St Athan Northern Access Road

Factual Ground Investigation Report

Project Number: 60509148

February 2017

Quality information

Prepared by	Checked by	Approved by
		
Elizabeth Willis Graduate Engineering Geologist	Mark Baker Senior Engineer	Carl England Technical Director
		
Michael Corlett Assistant Engineering Geologist		

Revision History

Revision	Revision date	Details	Authorised	Name	Position
0	13/01/2017	Draft for Issue		Mark Baker	Senior Engineer
1	27/01/2017	Final		Mark Baker	Senior Engineer
2	21/02/2017	Addendum – Final GW monitoring round included and dates updated		Mark Baker	Senior Engineer

Prepared for:

The Welsh Government

Prepared by:

Elizabeth Willis
Graduate Geologist
&
Michael Corlett
Assistant Engineering Geologist

AECOM Infrastructure & Environment UK Limited
Tricentre 3
Newbridge Square
Swindon
SN1 1BY
UK

T: +44 (0)1793 508 500
aecom.com

Table of Contents

Figures

Appendices

1. Introduction

1.1 General

AECOM Infrastructure & Environment UK Ltd (here after referred to as “AECOM”) was commissioned by the Welsh Government to perform a ground investigation to assist in the design of the proposed Northern Access Road, St. Athan, Wales.

Details of the ground investigation (GI) were to be presented as a Factual Report.

This report summarises the findings of the investigation undertaken by AECOM between the 21st November 2016 and 9th February 2017.

1.2 Objectives

The site investigation was carried out in accordance with the Specification for Ground Investigation at St. Athan – Northern Access Road (received 8th November 2016, Doc ref: GEO/ST.ATHAN/SPEC, Version 1) and aimed to identify the ground and groundwater conditions of the area of the proposed access road, in order to inform the design.

This report is factual only and specifically excludes detailed desk study, any geotechnical or geo-environmental interpretation and any advice on structural condition.

1.3 Investigation Scope

The initial investigation scope was provided to AECOM in 8th November 2016 (Doc ref: GEO/ST.ATHAN/SPEC, Version 1) and included 11no. Trial Pit locations with TRL probing - 10no. of which including Soakaway testing, and 4no. Rotary Boreholes with 8m installs.

2. Site details

2.1 Site Location

The site is located approximately 2km north-west of the village of St. Athan and approximately 5.2km south of the town of Cowbridge, South Wales. The site comprises a series of fields parallel to the northern edge of the St. Athan Ministry of Defence compound. The ground investigation exploratory hole locations were aligned along the proposed route of the new road in an approximate straight line running from west to east between the B4265 (SS 98157 68967) and Picketstone Close (ST 00321 69324).

The most westerly point is centered on OS National Grid reference SS 98272 68973, and the most easterly point is located at ST 00337 69316.

Figure 1 shows the location of the site within the surrounding area.

2.2 Site Description

The site is located in the Vale of Glamorgan, South Wales, approximately 3km north of the Bristol Channel coastline. The topography of the site is flat to gently undulating.

In the western area of the site, the B4265 road runs perpendicular to the site and carries traffic north-west towards the town of Llantwit Major and south towards St. Athan. In the eastern area of the site there is an active military training area towards the north and several aircraft hangers and a runway within the MOD compound towards the south.

There are three brooks that run though the site, one to the west, one to the east, and one running along the southern border of the site.

Llanmaes Brook to the west, intersects the site at SS 98571 68956, running approximately northwest to southeast, and has formed a 6 to 8m deep valley, within which a flood bund has been constructed within one of the fields to alleviate flooding in the area. To the east, the Nant y Stepsau brook is smaller and intersects the site

near to SS 99576 69217, running approximately northwest to southeast. Both brooks feed into the Boverton Brook which runs from east to west along the Eglwys-Brewis Road which runs along the southern edge of the site.

