks Schoolhouse, those on the unnamed access road and Aird Farm and are all expected to be served by the neighbouring sewage treatment works, There is evidence of previous derelict buildings within the north-eastern corner of the site, the function of which are unknown.
Unusual, Distinctive or Atypical Features	A dairy farm is present on the southern boundary of the site; an operational quarry is present on the east boundary of the site; a sewage treatment works is located on the north eastern boundary; seasonal variations reported in extent of standing water on site.

A mapped summary of the perceived catchment pressures is detailed in Figure 5.1 (see Annex 1).

6. INTERPRETATION OF RESULTS

The following assessment is based on the field tests and laboratory analytical results only.

6.1 General Summary

The dataset indicates nutrient enrichment within the site most notably on the southern and north eastern boundaries where there are increased nitrogen and phosphorus values. This is largely accounted for by what appears to be a polluting flow from the neighbouring dairy farm as described below.

Despite a limited understanding of the flow regime(s) on site, it is considered that the site acts as a sink with nutrients being retained (and used) within, rather than being 'flushed' from the site. This aligns with the understanding of when the loch was present on site but may however, only be a seasonal observation and requires a more detailed understanding of the flow dynamics to be confirmed.

Elevated total nitrogen, total phosphorus and (for AW10 only) potassium results were observed in all of the samples taken from the southern part of the site - namely AW06, AW08 and AW10. Each of these locations abut the intensively managed agricultural land on the southern perimeter and indicates a likely inflow of nutrients from agricultural practices from the southern part of the catchment. The dataset for AW06 highlights elevated levels across all parameters monitored and is deemed of concern since it is indicative of a pollution source. As the results for this location were atypical for the site as a whole they are discussed separately in section 6.2. Given the absence of any known direct application of nutrients to the site, the corresponding elevated values in AW02 and AW03 could be attributable to the input of exfiltration from the sewerage network (*e.g.*a leak) serving the neighbouring sewage works although no evidence was observed.

The presence of elevated total nitrogen and ammonia in AW10, coupled with low nitrate and low dissolved oxygen results, indicates anoxic conditions and nitrification taking place. Whilst this is most notable at AW10, this is potentially replicated in each of the groundwater sample results.

With the exception of iron concentrations in the groundwater samples, none of the analysed metals were recorded as being elevated or above expected concentrations. The inorganic concentrations of bioavailable nutrients were typically higher in the groundwater samples when compared to the surface water samples.

Total phosphorus levels were elevated in the upper (root zone) soil samples, with samples AW02A, AW03A and AW10A exhibiting concentrations almost twice those of the other soil samples collected. This could be due to the accumulation of plant debris in this area. Conversely, extractable phosphorus values were elevated in the lower soil samples when compared with those taken at the root zone, which is likely associated with typical reductive conditions at greater depth leading to a higher availability of phosphorus. The same trend is not apparent for nitrogen analyses.

6.2 Atypical Results

With the exception of AW06, no consistent atypical or anomalous results were recorded from soil or water samples at the site. Of the limited data set the observations of note are discussed below:

- With the exception of total iron, all of the laboratory results for AW06 were elevated – particularly for ammonia (with a very high result of 29.2mg/l recorded). The sample comprised an atypical green/brown colouration and was observed to have a strong

farm effluent odour. As this sample is an inflow to the site and collected immediately down gradient of the dairy farm, it is considered to be indicative of contaminated runoff from the farm. In direct contrast to the aforementioned ammonia result (which may have been further elevated by degradation taking place post-sampling/during transit to the lab), it should however be noted that the dissolved oxygen level in this sample is at 85.9%. This value is significantly higher than would be expected of pollutants (*e.g.* slurry) and/or organic enrichment – with the proposed explanation being that the inflow was very recent and the oxygen level not fully used up at the point the sample was collected. No evidence of slurry spreading was observed in this area.

- A contrast in dissolved oxygen value is recorded at the site with the high result for AW01 indicating a waterbody which is capable of supporting salmonid fish whereas in contrast, the value at AW08 (a groundwater sample in the western central area) is very low and indicative of deoxygenation from organic degradation.

- The presence of ammonia in all groundwater samples is indicative of either organic degradation or pollution from soil conditioning (*e.g.* application of animal wastes). As the values for these samples were typically higher than the surface water samples, and all had very low dissolved oxygen values, it indicates that the former may be applicable. However, this is contrasted by the typically elevated total phosphorus and total nitrogen values which would indicate the latter.

- Elevated iron values were recorded in all four groundwater samples with values of 2.29-17.1 mg/l recorded. As these are groundwater samples where conditions are such that dissolution of iron is likely to occur, this is not unexpected. The result for AW10 (of 17.1mg/l) was the highest level recorded and also aligns with elevated total phosphorus and total nitrogen results, and is therefore worth further investigation and may be attributable to inputs to the catchment.

