PRELIMINARY INTERIM EARTHWORKS REPORT

Herbert Road
Newport

Prepared for:

Riversee Limited

June 2016

Report No. 12032/ER1

REPORT TITLE	**:**	**Preliminary Interim Earthworks Report : Herbert Road, Newport**
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SECTION 1 Summary of Planned Earthworks

An area of land off Herbert Road, Newport is to be residentially developed.

In order to comply with current Government directives and the FCA approved by NRW a large section of the development site needs to be raised to a finished floor slab level of 9.95m AOD, which is between 2.5-2.75m above existing levels.

To date, the site has been part-filled with engineered fill. Fill works began in July 2015 and ceased in October 2015.

Terra Firma (wales) Limited has been employed by Riversee Limited to inspect, monitor and document the earthworks activities:

- Install water monitoring stations and test groundwater and reen water samples in accordance with Council and NRW requirements
- Install vibrating wire piezometers and settlement pins to monitor and assess the settlement occurring in underlying clay and peat deposits as a result of filling of the site
- Validate all imported materials to ensure they are uncontaminated in accordance with Terra Firma Remediation Strategy Report
- Maintain a site presence during fill works to document activities and advise as necessary
- Co-ordinate geotechnical validation testing of the imported fill

SECTION 2 Geotechnical and Geo-environmental Reporting

Terra Firma (Wales) Limited previously undertook geotechnical and geo-environmental investigation of the site for Greenhill Construction Limited.

The details of the investigation were reported on in March 2013 (Geo-environmental and Geo-technical Report No. 12032).

A copy of this report is provided in **Annex A.**

SECTION 3 Settlement Monitoring

During July 2015 six vibrating wire piezometers and eight settlement monitoring pins were installed across the site.

The location of these monitoring points is illustrated in **Figure 3.1** below.

