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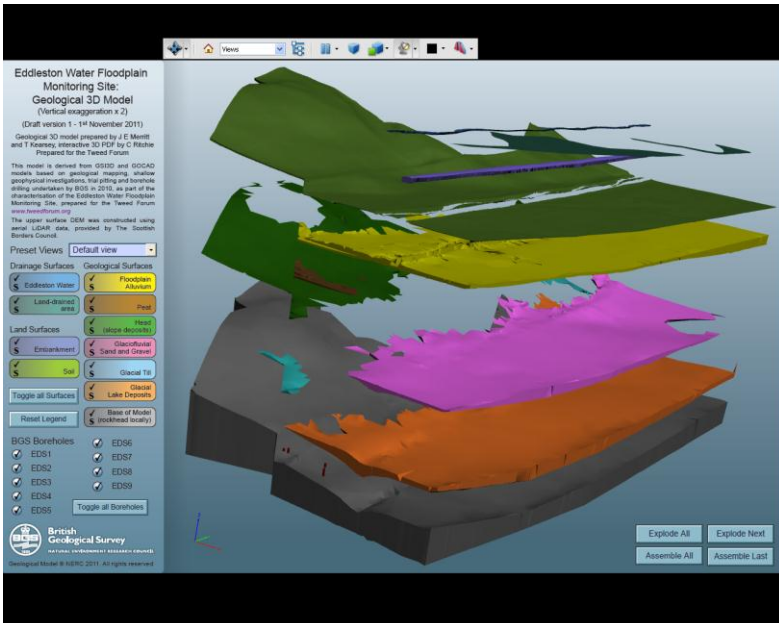
Metadata report for the Eddleston Water Floodplain GSI3D model

Geology and Landscape Scotland

Internal Report IR/13/032



BRITISH GEOLOGICAL SURVEY

Geology and Landscape Scotland

INTERNAL REPORT IR/13/032

Metadata report for the Eddleston Water Floodplain GSI3D model

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Summary

This report describes the work undertaken to characterise the shallow subsurface geology (Quaternary) at Eddleston in the Scottish Borders. In order to produce the GSI3D model the site was re-surveyed, trial pits were excavated, boreholes sunk and a series of geophysical surveys were undertaken.

The three dimensional model is part of a study including hydrogeology and soil hydrology to assess the impact of flooding within the Eddleston Water floodplain.

1 Modelled volume, purpose and scale

The Eddleston Water is a tributary of the River Tweed and this site was selected by the Scottish Government for promoting Natural Flood Management. The model was created as part of a larger project, the Eddleston Water Project, to improve the understanding of groundwater in relation to the subsurface geology and to aid in the design and testing of natural flood prevention and remediation measures in the Scottish Borders.

The modelled area is shown on Figure 1. It lies immediately north of Eddleston village.