2.2.1 Surrounding Land Uses

The land uses in areas surrounding the St. Athan Northern Access Road work package is summarised in Table 1, below:

TABLE 1 – SURROUNDING LAND USE

Direction	Land Use
North	Farmland, Villages of Picketston and Llanmaes
East	Farmland, Cardiff Airport, Cardiff
South	St Athan MOD Base and runway, Aberthaw Power Station, Bristol Channel
West	Town of Llantwit-Major, Farmland, Bristol Channel

3. Published Geology

3.1 Geology

Details of the geology underlying the site and the surrounding area have been referenced from the following sources:

- British Geological Survey Map, scale 1:50,000, Sheet 261 and 262 for Bridgend (Solid and Drift Edition), 1997; and
- British Geological Survey Geodex interactive geology viewer.

The geological maps indicate that there are generally no superficial deposits mapped in the work package, with the exception of localized alluvial deposits mapped in the vicinity of the Llanmaes Brook and Boverton Brook. Alluvial deposits were not mapped but would also be expected along the Nant y Stepsau.

A small area of Head Deposit is mapped to the northwest of the site upstream of the Llanmaes Brook. Tidal Flat, Blown Sand and Marine Beach Deposits associated with the Bristol Channel are mapped approximately 2.8km to the south of the site.

The solid geology in the work site is mapped as the Porthkerry Member of the Blue Lias Formation, comprising Jurassic thick limestones with thin mudstone partings. Locally, the limestone is secondarily silicified with the development of chert nodules and bodies.

4. Ground investigation details

4.1 Fieldwork

4.1.1 Site Work Summary

The locations of the exploratory holes are detailed in Figure 2. The site work comprised the following:

- 11no. Trial Pits (SK501 – SK510 and TP501) excavated using a JCB 3CX Eco to a maximum depth of 1.40m (bgl). Detailed logs are presented in Appendix A;
- 11no. TRL probe tests advanced through the base of machine-dug trial pits SK501 – SK510, and TP501. Detailed logs are presented in Appendix B;
- 10no. Soakaway Tests undertaken in machine excavated trial pits (SK501 – SK510). Detailed test results are presented in Appendix C;
- 4no. Rotary Boreholes (BH501 – BH504) were advanced through the base of a 1.20m hand excavated buried service inspection pit to a maximum depth of 8.50m bgl utilising Dynamic Sampling and Rotary Coring with water recirculation, and were installed with a 50mm standpipe as per instruction from the Engineer. Detailed logs and installation details are presented in Appendix D.

The main fieldwork was conducted over 10no. shifts carried out during day time hours between the 21st November and 2nd December 2016. The weather conditions were unsettled with periods of sunshine, heavy rain and strong winds.

4.1.2 Site Access Arrangements

The GI required access to locations via third party land.

- SK501 was accessed via Plot 17, Boverton Court Farm;
- SK502 was accessed via Plot 16, Tremains Farm;
- SK503, SK504 and BH501 were accessed via Plot 14, Millands Farm;
- SK505 and SK506 were accessed via Plot 12, Froglands Farm;
- SK507, SK508 and BH502 were accessed via Plots 6 and 9, Great House Farm;
- SK 509, BH503 and BH504 were accessed via the Pickestone Gate entrance of MOD land;
- SK510 and TP501 were accessed via the western entrance of the MOD base.

4.1.3 Ecological Considerations

Protected species are known to be present at or near the site.

- A badger sett has been identified in the vicinity of Llanmaes Brook (approx. grid reference SS 9857 6893);
- Slow-worms have been recorded in the Llanmaes Brook corridor near to SK502;
- Dormice have been recorded within the hedgerows near SK507.

Mitigation requirements for the avoidance of harm to protected species were discussed at the site start up meeting, and at each investigation location

4.1.4 Archaeological Considerations

As indicated in the specification, there are areas of archaeological interest at the site, and these were expected to be located within the western part of the site.

Archaeological supervision was present during the excavation of all machine-excavated trial pits.

The buried remains of an archaeologically significant wall were encountered during the excavation of SK501. These were recorded by the Archaeologist and the excavation was backfilled and relocated away from the structure.

4.1.5 Buried Service Clearance

Buried service plans were reviewed prior to any fieldwork activities commencing. At each exploratory holes location a visual check and buried service survey using a Cable Avoidance Tool (CAT) and Signal Generator (Genny) was carried out to satisfy the requirements of the permit to dig. Further CAT scanning was undertaken at 200mm intervals during the excavation of the Trial Pit holes, to a maximum depth of 1.20m bgl.