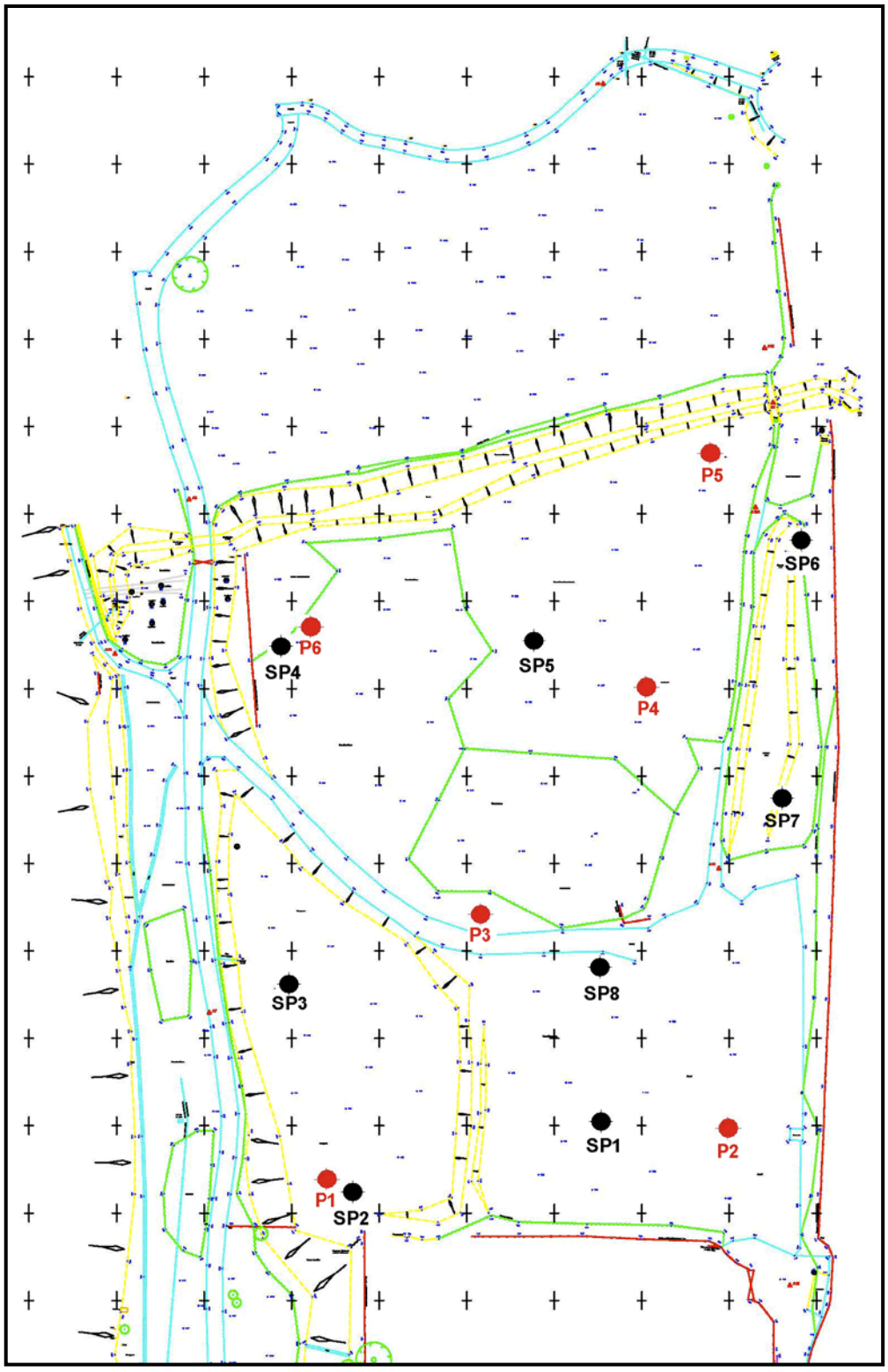


Figure 3.1: Piezometer (P1 – P6) and Settlement Pin (SP1 – SP8) Locations

Settlement Monitoring (Continued)

The piezometers and settlement pins were monitored and surveyed at regular intervals during the earthworks completed so far (July to October 2015), and intermittent monitoring was also completed in the period between October 2015 and May 2015.

With raising ground levels settlement is expected to occur on site in two phases, instantaneous and primary settlement and subsequent secondary settlement.

During instantaneous settlement the soil experiences only shear deformation resulting into change in shape without volumetric deformation. The loss of pore pressure in the soil is zero. Since this settlement is instantaneous it can only be monitored via monitoring pins as the pore pressure cannot be measured (zero).

During primary consolidation / settlement the soil is deformed by movement and compression of soil particles which overall results in volume change. Water held in pores of a saturated soil will migrate to pores of lower pressure (The process of consolidation). Primary settlement is time dependent on a logarithmic scale and stops when pore water pressure returns to baseline level.

Secondary consolidation / settlement occurs following the fall of pore water pressure. Secondary consolidation / settlement includes but is not limited to the following factors;

- Creep: With increasing pressure the grains may become so tightly packed that they will deform causing the soil mass to continue to reduce in volume
- Viscous behaviour of water between particles and pore water: During secondary compression the highly viscous water between the points of contact of soil particles is squeezed out.
- Compression and degradation of organic matter,

Consolidation is a process by which soils decrease in volume by decreasing water content within a saturated soil without replacement of water by air. Consolidation occurs when water is expelled under long term static loads. When a stress or surcharge is applied to a saturated soil the soil particles can compact, therefore reducing its bulk volume and excess water will be “squeezed out”. As a soil consolidates excess pore water pressure will fall.

Vibrating wire piezometers were used to monitor pore water pressures (a pressure correlating to meters of water). Vibrating wire piezometers convert fluid pressures on a sensitive diaphragm into a frequency signal. The signals are capable of long transmission distances without degradation, tolerant of wet wiring conditions and resistant to external electrical noise.

Settlement Monitoring (Continued)

To measure settlement baseline data is required.