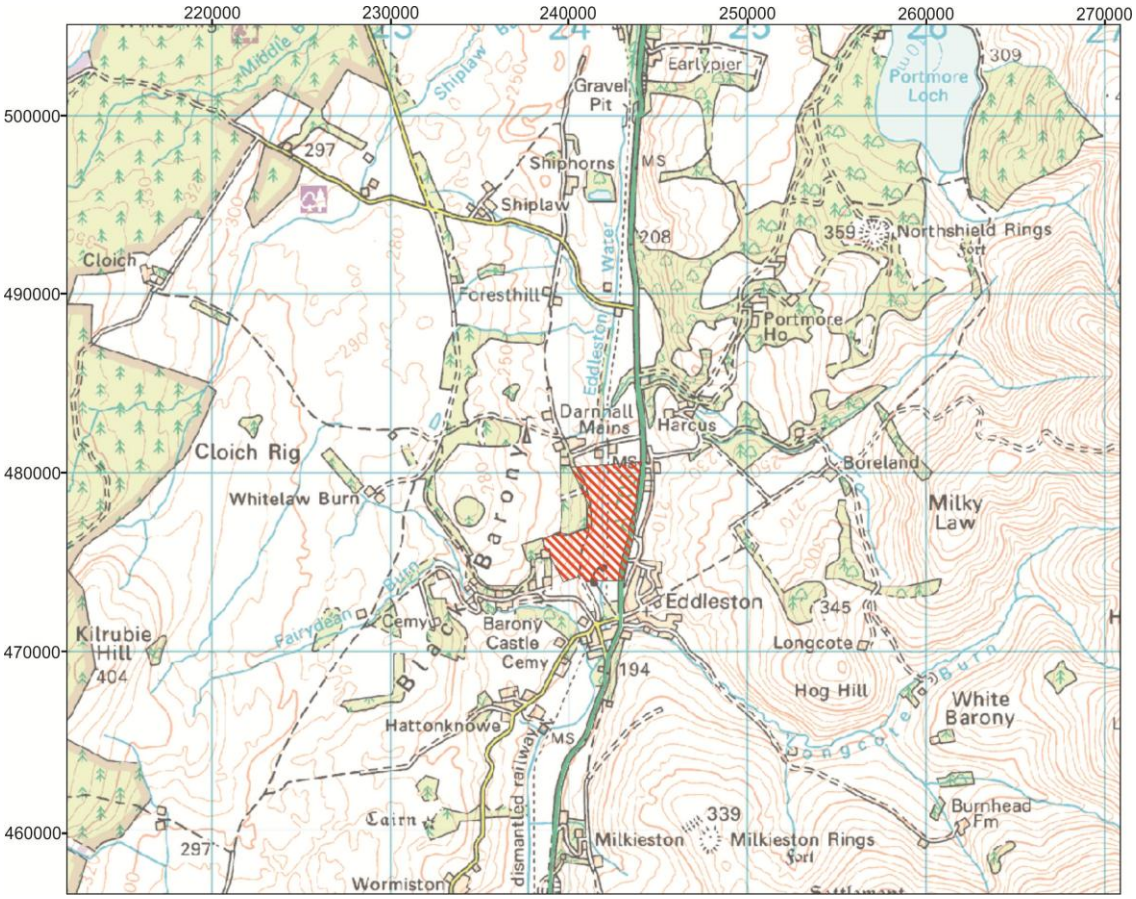

Figure 1: Location of the Eddleston experimental site

The modelled area, known as the Eddleston experimental site, is taken to be typical of the floodplain and valleysides of the whole of the Eddleston Water catchment (Figure 2). It covers an area of approximately 0.2 km² (approximately 400 m by 500 m). The completed model was made available to partners, namely The Tweed Forum and the University of Dundee, and is part of the wider Eddleston Water Project[1] with a purpose to provide information on the flow of groundwater with relation to superficial deposits, (Ó Dochartaigh et al., 2012). The model is also available to the public as a 3D pdf on the British Geological Survey (BGS) website[2].