6.3 Additional Considerations

SEPA have confirmed that the site falls within the corresponding proposed operational area for the Galloway Coastal diffuse pollution priority catchment. All agricultural land within the catchment of the site has been visited during one-to-one visits.

7. CONCLUSIONS

Accounting for the limitations outlined in section 3, the analytical results show a clear trend of elevated inorganic nutrients within the site inflows and groundwater. There are observations that indicate that the site has been, and is being, influenced by agricultural practices within the wider catchment and that it is potentially directly affected by an input from the dairy farm. From the limited data it is considered that the likely explanation of changes in vegetation types within the site are a result of agricultural practices leading to increased nutrient availability, coupled with historical hydrological changes which have led to variations in water levels across the site as a whole.

The location of the site exacerbates the aforementioned observations as it sits at a low level within the catchment (9m AOD) and acts as a sink for the surrounding landform. It is therefore expected that the site will be heavily influenced by the quality and quantity of water which flows to the site. These flows vary seasonally, will leach nutrients from the surrounding catchment and due to the levelling out of the landform and poor drainage, will accumulate. This process is likely to be dominated by surface water flows but groundwater sources may have a notable seasonal impact. As detailed in section 2.4, the site initially comprised a loch which over time has been infilled by organic material. This has in turn created a rich substrate in which other plants could prosper which leads to further infilling and the successional change that is presently observed. This process will be further compounded by the poor site drainage and inflow of nutrients.

Evidence of agricultural improvements to the immediate catchment is expected to have resulted in an accelerated nutrient inflow to the site. Coupled with poor drainage, it is considered that this could have a direct effect on the existing vegetation with a greater availability of nutrients altering the naturally occurring community composition. The nutrient transfer may be further heightened by the potential of contaminated inflows observed from the neighbouring dairy farm and sewage works. This is exacerbated by the absence of a management agreement at the site and of buffer strips to the land on the immediate boundary.

Several residential properties are located within the catchment and up gradient and in close proximity of the site. The sewage works on the eastern boundary of the site is expected to serve these dwellings. It is possible that the collecting sewage network (comprising the untreated foul water) will flow along the access road on the eastern boundary. Given that this pipework is likely to be aging, it is possible it will be leaking and be a potential source of nutrients to the site and/or the groundwater. The collection of soil and water data within the fields outwith the site boundary, or the boundary itself, would be needed to corroborate this. The same principle applies to the surface water and foul drainage from the quarry, the details for which have not been determined under the terms of this study. The collection of soil and water data within the fields outwith the site boundary, or the boundary itself, would be needed to corroborate these claims.

The activities within the quarry may have resulted in changes to the hydrology within the catchment. Similarly, the presence of derelict buildings in the north east corner of the site indicates former anthropogenic activities. As no further information has been reviewed or made available, the potential impact on the nutrient status and water levels within the site is unknown.

In addition to the residential properties and quarry, there will be some runoff, albeit minimal, from the causeway (access track) which passes through the site. This track is expected to be used by estate 4x4 vehicles which will have a heightened impact and cause rutting in wet weather conditions leading to the infilling of the site drains and inhibiting throughput. A more

significant contribution is likely to be made from the A75(T), the means, volumes and contaminants of which have not been quantified as part of this study.

Historical records indicate that there have been variations in the size of the open water areas within the site. Given the limited records, it appears that this has not been a quantitative assessment despite this information being of value in understanding the seasonal and annual changes to the site.

The management of scrub on site is noted in the SCM form (SNH, 2010c). No details are stated as to how this is being (or to be) controlled. If manual cutting techniques are employed then it is advised that the resulting waste is removed from site to minimise the build-up of leaf litter and ensure that the bioavailable nutrients are not recycled within the soil through microbial activity.

8. RECOMMENDATIONS

Based on the limited understanding gained from the sampling exercise and catchment visits, the following recommendations are proposed:

8.1 Monitoring

i. Undertake a long-term targeted monitoring study at selected locations within the site for key plant nutrients – to include orthophosphate and bioavailable (extractable) nitrogen. Ideally this would be undertaken over the course of several seasons (ideally for a minimum of one year). The data from such should be compared alongside rainfall data and seasonal abnormalities to seek to understand the nutrient dynamics taking place within the site.

ii. In conjunction with (i) assess the seasonal flow and nutrient loads of the mapped field drains and compare these with those of the Bishop Burn, which flows from the site. This data would be of direct value in being able to assess the flow dynamics of the site and to understand retention times and season variations in throughput.