Table 3.1 Installation details of Piezometers

Piezometer	Depth	Strata Description	Initial Reading		Possible Baseline Reading	
			mH2O	Date	mH2O	Date
P1	6.30mbgl	Peat	2.05	14/7/15	4.45	23/7/16
P2	2.60mbgl	Clay	0.017	15/7/15	2.20	24/7/16
P3	3.70mbgl	Clay	2.429	16/7/15	2.20	24/7/16
P4	4.95mbgl	Peat	0.358	16/7/15	4.10	22/7/16
P5*	2.90mbgl	Peat	0.324	17/7/15	1.95	29/7/16
P6	5.00mbgl	Clay	4.087	22/7/15	4.50	28/7/16
*P5 was last recorded on 4/1/16. The piezometer has been destroyed.						

The possible baseline readings are considered representative although project program would not permit prolonged monitoring to refine the baseline pressures further.

During the establishment of a baseline the piezometers were monitored for changes in pore pressure coinciding with changes in tide level. The tidal range of the River Usk in Newport can extend over 13m. Tide information from The United Kingdom Hydrographic Office for Newport, Wales was used to identify low tide and high tides. Despite the significant tidal range the effect on piezometers was slight / negligible.

As confirmation the piezometers were measured again from low tide to high tide, (a 10.3m tidal range) between 11:00 and 17:00 on 27/5/2016. The data is summarised below.

Table 3.2 Tidal Effect on Piezometers

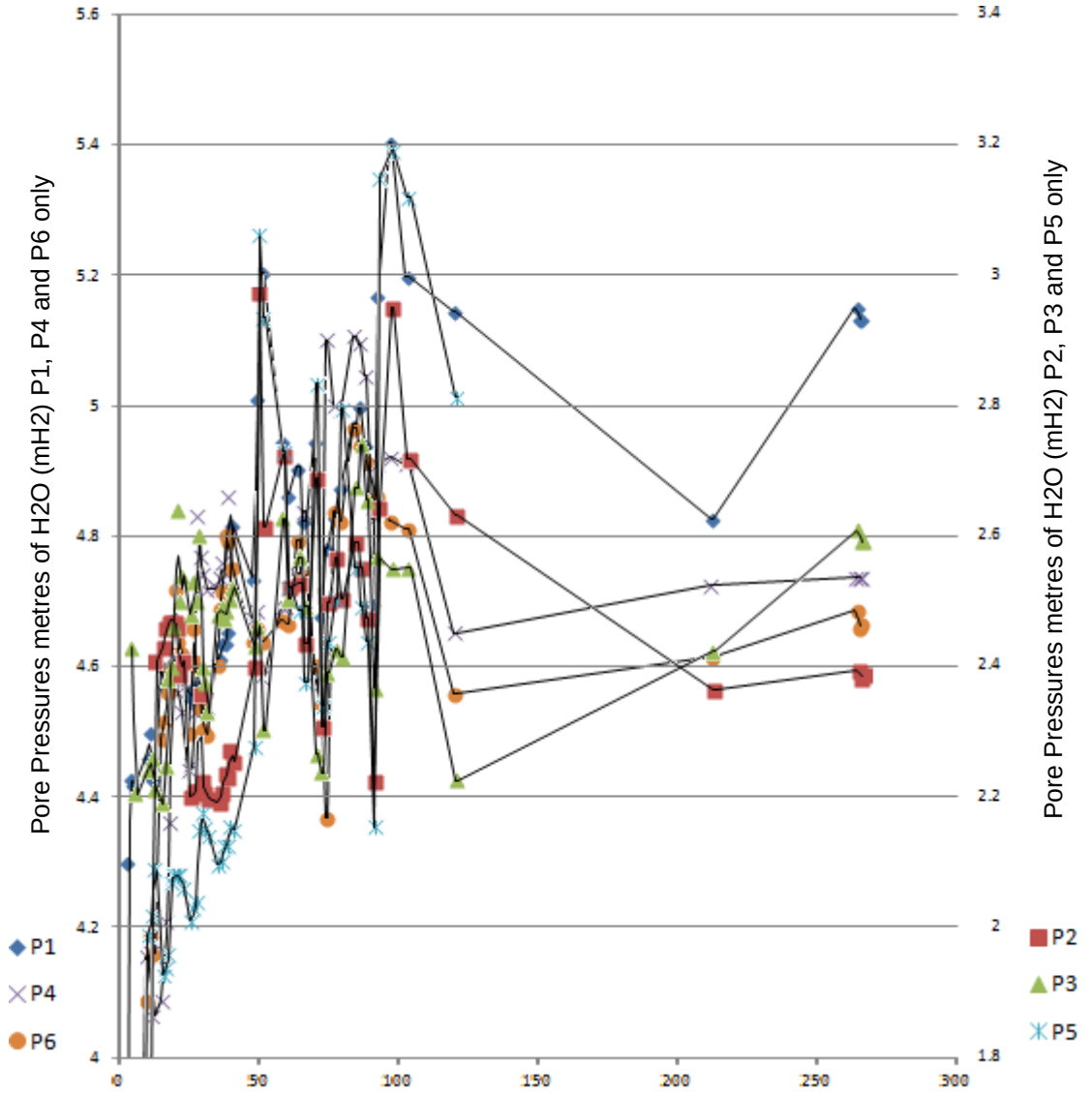
Time	11:00	14:00	17:00	Maximum measured Change in Pore Pressure
Tide Description	Low Tide	Rising Tide	High Tide	
P1	5.151573	5.13387	5.13387	-0.018mH2O
P2	2.3939187	2.3825055	2.3882121	-0.011mH2O
P3	2.6096248	2.5912062	2.5912062	-0.018mH2O
P4	4.7355286	4.7355286	4.7355286	0mH2O
P5	Destroyed			
P6	4.6853254	4.6593008	4.6646852	-0.026mH2O
Pore Pressures reported in mH2O.				