4.1.6 Sampling

Representative bulk (B) and small disturbed (D) geotechnical samples were taken from suitable strata encountered during the excavation of the exploratory holes. Environmental (ES) samples were taken at 0.30m, 0.50m, and 1.00m intervals in the exploratory holes. In addition, Core samples (C) were taken from suitable strata encountered during the excavation of the Rotary boreholes.

4.1.7 In-situ Testing

Standard Penetration Tests (SPT) were carried out in accordance with BS EN ISO 22476-3: 2005+AL: 2011 in all Rotary Boreholes at the base of the inspection pit and where ground conditions allowed, except for BH504. The SPT tests were carried out using the drop weight fitted to the Comacchio Geo 205 drilling rig for all holes. The trip hammer used was independently calibrated and the details are presented in Table 2, below.

TABLE 2 – SPT HAMMER CALIBRATION DETAILS

Rig	Hammer ID	Energy Ratio [ER] (%)
Comacchio GEO 205	NH 01	71

In-situ Hand Shear Vane (HSV) testing was carried out on suitable cohesive strata encountered within the Exploratory Hole locations to a depth of 1.20m bgl. Each test comprised the taking of 3no. readings to determine the peak shear strength of the material encountered. Unless significant difference was observed, the mean value of these readings was taken and the resultant values are shown on the exploratory hole logs. HSVs were undertaken in excavated material for SK503 and SK504, and recorded as residual values.

In-situ Soakaway testing was carried out in exploratory holes SK501 – SK510 generally in accordance with BRE 365: 2016. Each test comprised the filling of a machine excavated Trial Pit with water to an arbitrary depth to within 0.5m of ground level and recording the time taken for the water to disperse into the ground where practical. Soakaway tests were repeated 3no. times where possible, however due to the high, or often negative infiltration rate in a number of the pits, only 1no. test was undertaken at these locations.

4.1.8 Groundwater

Groundwater levels were recorded during the excavation of all exploratory holes, the details of which are shown in the exploratory hole logs in Appendices A and D.

All Rotary Boreholes were installed with 50mm standpipe and filter pack to a maximum depth of 8.30m bgl for subsequent monitoring following the initial fieldwork period. 3no. rounds of monitoring have been undertaken (on the 8th December 2016, 9th January and 9th February 2017). The monitoring observations are discussed in Section 7.

5. Laboratory Testing

5.1 Geotechnical Laboratory Testing

Geotechnical testing was carried out on selected soil samples by GEO Site & Testing Services Ltd at their laboratory in Llanelli, Carmarthenshire in accordance with their UKAS accreditation. Table 3, below, details the total number of each type of test undertaken. The test results are presented in Appendix E.

TABLE 3 – GEOTECHNICAL LABORATORY TESTING SUMMARY

Test	No. of Tests
Natural Moisture Content BS 1377-2: 3.2	7
Plasticity Index (4-point) BS 1377-2: 4.3 & 5.3	7
Particle Size Distribution (by wet sieving) BS 1377-2: 9.2	5
California Bearing Ratio (CBR) BS 1377: 4	5
Uniaxial Compressive Strength (UCS)	2
Dry Density Compaction – 2.5kg 1377 : 1990 Part 4 : 3.3	2
Lab Shear Vane	3
Point Load Test ISRM / BS 1377-2/3.3 Brock & Franklin 1972.	4
Slake Durability ISRM / BS 1377-2/3.3 2/2	4
Suite D – Brownfield with Pyrite	4

5.2 Chemical Laboratory Testing

Chemical analysis was carried out on selected soil samples and water samples taken from the boreholes by Derwentside Environmental Testing Services (DETS) at their laboratory in Consett, County Durham, in accordance with their UKAS/MCERTS accreditation. Table 4, below, details the total number of each type of test undertaken. The test results are presented in Appendix F.

TABLE 4 – CHEMICAL LABORATORY TESTING SUMMARY

SOIL	
Test	**No. of Tests**
Asbestos	14
CLEA Metals	24
Cyanide (free)	24
Hexavalent Chromium	24
Total Organic Carbon	28
pH	28
BTEX and MTBE by GC-MS	28
TPH CWG	28
PAH EPA 16 (CGMS) low detection limit	28
VOC	28
WATER	
Test	**No. of Tests**
CLEA Metals	10
BTEX inc MTBE	10
TPH CWG	10
Phenol (Monohydric)	10
Speciated PAHs	10
VOC	10
Sulphate (SO_4)	10
Hexavalent chromium	10
Cyanide	10

Test detection limits are indicated with test results in Appendix F.