8.2 Other Commissioned Studies

iii. Undertake further study to understand the quality and quantity of inputs from the A75(T) which will comprise contaminants from vehicles including potentially toxic rubber compounds and hydrocarbons.

iv. Undertake hydrological and hydrogeological assessment of the site. This should include:

    a. a review of the loss of open/standing water within the site and determine the extent of seasonal/annual variation in water levels. If such were routinely quantified, over a period of time this would aid the understanding of the hydrology at the site and aid the resulting management to control such at a stable level (if this were deemed desirable), as well as afford additional benefits to maintaining (or improving) the designated habitats; and

    b. a review of the operational quarry and understand how the recent practices may have influenced drainage to and within the SSSI as well as the wider catchment.

v. Undertake core sampling of open water sediments to understand historic source pollution and retained nutrients. It is considered likely that there will be a significant volume of nutrient bound up in these sediments this may be being slowly released into the water column and aiding successional change.

vi. Undertake a detailed library review, including historical mapping and local data sources, to seek to understand historical land use and information relating to the SSSI and contributing catchment. This should seek to determine when the peat cutting is likely to have been undertaken and when ceased, and the resulting timescale for the infilling of the associated excavations.

8.3 Management

vii. The desk study did not reveal any detailed site monitoring having been undertaken at this site. Where no recent site condition monitoring is confirmed, it is recommended that a detailed assessment is undertaken to facilitate understanding in context with the findings of this diffuse pollution study and establish a baseline for future studies.

viii. Review the value of a management agreement for the site and incorporate measures to control the impacts of the existing management practices resulting in the changes observed to the designated habitats.

ix. Review the use of fertilisers and soil conditioning applications within the landholding immediately adjacent to the site boundary, as well as the management of the dairy steading.

x. Review the policy for the removal of site vegetation and the methods used to control/manage such. Where future management practices require vegetation to be cut and removed from site instead of applying chemical applications. Consideration should be given to the removal at the root zone rather than cutting of above ground stem and should be followed by appropriate off-site disposal as this will lead to a net reduction in nutrients from the catchment, minimise regrowth and avoid the need for the use and reapplication of potentially harmful chemicals. This is particularly applicable to marginal and aquatic vegetation.

8.4 Landowners

xi. Proactively engage with local landowners to understand the existing and (foreseeable) proposed changes to the immediate catchment including field usage, crop type and soil conditioning approaches. Consider appropriate management strategies accordingly - for example, buffer strips, exclusion zones, routine spot monitoring *etc*.

xii. Proactively engage with dairy steading to understand current management and address potential pollution issues.

xiii. Proactively engage with catchment landowners to understand the historical land use practices to determine changes which are likely to have influenced the site. This should include the now derelict buildings on the north eastern boundary and an appraisal of how the operations therein may have influenced conditions at the site.

xiv. Review of the ownership of the identified land drains and the future management and maintenance of such.

8.5 External Consultations

xv. Liaise with Scottish Water to understand the condition of the sewerage network in the catchment and potential for leaks to impact on the site. Request any data on effluent quality where the discharge is subsequently deemed to have an impact on the site.

xvi. Engage with SEPA to:

a. undertake an immediate investigation into the perceived level of contamination entering the site from the dairy farm (re: results for AW06 as detailed in section 6.2).

b. understand the sewage disposal methods in place for the sewage works on the north eastern perimeter of the site, the identified properties and the quarry within the wider catchment, and the corresponding controls in place to limit nutrient enrichment to the SSSI;

c. discuss the options regarding regulatory controls on the use of nutrients in the catchment from agricultural activities. Draw on the work they have undertaken

to visit the site as part of the 'Priority Catchment' work and on farm inspection assessments; and

d. understand whether there have been any known pollution incidents within the catchment which could have influenced the SSSI.

xvii. Engage with the quarry operator to understand the controls in place for the water management at the facility.

From the stated conclusions and identified pressures (Figure 7.1) the key actions to seek to reverse the present declining status of the site are to seek to immediately address the suspected pollution source at the adjacent dairy farm (xvia); and in turn address the inputs to the site from the agricultural catchment (xi), the field drains (xiv), the sewage works and sewerage system (xv) and the quarry (xvii); and assess the requirements for optimum water levels/through flow at the site (i & iv).