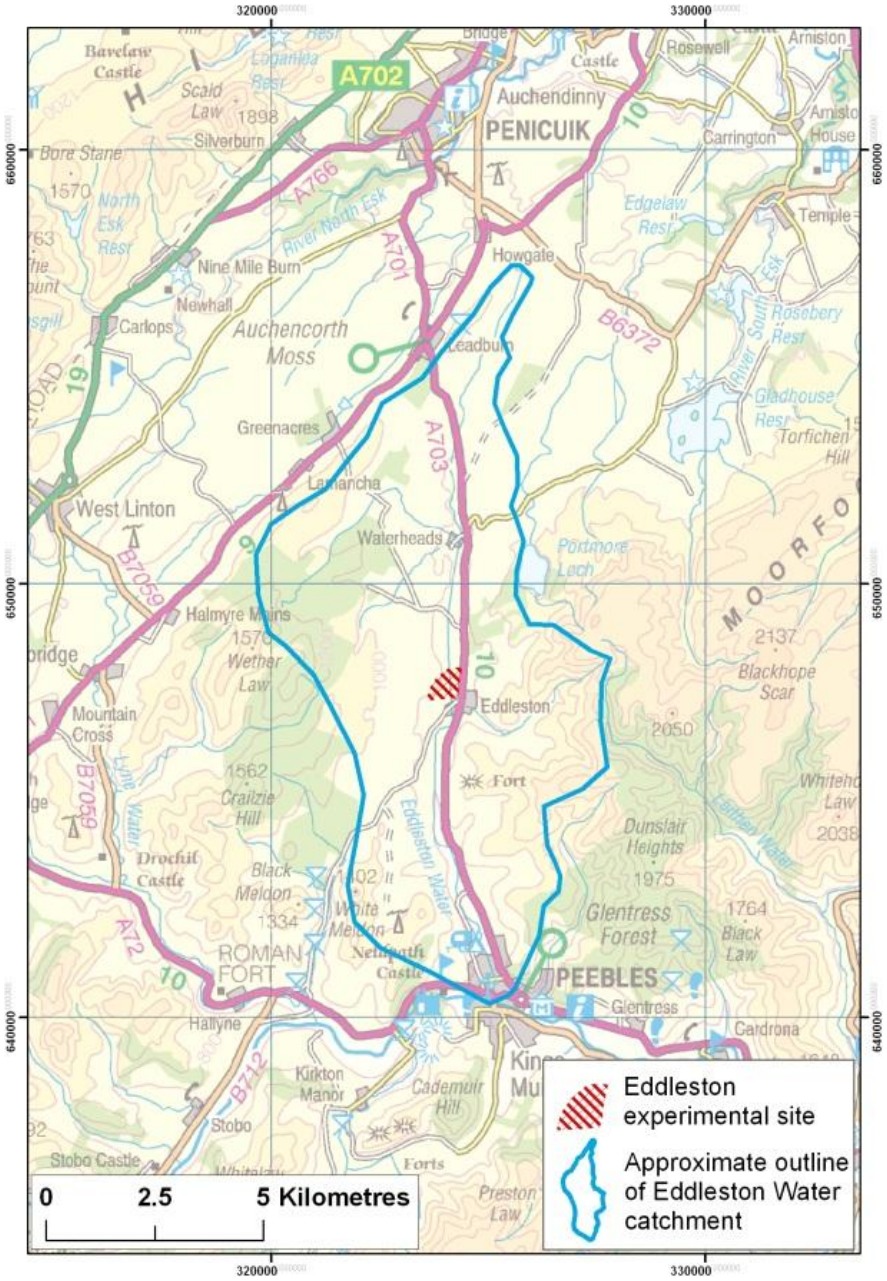

Figure 2: Location of the Eddleston Water Catchment area

[1]http://www.sepa.org.uk/flooding/flood_risk_management/working_with_nature/the_eddleston_water_project.aspx

[2]http://www.bgs.ac.uk/

2 Modelled surfaces/volumes

name	stratigraphy	lithostrat	genesis	age
water	null	water	null	Recent
mgr	mgr	mgr	man made	Recent
channel	channel	channel	NULL	Recent
soil	Z	soil	Weathering and cultivation	Recent
peat_1	P	peat_1	organic	Recent
drain	pipe	drain	man made	Recent
alv_v_1	V	alv_v_1	abandoned meander	Flandrian
alv_cz_1	CZV	alv_cz_1	overbank	Flandrian
peat_2	P	peat_2	organic	Flandrian
alv_v_2	VZS	alv_v_2	braided or meander	Flandrian
alv_cz_2	CZ	alv_cz_2	overbank	Flandrian
alv_v_3	V	alv_v_3	braided or meander	Flandrian
alv_cz_3	CZ	alv_cz_3	overbank	Flandrian
head_1	VZ	head_1	slope	Flandrian
sagr_1	VS	sagr_1	glaciofluvial	Devensian
till_1	CZSVLB	till_1	glacial	Devensian
head_2	VZ	head_2	slope	Devensian
peat_3	P	peat_3	organic	Devensian
organic_silt	ZP	organic_silt	organic	Devensian
glld_1	C	glld_1	glaciolacustrine	Devensian
sagr_2	VS	sagr_2	glaciofluvial	Devensian
till_2	CZSVLB	till_2	glacial	Devensian
glld_2	C	glld_2	glaciolacustrine	Devensian
rockhead	rockhead	rockhead	null	null
base_model	base_model	base_model	virtual	null
peat_lens_top	peat_lens_top	peat_lens_top	organic	Flandrian
peat_lens_base	peat_lens_base	peat_lens_base	organic	Flandrian

Table 1: Generalized Vertical Section (GVS) showing modelled units

		Km²	Square m	Cubic km	Cubic m	Average thickness m
Model		0.2346720	234672.0000			
Made ground		0.0082950	8295.0000	0.0000183	18288.2800	2.2047354
Soil		0.2238210	223821.0000	0.0000966	96635.2300	0.4317523
Peat_1		0.0007440	743.9646	0.0000003	343.8254	0.4621529
Alv_v_1		0.0095530	9553.0000	0.0000038	3771.8920	0.3948385
Alv_cz_1		0.1144919	114491.9000	0.0001034	103422.0000	0.9033128
Peat2		0.0053845	5384.5000	0.000001	1800.3430	0.3343566

				8		
Alv_v_2		0.1324666	132466.6000	0.0004775	477495.9000	3.6046513
Alv_cz_2		0.0143966	14396.6000	0.0000185	18522.6300	1.2865975
Alv_cz_3		0.0004721	472.1111	0.0000001	140.1409	0.2968388
Head_1		0.0004043	404.2763	0.0000001	119.6151	0.2958746
Sagr_1		0.1255495	125549.5000	0.0003958	395821.6000	3.1527135
Till_1		0.0079064	7906.4000	0.0000083	8275.5690	1.0466924
Head_2		0.0771733	77173.3000	0.0000660	65981.1800	0.8549742
Glld_1		0.1294719	129471.9000	0.0005890	589048.4000	4.5496235
Sagr_2		0.0027417	2741.7000	0.0000027	2688.7810	0.9806985
Till_2		0.0055258	5525.8000	0.0000047	4687.0430	0.8482108
Peat_lens_top		0.0003711	371.1021	0.0000001	50.9616	0.1373249

Table 2: Calculated outcrop areas, volumes and thicknesses

3 Modelled faults

Not applicable

4 Model datasets

General caveats regarding BGS datasets and interpretations are:

- Geological observations and interpretations are made according to the prevailing understanding of the subject at the time. The quality of such observations and interpretations may be affected by the availability of new data, by subsequent advances in knowledge, improved methods of interpretation, improved databases and modelling software, and better access to sampling locations.
- Raw data may have been transcribed from analogue to digital format, or may have been acquired by means of automated measuring techniques. Although such processes are subjected to quality control to ensure reliability where possible, some raw data may have been processed without human intervention and may in consequence contain undetected errors.