Pore water pressure would be anticipated to increase at high tide with rising water levels however this does not appear to be evident. The equivalent of under 30mm groundwater change was observed between low tide and high tide in this instance. It is considered that the groundwater beneath the site is unlikely to be significantly influenced by the high tidal range of the Usk.

Pore water pressure was monitored daily (or more) during the period of full time supervision. Full time supervision was between 14/7/2015 through to 20/8/2015. Budgetary constraints from 20/8/2015 meant that monitoring became less frequent.

Settlement Monitoring (Continued)

Graph 3.1 : Piezometer Monitoring Results

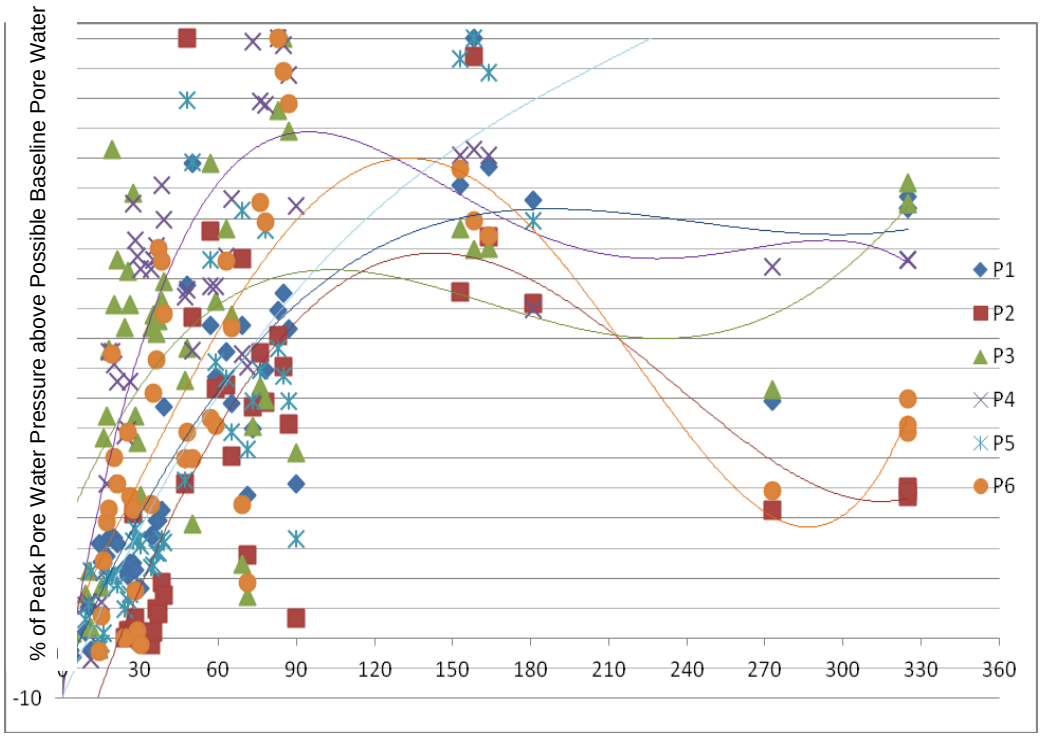


During full time supervision the increasing pore water pressures observed from the piezometers appeared to correlate with the placement of fill. As evidenced by jumps in pore water pressure over the day. Peak pore water pressure dissipated initially quickly but the rate of dissipation reduced resulting in jumps of pore water pressure.

Settlement Monitoring (Continued)

During settlement pore water pressure dissipates as water is squeezed out of consolidating material. The graph below shows the generation of peak pore water pressure generated by the placement of fill typically between 3 and 5 months after the commencement of the earthworks.

Graph 3.2 : Dissipation of Peak Pore Water Pressure



Days since 14/07/2015. (Installation of first piezometer)

Pore water pressure has been observed to be dissipating, evidence of consolidation and settlement. However the monitoring of pore water pressure dissipation has been disrupted by unsupervised filling events subsequent to the termination of full time supervision.

Pore water pressure dissipation of a single filling event should produce a single curve. Unsupervised filling events are likely to explain for the polymodal lines of best fit of pore water dissipation suggesting that following the initial placement of the assessed stockpile further material has been placed on site. Gaps in monitoring at 4 months and 8 months after the commencement of the earthworks have lead to some uncertainty over likely pore water pressures beneath the site at those times.

A summary of pore water pressure dissipation 11 months after commencement of the earthworks is presented below;

Settlement Monitoring (Continued)

Table 3.3 Summary of Piezometer Monitoring to Date14/7/15 to 27/5/16		
Piezometer 1	Strata: Peat (6.30mbgl)	Location: South-western Corner of Site (Near River Usk Embankment)
Piezometer P1 dissipated to 40% of peak pore water pressure after 3 months but has recently increased to over 70% indicating the recent placement of fill. After a period of dispersion of water pressure there was a significant increase in pore water pressure at Piezometer P1 located beneath a recently placed plateaued stockpile.		