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ANNEX 1: FIGURES

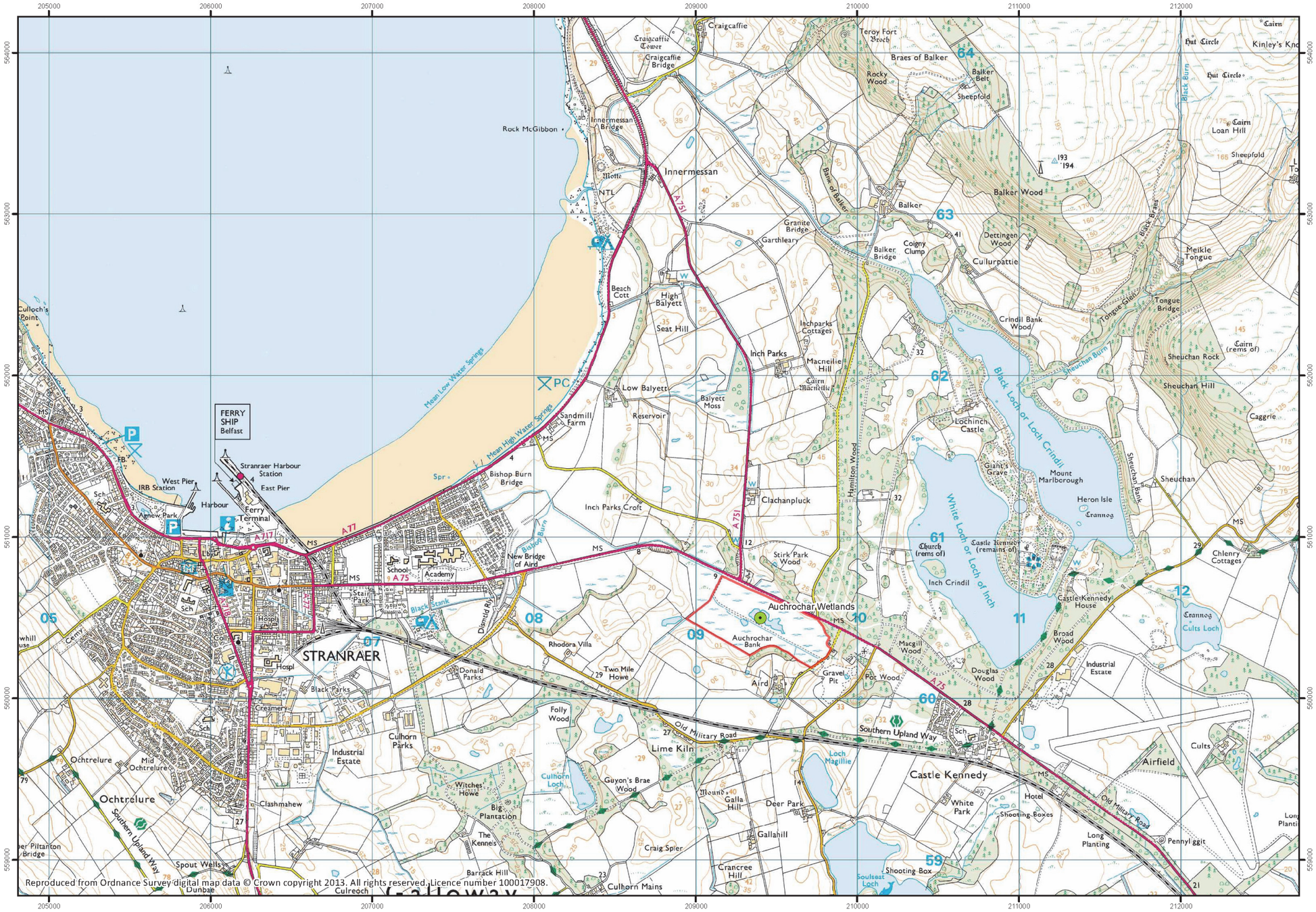