4.1 DATA LOCATION

W:\Teams\SST\EddlestonWaterFloodPlain\Documents\Eddleston_GSI3D_Model_Report_QA\Eddleston_GSI3D_Final_Model

4.1.1 Data (DTM)

The DTM used was derived from high resolution (2m) Lidar data provided by Scottish Borders Council.

4.1.2 Data (geological surveying)

The Eddleston area was re-surveyed at two-levels of detail between July and September 2010. The Eddleston catchment area, 679.5 km², was resurveyed by C. A. Auton at 1:10 000 scale to revise the interpretation of the distribution of glacial, post-glacial and artificial deposits, (BGS, 2011)

A detailed survey of the Eddleston experimental site at c. 1:500 scale was carried out in July 2010 by J. E. Merritt. This survey involved augering 42 holes, (Figure 2) in order to investigate the shallow geology and provide additional data with regards to the construction of the GSI3D model. Both surveys were undertaken using digital field data capture within the BGS Sigma Mobile workflow.

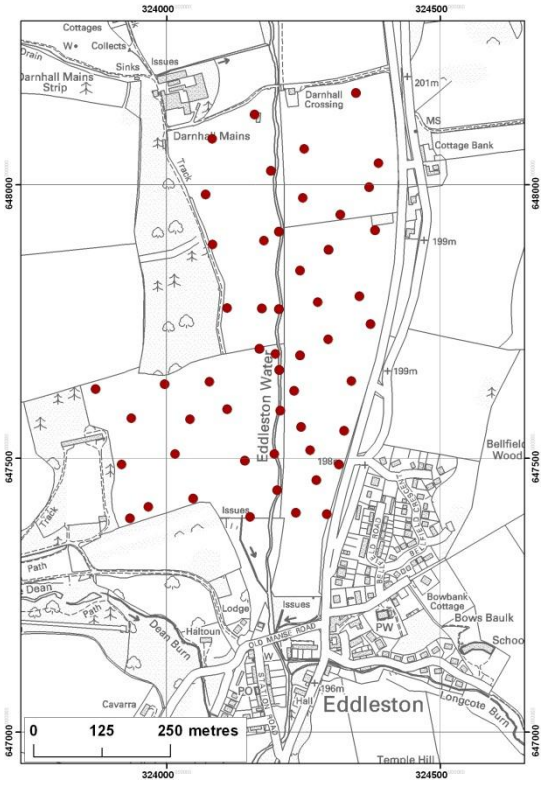

Figure 3: Location of auger holes

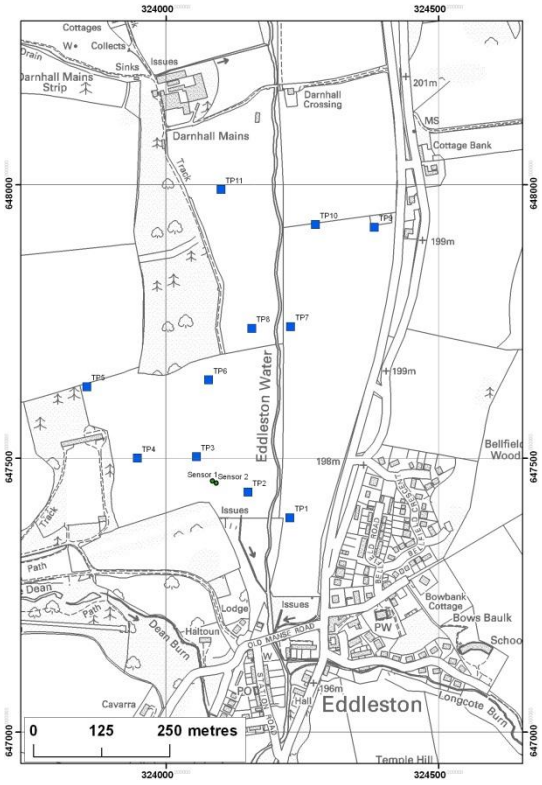

Figure 4: Location of trial pits

4.1.3 Data (trial pits and boreholes)

Eleven trial pits were dug across the Eddleston site between 16th and 18th August 2010, (Figure 3), these were logged, sampled and re-instated, (see Table 3).