Piezometer 3	Strata: Clay (2.60mbgl)	Location: Southern Centre of Site
Piezometer P3 like Piezometer P1 also dissipated to 40% of peak water pressure taking ~6 months. Piezometer P3 like Piezometer P1 has also recently increased to over 70% of peak pore water pressure. After a period of dispersion of water pressure there was a significant increase in pore water pressure at Piezometer P3 both located adjacent to a recently placed plateaued stockpile to the south of the site.		
Piezometer 2	Strata: Clay (3.70mbgl)	Location: South-eastern Corner of Site (Near Rail Embankment)
Piezometer P2 dissipated initially but rose again to 95% of peak water pressure after 3 months. Pore water pressure dissipated again taking a further 3 months to dissipate to ~20% of peak pore water pressure however recently no dissipation has been recorded. After a period of dispersion of water pressure there was a slight increase in pore water pressure at Piezometer P2 located adjacent to a recently placed plateaued stockpile.		
Piezometer 4	Strata: Peat (4.95mbgl)	Location: North-Centre of Site
Piezometer P4 dissipated initially falling to 55% of peak pore water pressure after 3 months. Pore water pressure at Piezometer P4 has failed to dissipate in the last 4 months and currently in excess of 60% of peak pore water pressure. After a period of dispersion of water pressure there was a slight increase in pore water pressure at Piezometer P4 located near a recently placed plateaued stockpile.		
Piezometer 5	Strata: Peat (2.90mbgl)	Location: North-eastern corner of Site (Near Rail Embankment)
Before being destroyed Piezometer 5 was observing evidence of peak pore water pressure dissipation having dissipated to 70% of peak water pressure within a month.		
Piezometer 6	Strata: Clay (5.00mbgl)	Location: North-western corner of Site (Near River Usk Embankment)
After 6 months pore water pressure appears to have dissipated between to 20-40% of peak pore water pressure. The recent changes to pore water pressure only equate to an equivalent groundwater level change of ~100mm which is considered possible especially considering proximity to the River Usk and the sensitivity of the peat. After a period of dispersion of water pressure there was a slight increase in pore water pressure at Piezometer P6. There appears to be no obvious cause for this and may be a result of natural variation. Peat is known to be a more susceptible material to change than clay.		
Observations: Primary settlement is not complete since pore water pressure continues to fall. Dissipation of pore water pressure appears faster in the peat layers than in the clay. Piezometer 1 set within peat took roughly half the time for peak pore water pressure to dissipate to 40% than Piezometer 3 set within clay.		