Figure 1.1: Site Location Map

Auchrochar Wetlands

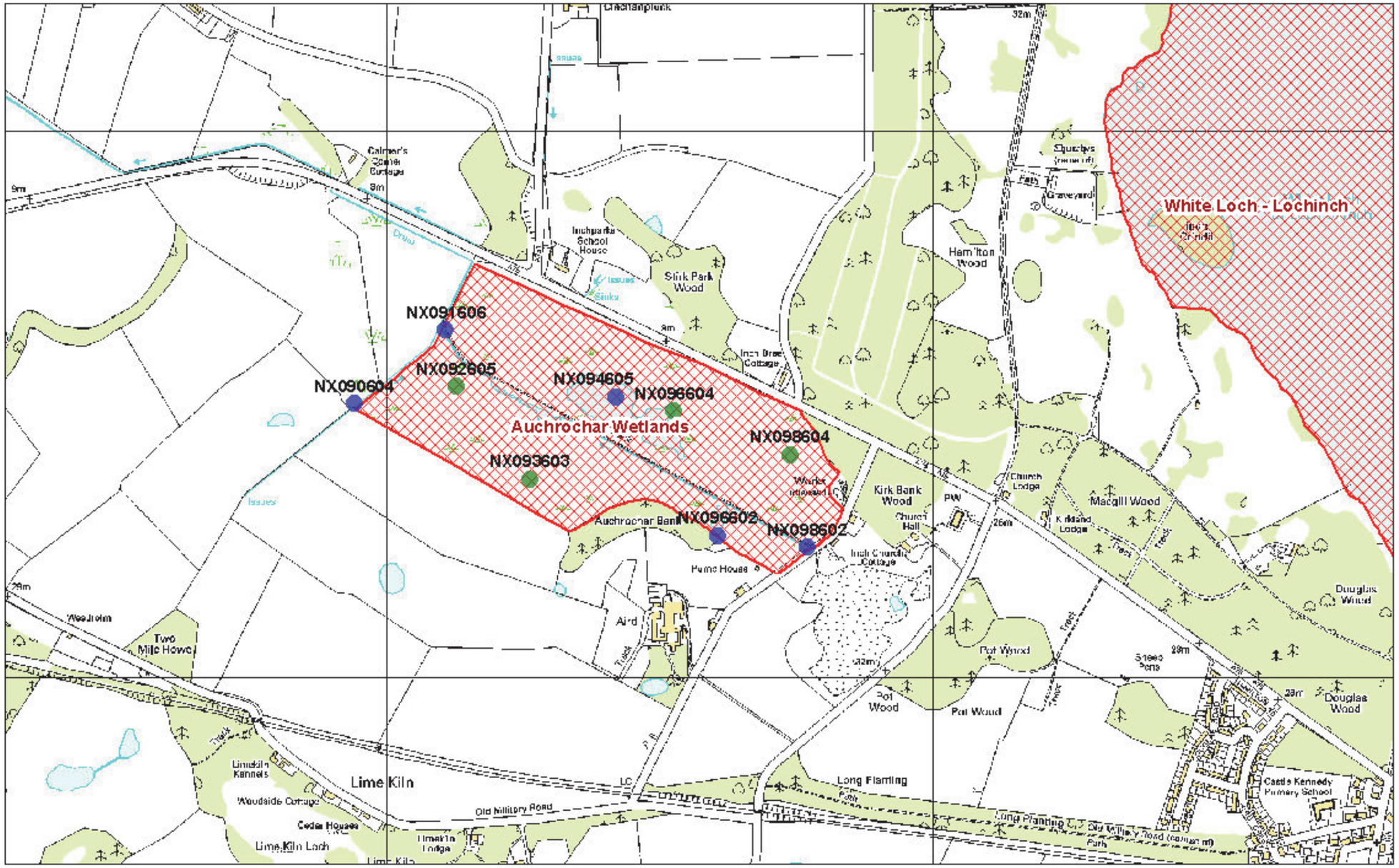
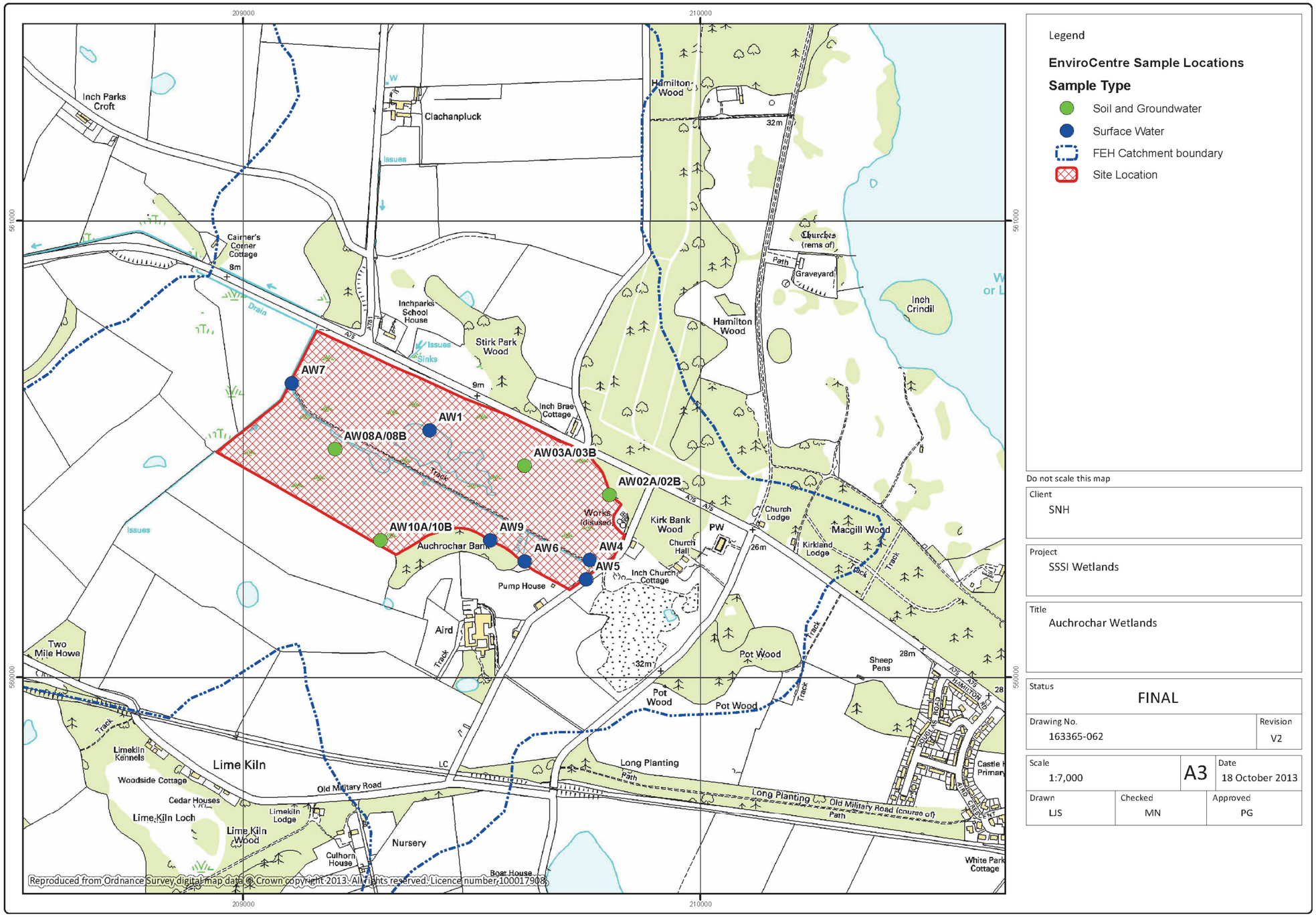