Trial pit identifier	Easting	Northing	Elevation (m OD)	Depth (m)
TP1	324228.1	647391.7	195.99	2.30
TP2	324150.7	647438.3	195.96	3.30
TP3	324056	647503.1	207.17	1.10
TP4	323947.4	647500.7	230.03	1.40
TP5	323854.7	647631	243.37	2.33
TP6	324078.4	647643.3	211.22	2.00
TP7	324229.1	647741.1	197.9	2.40
TP8	324157.7	647738	200.44	1.60
TP9	324382.9	647922.7	198.59	3.00
TP10	324274.9	647927.5	198.76	1.90
TP11	324101.4	647991.6	212.63	3.85

Table 3: Summary of trial pit location and depths

Nine boreholes were drilled with a shell and auger (percussion) rig, in order to maximise the amount of geological material recovered, (Figure 5). These were drilled between 28th April and 13th May 2011. Detailed logging of disturbed samples collected from the boreholes was subsequently undertaken in Murchison House and full BGS approved borehole logs produced. These now reside in the Single Onshore Borehole Index (SOBI) corporate database.

In order to monitor the hydrological properties of the floodplain, piezometers were installed in each of the boreholes. A summary of the boreholes drilled can be seen in Table 4.

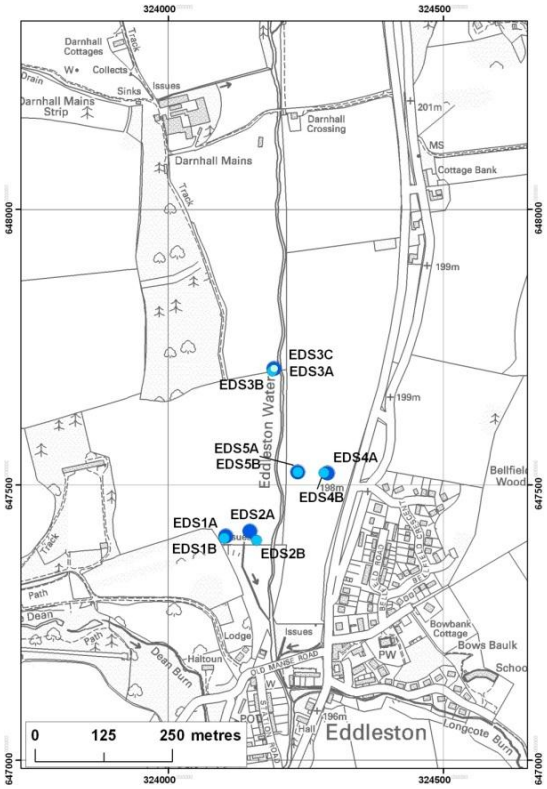

Figure 5: Location of boreholes

Temporary borehole (drilling) identifier	Easting	Northing	Borehole depth (m)	Geology
EDS1	324105	647407	5.31	Sandy alluvial or glaciofluvial gravel
EDS2	324102	647403	1.65	Peat
EDS4	324149	647416	7.61	Very sandy gravel
EDS3	324161	647399	4.2	Very sandy gravel
EDS5	324193	647711	8.58	Sandy gravel
EDS6	324190	647707	4.75	Sandy gravel
EDS5	324193	647711	1.58	Sandy gravel
EDS7	324290	647521	8.02	Sandy gravel
EDS8	324284	647522	5.04	Very sandy gravel
EDS9	324236	647523	13.07	Gravel
EDS9	324236	647523	4.7	Sandy alluvial or glaciofluvial gravel

Table 4: Summary of boreholes drilled

4.1.4 Data (geophysical survey)

Near-surface geophysical surveying at the Eddleston site was carried out between 9th and 12th August 2010 by BGS geophysicists. Three surveying methods were used: Electromagnetic Induction (EM), 2D Electrical Resistivity Tomography (ERT) and Ground Penetrating Radar (GPR) (see section 3, "Geophysical surveying", Ó Dochartaigh et al., 2012). A summary of the

number of survey lines run can be seen in Table 5 and Figure 7 shows the location of the geophysical lines.

Geophysical method	Number of survey lines
EM	39 (33 on a regular grid east of the river)
ERT	5
GPR	29 (19 on a regular grid east of the river)

Table 5: Summary of geophysical lines

4.1.5 Data (sections)

Cross-sections were constructed to coincide with geophysical lines. Some extra sections were created to help with model constraint and calculation, (Figures 6 and 7).