Settlement Monitoring (Continued)

Settlement monitoring pins were installed targeting the following areas;

Monitoring Pin 1: South-eastern Corner of the site, near rail embankment,
Monitoring Pin 2: South-western Corner of the site, near River Usk Embankment,(Destroyed)
Monitoring Pin 3: Western Edge of the site, near River Usk Embankment,(Destroyed)
Monitoring Pin 4: North-western Corner of the site, near River Usk Embankment,(Destroyed)
Monitoring Pin 5: Northern edge of the site, near reen,
Monitoring Pin 6: North-eastern corner of the site, near rail embankment,(Destroyed)
Monitoring Pin 7: Eastern Edge of the site, near rail embankment,
Monitoring Pin 8: Centre of site

Unfortunately half of the original monitoring pins were distrubed during the earthworks causing the loss of corresponding baseline information for settlement monitoring. A summary of all survey data to date is presented in **Table 3.4** below.

Table 3.4 Summary of Survey Data

	Round1	Round2	Round3	Round4	Round5	Round6	Round7	Round8
Pin	17/7/15	24/7/15	7/8/15	17/8/15	24/8/15	2/10/15	29/12/15	17/3/16
P1	9.435	9.435	9.435	9.435	9.424	9.427	9.4187	9.418
P2	D	10.069	D	D	D	D	D	D
P2A	-	-	10.071	10.064	10.055	10.059	10.0464	10.0429
P3	9.136	9.136	9.137	D	D	D	D	D
P3A	-	-	-	9.195	D	D	D	D
P3B	-	-	-	-	-	9.708	9.6882	9.68
P4	8.772	8.773	8.771	D	D	D	D	D
P4A	-	-	-	-	9.009	9.013	8.9902	8.982
P5	9.195	9.195	9.198	9.195	9.186	9.178	9.1563	9.149
P6	9.22	D	D	D	D	D	D	D
P6A	-	9.268	9.267	9.271	9.264	9.274	9.2721	9.263
P7	8.954	8.954	8.955	8.955	8.945	8.935	8.9125	8.91
P8	9.209	9.209	9.207	9.208	9.199	9.202	9.1563	9.185

- = not present
D = Destroyed,
Green filled cells indicate pins with a mostly complete set of monitoring data

During earthworks half of the monitoring points were lost or damaged resulting in the loss of data comparable to baseline conditions. Monitoring Pins 2, 3, 4 and 6 were lost. Monitoring Pins 1, 5, 7 and 8 remain intact.