Figure 2.1: SNH Proposed Sampling Location Plan



Legend

EnviroCentre Sample Locations

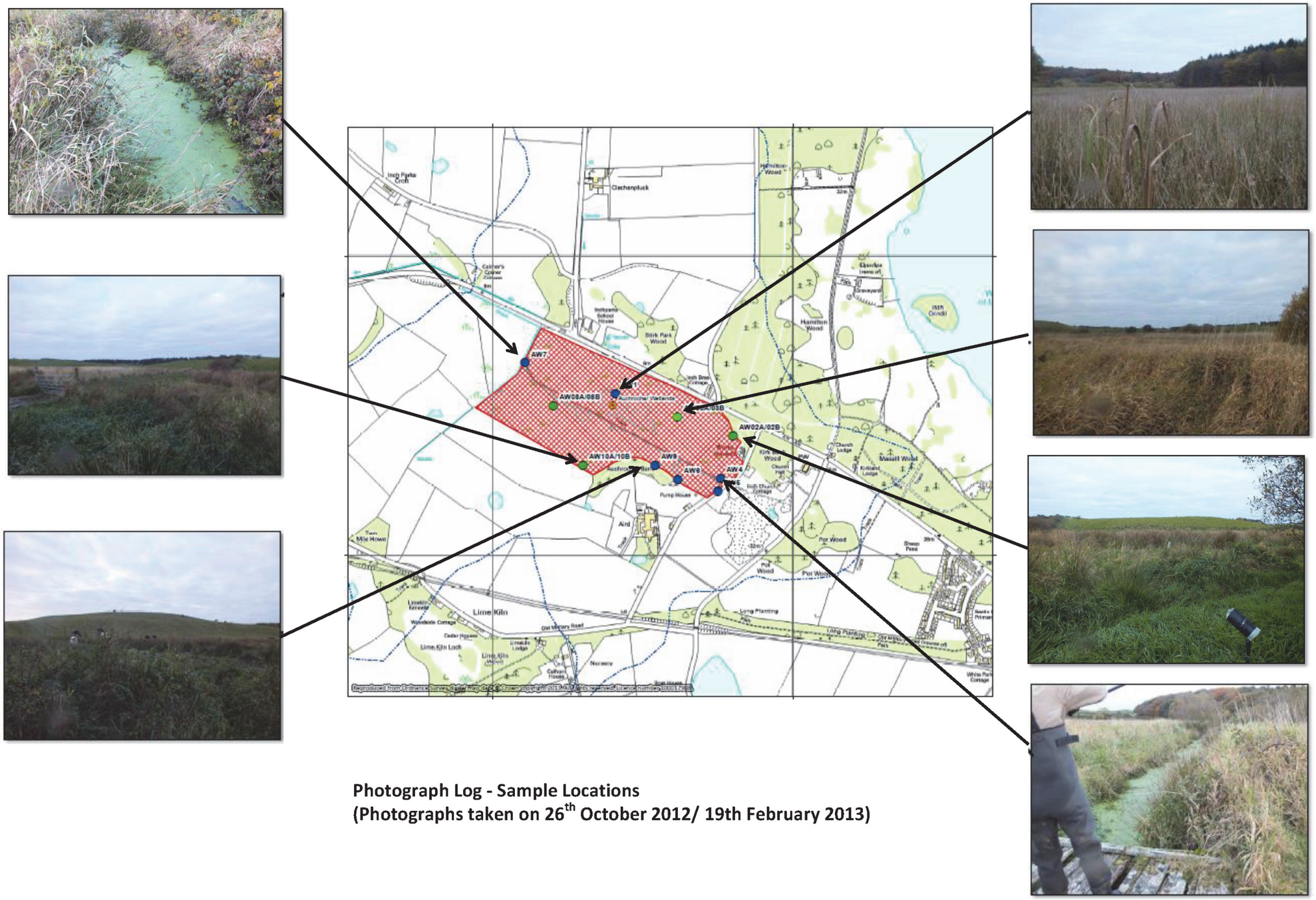
Sample Type

- Soil and Groundwater
- Surface Water
- FEH Catchment boundary
- Site Location

Do not scale this map

Client	SNH
Project	SSSI Wetlands
Title	Auchrochar Wetlands
Status	FINAL
Drawing No.	163365-062
Revision	V2
Scale	1:7,000
A3	
Date	18 October 2013
Drawn	LJS
Checked	MN
Approved	PG