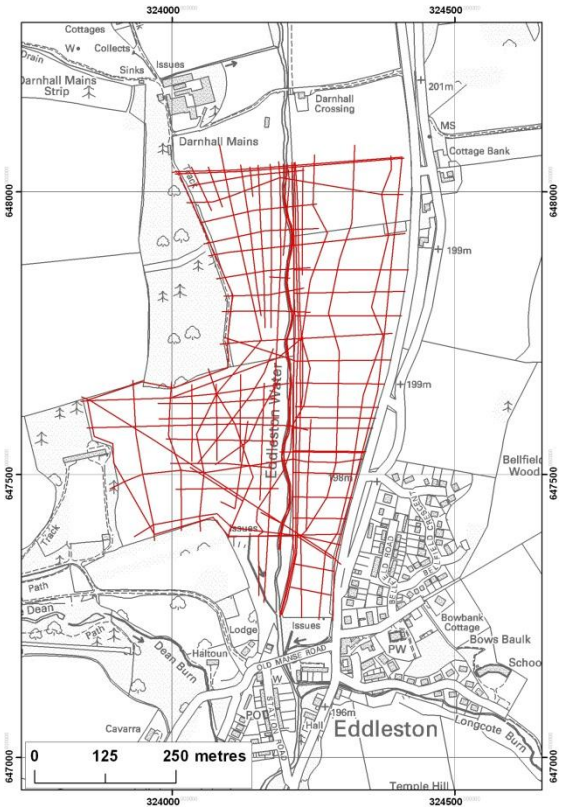

Figure 6: Lines of cross-section for use in GSI3D

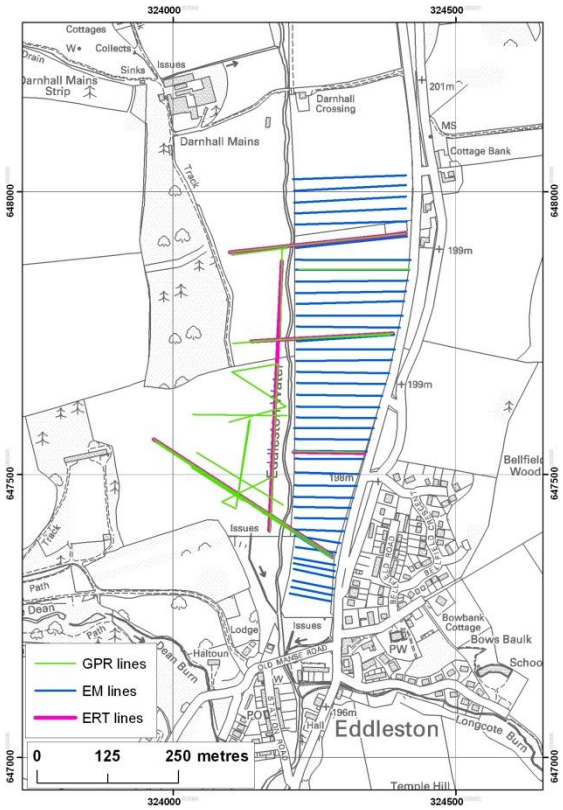

Figure 7: Location of geophysical lines

5 Dataset integration

All data were brought together in the GSI3D modelling software where it can be viewed and interrogated in 2D and 3D.

6 Model development log

- All digital data were processed, prepared and imported into the GSI3D modelling software.
- A generalised geological section was devised to best fit the deposits seen and recorded in the data collection phase.
- Cross-sections were constructed to coincide with geophysical lines. Some extra sections were created to help with model constraint and calculation.
- All borehole, trial pit, auger hole and geophysical data were considered during interpretation.
- At the end of interpretation a checking phase based on interrogation of a fence diagram of all cross-sections was performed.
- Geological envelopes marking the extents of each geological unit were then created.
- Final model calculation was performed with several iterative phases to get the best model calculation possible.
- Model calculation is by triangulation of nodes from correlated geological units in cross-section lines, geological envelopes and DTM.
- The model was exported to the BGS Lithoframe viewer (a model viewing and interrogation package) and to 3D PDF.
- During the process of model checking for Quality Assurance purposes it was noted that some of the field observation points did not have start heights and were therefore shown incorrectly in the 3D window, i.e. situated at the base of the model. This matter was resolved by entering start heights calculated using a Nextmap DTM and GIS software.
- Checking of the geological units of the model indicated that in the northern part of the model to the west of the river the units had to be altered to make them older than the units on the east side of the river. Two units and envelopes were changed from SAGR1 to SAGR2 and TILL1 to TILL2. One new unit and one new envelope were created, GLLD2.

7 Model workflow

The methodology for construction of models in GSI3D is described in great detail by Kessler et al. (2008; http://nora.nerc.ac.uk/3737/1/OR08001.pdf). It principally involves construction of cross-sections between the best quality data available followed by envelope construction around the limits of the geological units.