Justification of Survey Rounds;

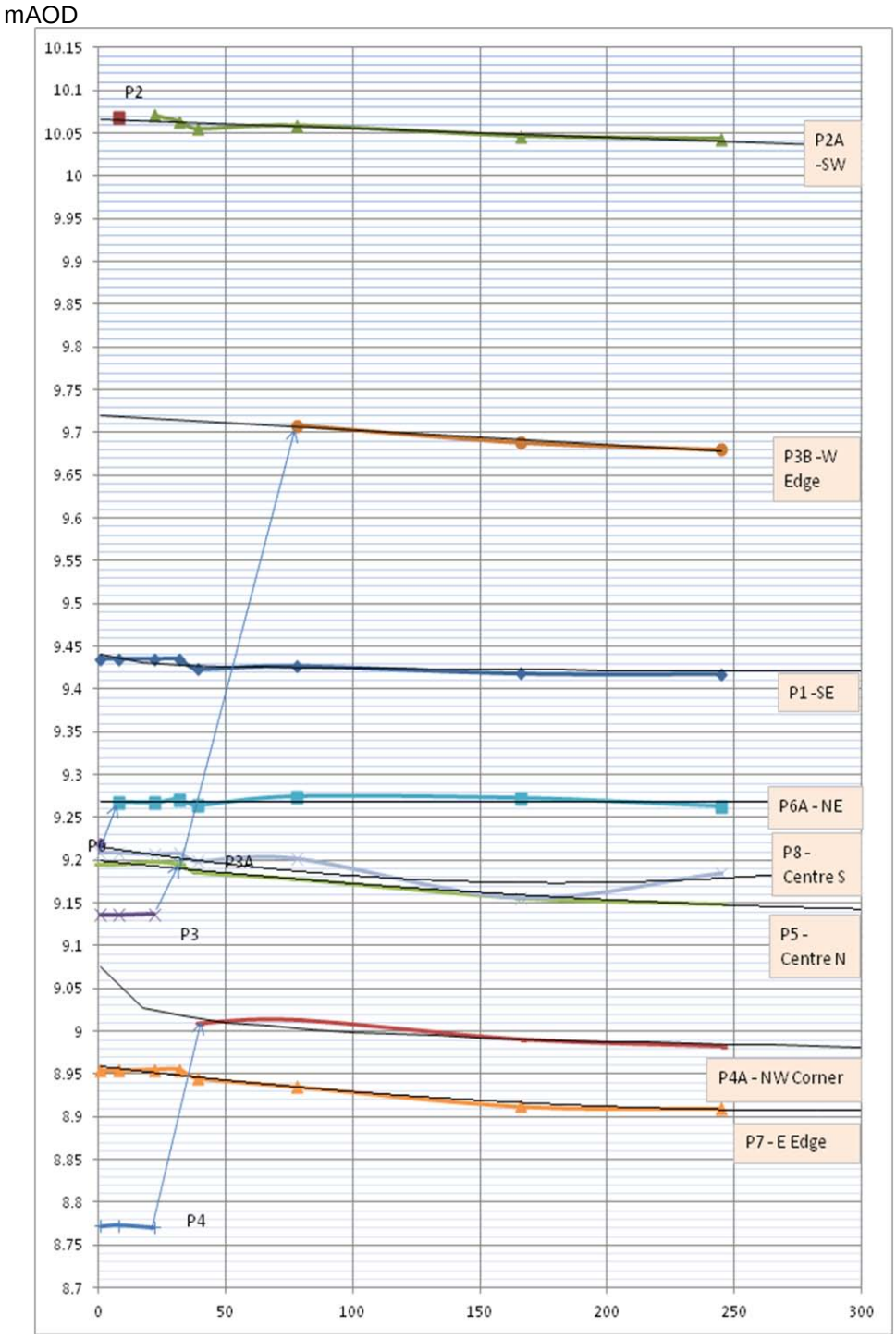
Round 1, 17/7/15.	Initial Survey (P2 damaged - not surveyed)
Round 2, 24/7/15.	Initial Survey of P2 and P6A
Round 3, 7/8/15,	Initial Survey of P2A
Round 4, 17/8/15,	Initial Survey of P3A and survey of damaged P2A
Round 5, 24/8/15,	Initial Survey (P3A damaged - not surveyed)
Round 6, 2/10/15	Initial Survey of P3A

Round 7, 29/12/15	Follow up survey
Round 8, 17/3/15	Follow up survey

Settlement Monitoring (Continued)

The graph below shows all of the surveyed monitoring pins on an arithmetic time scale. When a monitoring pin was damaged or destroyed an effort was made to replace the pin. When a monitoring pin was damaged / destroyed it was given a sequential alphabetical designation.