Figure 2.2: Plan of Actual Sampled Locations



Photograph Log - Sample Locations
(Photographs taken on 26th October 2012/ 19th February 2013)

Figure 2.3: Photographs of each Sampling Location

Photograph Log- Surrounding Catchment
Photograph Taken 19th February 2013

Figure 2.4: Photographs of Surrounding Land Use

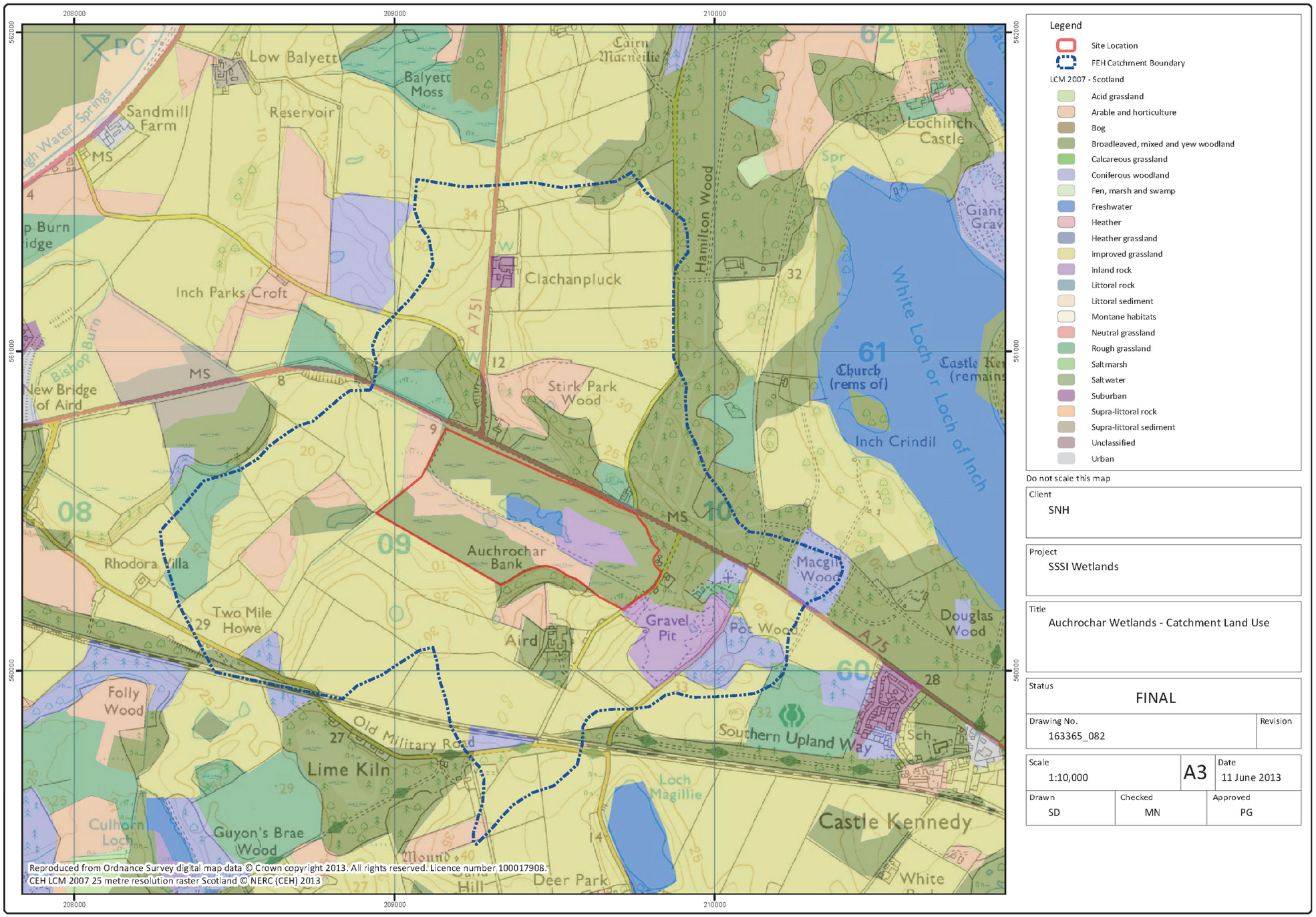
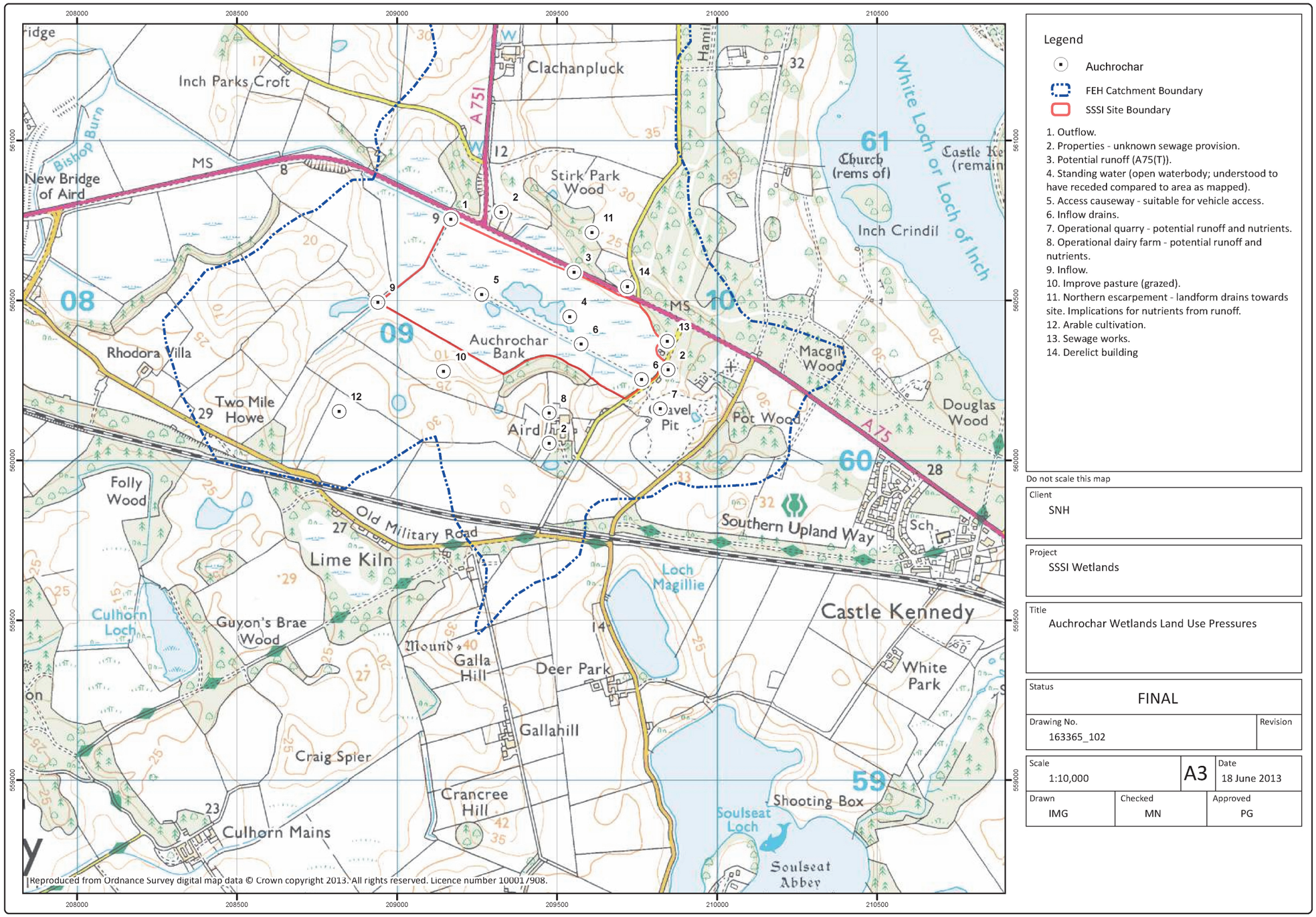


Figure 2.5: Catchment Land Use Characteristics



Legend

- Auchrochar
- FEH Catchment Boundary
- SSSI Site Boundary

1. Outflow.
2. Properties - unknown sewage provision.
3. Potential runoff (A75(T)).
4. Standing water (open waterbody; understood to have receded compared to area as mapped).
5. Access causeway - suitable for vehicle access.
6. Inflow drains.
7. Operational quarry - potential runoff and nutrients.
8. Operational dairy farm - potential runoff and nutrients.
9. Inflow.
10. Improve pasture (grazed).
11. Northern escarpement - landform drains towards site. Implications for nutrients from runoff.
12. Arable cultivation.
13. Sewage works.
14. Derelict building

Do not scale this map

Client	SNH
Project	SSSI Wetlands
Title	Auchrochar Wetlands Land Use Pressures
Status	FINAL
Drawing No.	163365_102
Revision	
Scale	1:10,000
A3	
Date	18 June 2013
Drawn	IMG
Checked	MN
Approved	PG

Figure 5.1: Catchment Pressures Summary

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