8 Model images

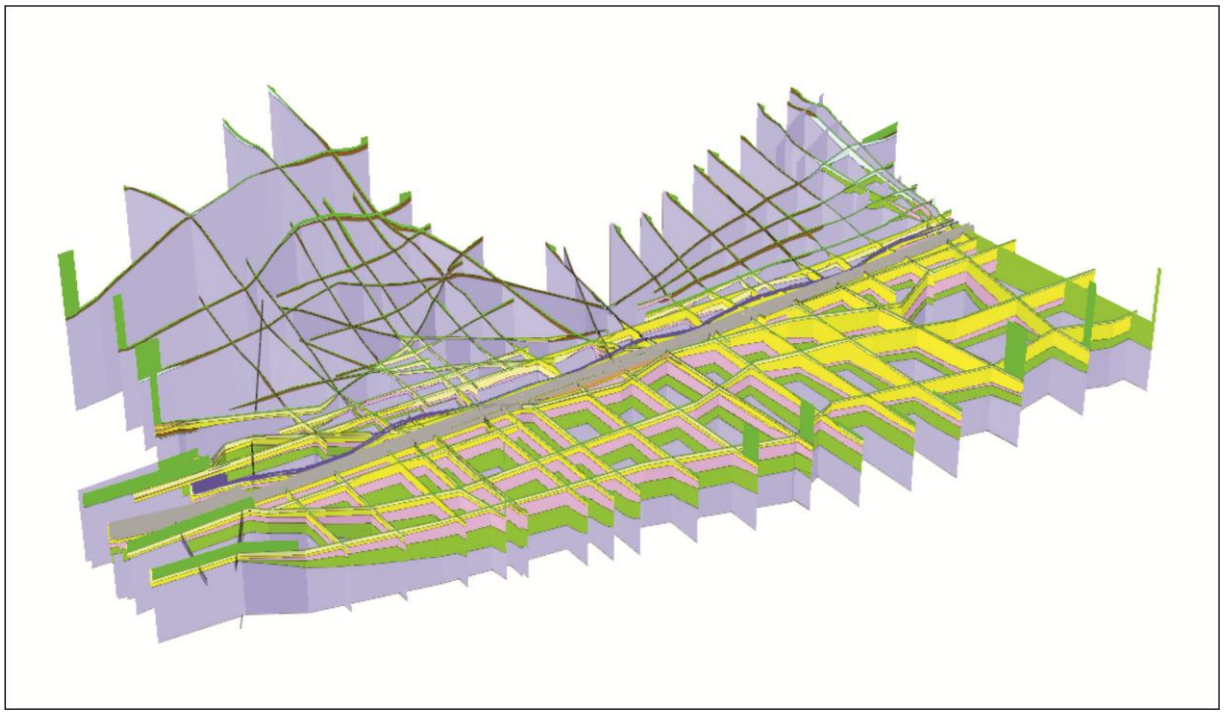

Figure 8: 3D geological model of the Eddleston experimental site showing cross-sections, vertical exaggeration x2