6. Ground conditions

6.1 Stratigraphy

The ground conditions at the site are summarised in Table 5 below.

TABLE 5 – GROUND CONDITIONS SUMMARY

Stratum	Depth to Top of Stratum (m)	Thickness (m)
Made Ground (including Topsoil)	Ground Level	0.20 - 0.65
Probable Alluvium	0.20 – 0.45	0.10 - 2.20
Distinctly Weathered Porthkerry Member	0.35 – 1.30	0.01* - 1.70
Partially Weathered Porthkerry Member	0.70 – 2.40	0.10* – 7.80*
Porthkerry Member	2.40	5.60*

* Base of stratum not proven, greater thicknesses may be present.

6.1.1 Made Ground

Made Ground was encountered at every exploratory hole location and proved to a maximum depth of 0.65m bgl. The Made Ground generally comprised two layers; a topsoil layer (to an average depth of 0.30m bgl) with grass and vegetation at the surface, and a secondary layer beneath:

- Soft dark brown slightly gravelly sandy CLAY with abundant rootlets. Gravel is subangular to rounded fine to coarse of limestone. Sand is fine to coarse (TOPSOIL);
- Soft becoming firm brown slightly gravelly silty CLAY with rare rootlets. Gravel is subrounded to rounded fine to medium of brick and limestone. Occasionally encountered with fine to coarse sand. Dark brown very sandy very gravelly clay with frequent rootlets. Gravel is subangular to subrounded fine to coarse of igneous rock. Sand is fine to coarse.

6.1.2 Probable Alluvium

Material consistent with Probable Alluvium Deposits was encountered immediately below the topsoil within all locations, with the exception of SK501, SK505, SK506 and SK510, and comprised:

- Soft becoming firm orangish and yellowish brown slightly gravelly CLAY. Gravel is angular to subangular fine to medium of limestone and mudstone;
- Soft locally firm slightly reddish brown silty CLAY with occasional roots and low cobble content. Cobbles are subangular of limestone;
- Soft becoming firm light yellowish brown slightly gravelly CLAY. Gravel is subangular firm of limestone and mudstone;
- Firm occasionally friable brown mottled light grey slightly sandy gravelly CLAY regularly with very frequent roots. Gravel is subangular to subrounded firm to medium of limestone and mudstone. Sand is fine to medium;
- Firm becoming stiff orangish brown mottled light grey slightly gravelly CLAY. Gravel is angular to subrounded firm to medium of mudstone and limestone; and
- Firm light grey mottled yellowish orange silty CLAY.

6.1.3 Porthkerry Member

The solid geology in the area is mapped as the Porthkerry Member. Three units were encountered during the ground investigation, a distinctly weathered upper surface, a partially weathered unit below, and an apparently unweathered unit. The distinctly weathered surface comprised:

- Firm brown to yellowish brown slightly gravelly slightly sandy CLAY with low to medium cobble content. Cobbles are subangular of limestone and/or mudstone. Gravel is angular to rounded fine to medium of limestone and/or limestone. Sand is fine to medium;
- Medium strong to weak grey weathered crystalline LIMESTONE with extremely closely spaced (~2-5mm), planar rough, open fractures infilled with orangish brown clay. Recovered as: Grey angular to subangular cobbles of limestone;
- Medium strong to extremely weak grey weathered LIMESTONE with subhorizontal and subvertical closely spaced, planar rough, open fractures with orangish brown surface staining and soft to firm orangish brown silty clay infill. Recovered as: Grey angular to subangular cobbles of limestone with soft to firm orangish brown silty clay infill;
- Medium strong to weak grey weathered crystalline LIMESTONE occasionally with fossil fragments. Recovered as: Grey angular to subangular cobbles with soft orangish brown silty clay infill; and
- Medium strong locally weak light grey locally yellowish orange weathered LIMESTONE.