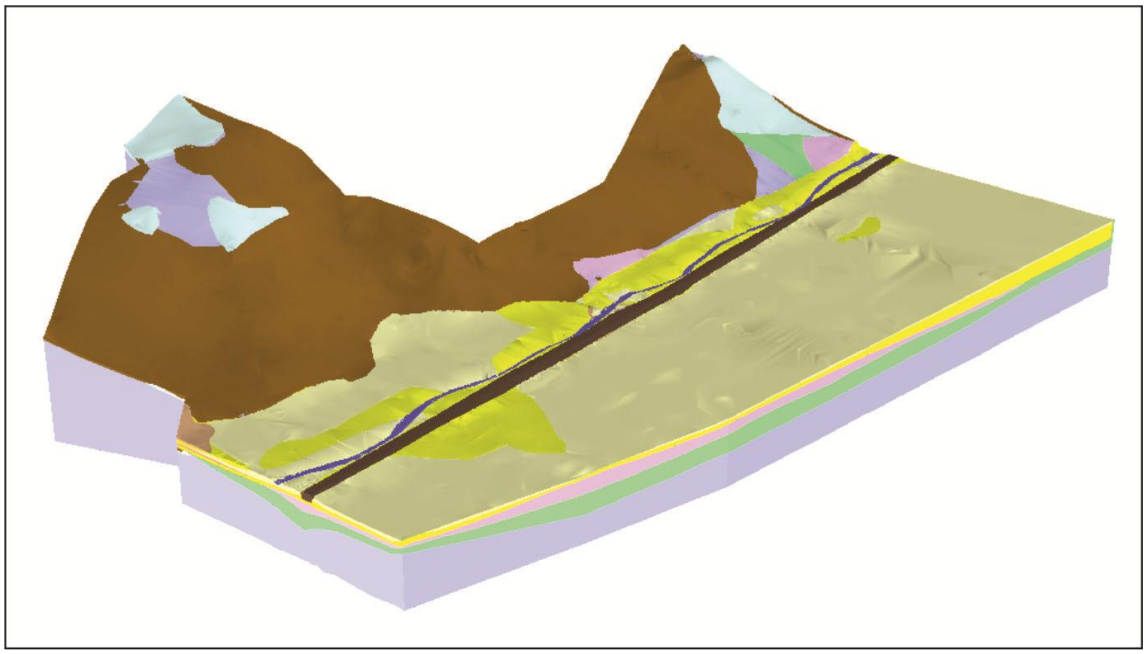

Figure 9: View from southeast with soil layer removed to show underlying superficial deposits, vertical exaggeration x2

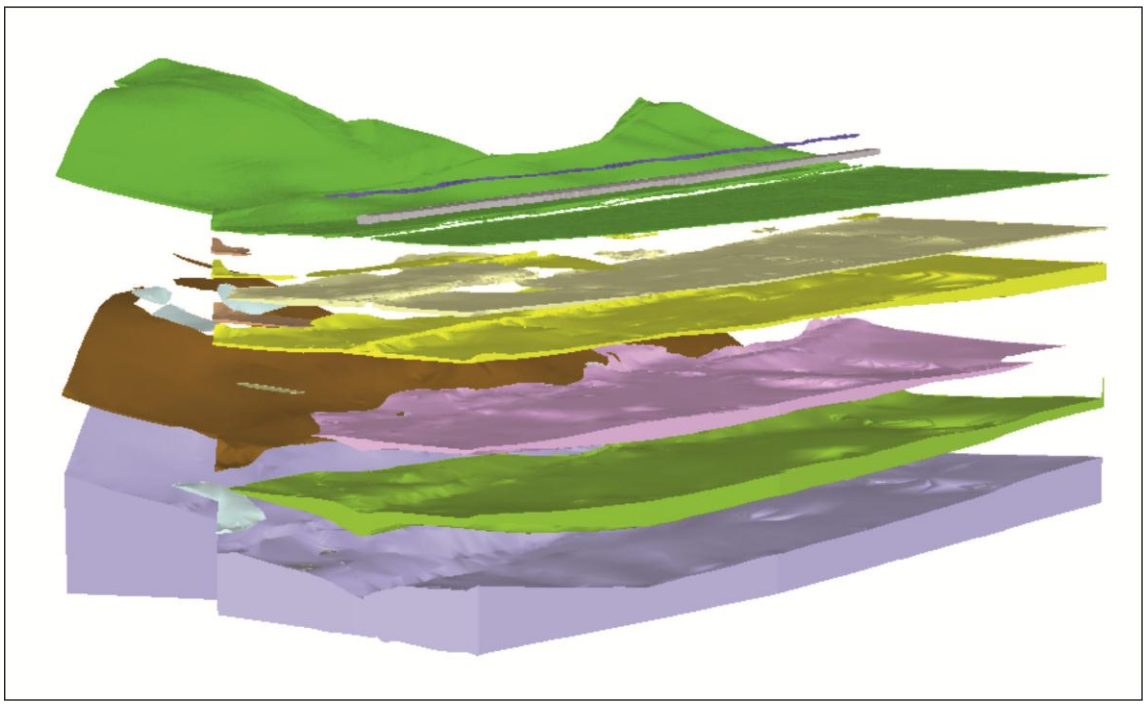

Figure 10: GSI3D model exploded showing all units, vertical exaggeration x2

References

British Geological Survey holds most of the references listed below, and copies may be obtained via the library service subject to copyright legislation (contact libuser@bgs.ac.uk for details). The library catalogue is available at: http://geolib.bgs.ac.uk.

BRITISH GEOLOGICAL SURVEY , 2011. Eddleston Water Catchment, Superficial. 1:25 000 scale. (Keyworth, Nottingham: BGS).

KESSLER, H, MATHERS, S.J. SOBISCH, H-G AND NEBER, A.2008. GSI3D – The software and methodology to build systematic near-surface 3-D geological models. (Version 2) *British Geological Survey Open Report*, OR/08/001 144pp.

Ó DOCHARTAIGH, B. É. MACDONALD, A.M. MERRITT, J. E. AUTON, C. A. ARCHER, N. BONELL, M. KURAS, O. RAINES, M.G. BONSOR, H. AND DOBBS, M. 2011. Eddleston Water Floodplain Project: Data Report. *British Geological Survey Open Report*, OR/12/059. 95pp.