The partially weathered Porthkerry Member unit comprised:

- Medium strong locally weak light grey locally stained orange weathered medium bedded LIMESTONE with extremely closely spaced (~2–5mm) open (~1-2mm) fractures with soft orangish brown silty clay infill. Occasionally described as recrystallised limestone. Frequently recovered as cobbles;
- Medium strong light grey weathered crystalline LIMESTONE;
- Strong grey partially weathered medium bedded LIMESTONE with occasional shell fragments and two sets of irregular fractures infilled with firm clay. First set: Subhorizontal, closely spaced, planar rough, open infilled with firm greenish yellowish brown silty clay. Second set: Subvertical (~50^{o}), closely spaced, planar rough, tight with orange surface staining; and
- Strong grey or brown closely bedded calcareous fossiliferous crystalline MUDSTONE with extremely closely spaced (~2-5mm) fractures. Occasionally described as laminated.

The unweathered Porthkerry Member unit comprised:

- Strong dark grey medium bedded shelly LIMESTONE with calcite veins and subvertical (~45^{o}) closely spaced, planar rough, partly open with orange surface stained fractures. Interbedded with hard very dark grey CLAY with shell fragments and Gryphaea fossil (~30mm).

7. Groundwater

7.1 Groundwater Observations

Groundwater observations within the exploratory during the initial fieldwork period are summarised in Table 6 below.

TABLE 6 – GROUNDWATER CONDITIONS SUMMARY

Hole ID	Groundwater Entry (m bgl)	Water Strike Remarks	Observation during Soakaway Tests
TP501	Dry during excavation	-	-
SK501	Dry during excavation	-	-
SK502	Dry during excavation	-	-
SK503	1.30m	Rising to 1.20m after 20 minutes	Water level static during test
SK504	0.80m	Rising to 0.71m after 20 minutes	Water level rising in pit for 165mins to 0.41m bgl
SK505	Dry during excavation	-	-
SK506	Dry during excavation	-	-
SK507	0.80m	Standing after 20 minutes	Water level rising in pit for 60mins to 0.49m bgl
SK508	0.95m	Rising to 0.60m after 20 minutes	Water level rising in pit for 480mins to 0.18m bgl
SK509	1.20m	Rising to 1.00m after 20 minutes	Water level rising in pit for 1110mins to 0.30m bgl
SK510	Dry during excavation	-	-
BH501	1.30m	Standing after 20 minutes	-
BH502	0.70m	Falling to 1.20m after 20 minutes	-
BH503	1.20m	Standing after 20 minutes	-
BH504	1.30m	Falling to 1.38m after 20 minutes	-

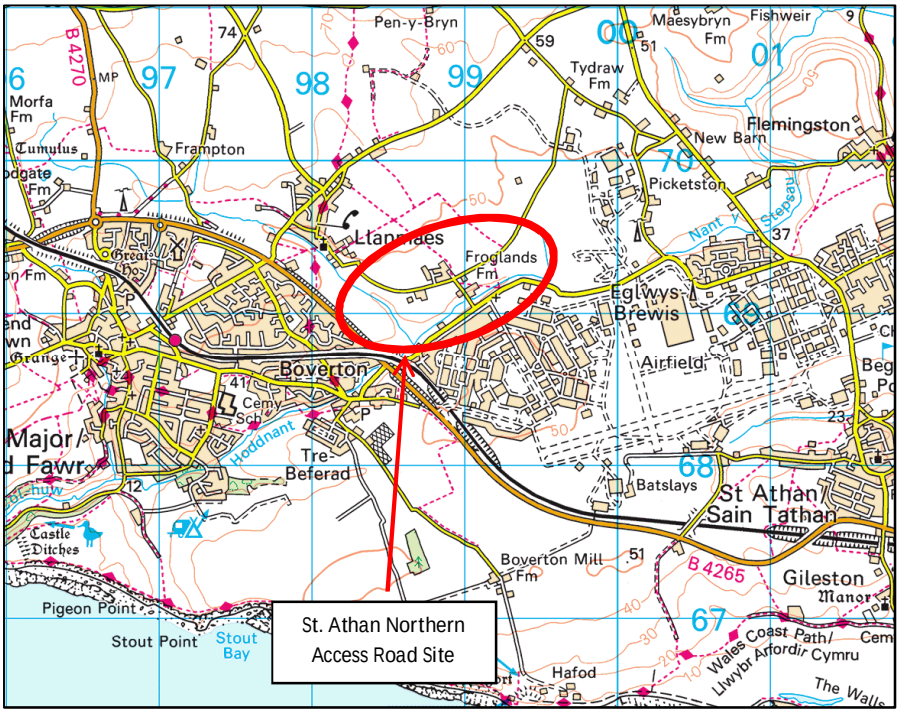
It should be noted that the groundwater conditions observed in the exploratory holes are those appertaining to the period of the investigation. Groundwater levels may vary due to seasonal fluctuations in rainfall, but in the shorter term, can be affected by antecedent weather conditions or other causes.

7.2 Groundwater Monitoring

BH501, BH502, BH503 and BH504 were installed with a 50mm standpipe and filter pack for subsequent monitoring, following the initial fieldwork period. Groundwater monitoring visits were undertaken on 8th December 2016, 9th January 2017 and 9th February 2017. The groundwater observations made during these visits are presented in Appendix G.

During the monitoring visits, groundwater samples were taken from each borehole for subsequent testing (laboratory results are presented in Appendix G). BH501 was not sampled during the first two of the sample rounds due to the presence of wet sediment at the base of the well and insufficient water for a sample.

Figures



KEY

Site Location:

Prepared By	LT	St. Athan Northern Access Road	AECOM
Checked By	MC	**FIGURE 1 - SITE LOCATION PLAN**	
Job No	60509148	St. Athan Northern Access Road Ground Investigation	
Date	Jan-17	Welsh Government	

ISO A1 594mm x 841mm

Project Management Initials: Designer: MC Checked: MB Approved: CE

Last saved by: ELENA.MARTIN Last Plotted: 2017-01-25

N

SK506

SK505

SK504

SK503

BH501

SK502

SK501 A

SK501 B

FINAL LOCATION

ARCHAEOLOGICAL STRUCTURE ENCOUNTERED

0 50 100 m

1:2000 @ A1

AECOM

PROJECT

ST. ATHAN NORTHERN ACCESS ROAD

CLIENT

WELSH GOVERNMENT

Llywodraeth Cymru
Welsh Government

CONSULTANT

AECOM
1 CALLAGHAN SQUARE
CARDIFF
CF10 5BT
TEL: (029) 20674600
FAX: (029) 20674699

KEY

PROPOSED KEY INFORMATION

BOREHOLE	BH
TRIAL PIT	TP
SOAKAWAY TEST	SK

ISSUE/REVISION

IR	DATE	DESCRIPTION
A	23/01/2017	FINAL VERSION

KEY PLAN

PROJECT NUMBER

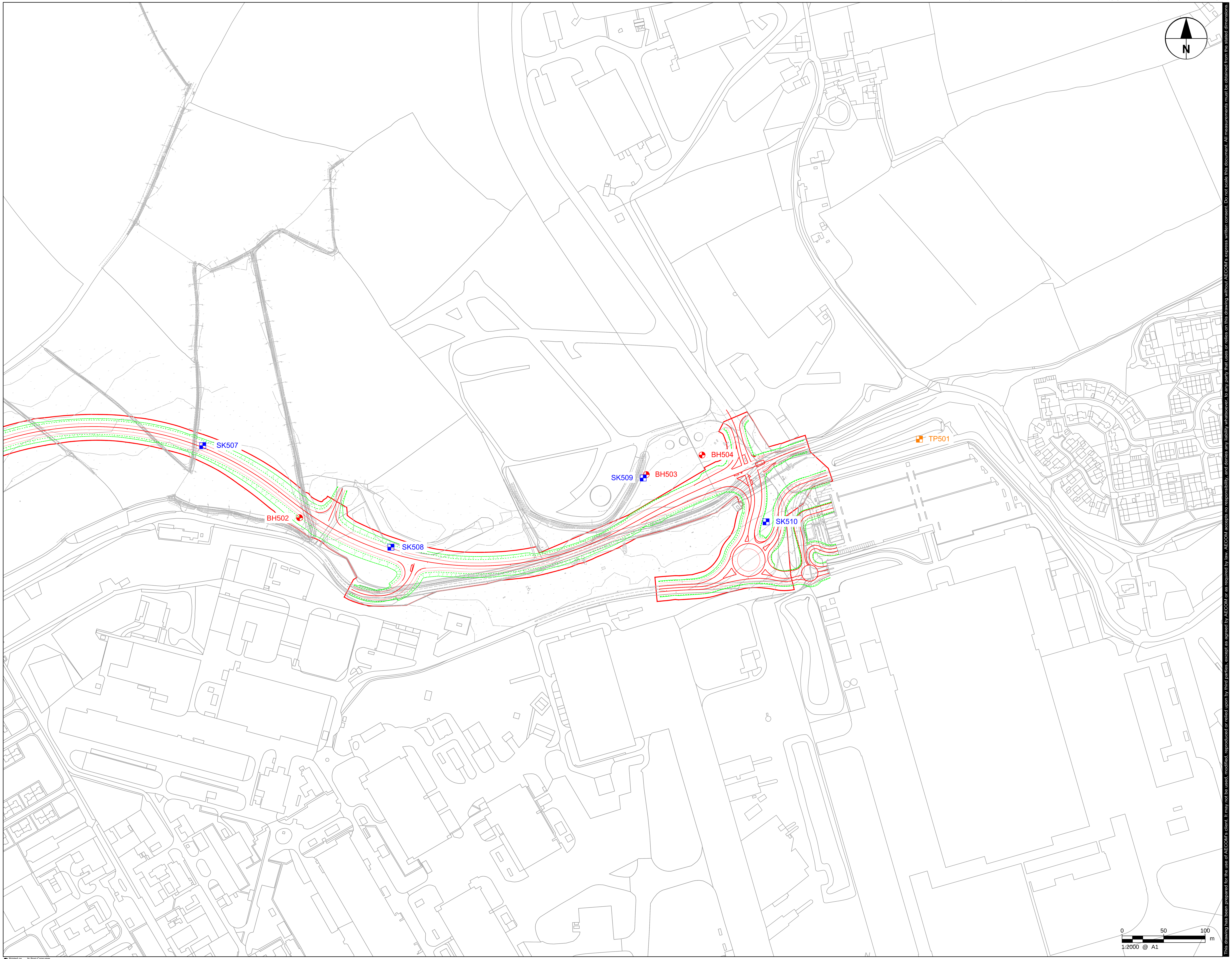
60509148

SHEET TITLE

ST. ATHAN
EXPLORATORY HOLE LOCATION PLAN
SHEET 1 OF 2

SHEET NUMBER

60509148-SHT-30-0000-CT-0652



AECOM

PROJECT

ST. ATHAN
NORTHERN
ACCESS
ROAD

CLIENT

WELSH GOVERNMENT

Llywodraeth Cymru
Welsh Government

CONSULTANT

AECOM
1 CALLAGHAN SQUARE
CARDIFF
CF10 5BT
TEL: (029) 20674600
FAX: (029) 20674699

KEY

PROPOSED KEY INFORMATION

BOREHOLE	BH
TRIAL PIT	TP
SOAKAWAY TEST	SK

ISSUE/REVISION

I/R	DATE	DESCRIPTION
A	23/01/2017	FINAL VERSION

KEY PLAN

PROJECT NUMBER

60509148

SHEET TITLE

ST. ATHAN
EXPLORATORY HOLE LOCATION
PLAN
SHEET 2 OF 2

SHEET NUMBER

60509148-SHT-30-0000-CT-0653

ISO A1 594mm x 841mm
Approved: CE
Checked: MB
Designer: MC
Project Management Initials:
Last saved by: ELENA.MARTIN Last
Filename: \\EU.AECOMNET.COM\EUPROJECTVOL\UKCDF1-TP\PROJECTS\HIGHWAYS - ST ATHAN\603 EXECUTION\03 DOCUMENTS\08 CAD\01 WORKING\DRAWINGS\0600 - EARTHWORKS\01 PLANNING\60509148-SHT-30-0000-CT-0652_0653 FINAL.DWG
Plotted: 2017-01-25
Printed on ___% Post-Consumer Recycled Content Paper