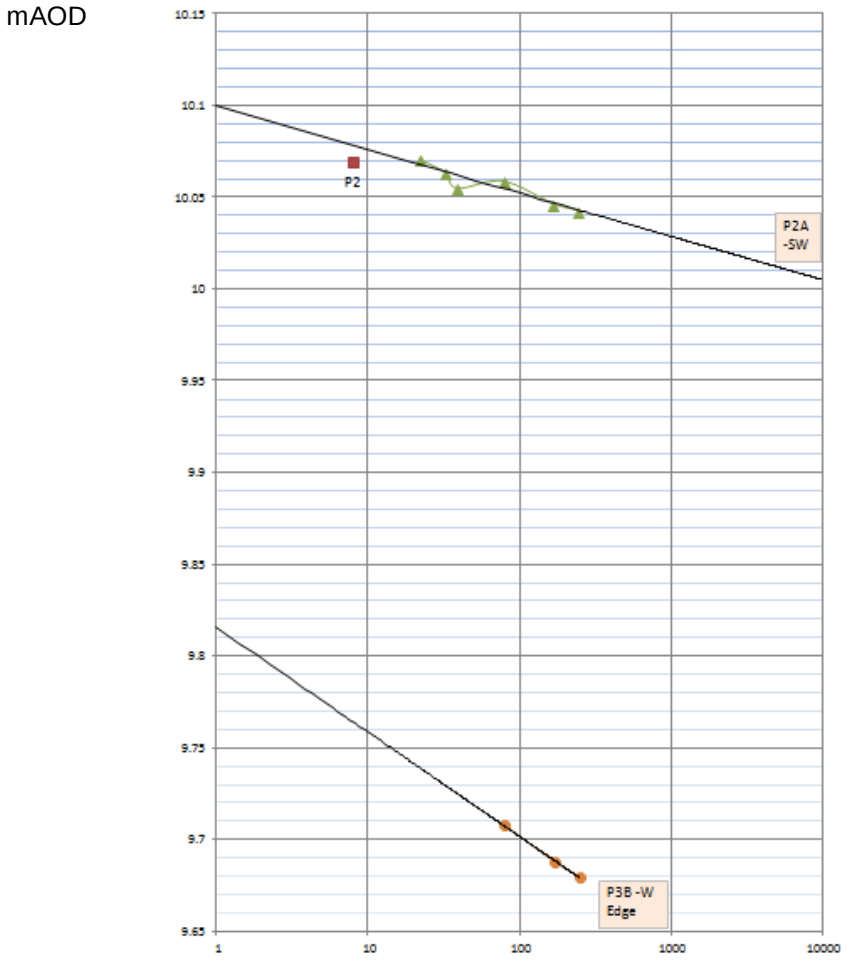
Graph 3.3 : Settlement Monitoring Pin Results



Settlement Monitoring (Continued)

In principle secondary settlement is infinite with settlement rates dropping on a logarithmic scale. However in practice the increase in settlement after 10^4 days (~30years) appears to be generally "complete".

Graph 3.4 Settlement at Monitoring Pins P2A and P3B
(South-western Corner and Western Edge only)



Days since 17/07/2015. (First survey of Settlement Pins) – Log base 10
* Note Original Pins of P2, P3 and P3A were lost or damaged.

Monitoring Pin 2

Unfortunately baseline conditions for Monitoring Pin 2 (located within the south-western corner of the site) were lost as the pin was destroyed following the placement of fill. Monitoring Pin 2A however recorded ~28mm of settlement over 7 months. Whilst the initial readings may be lost it may be possible to conjecture future settlement from the data obtained.

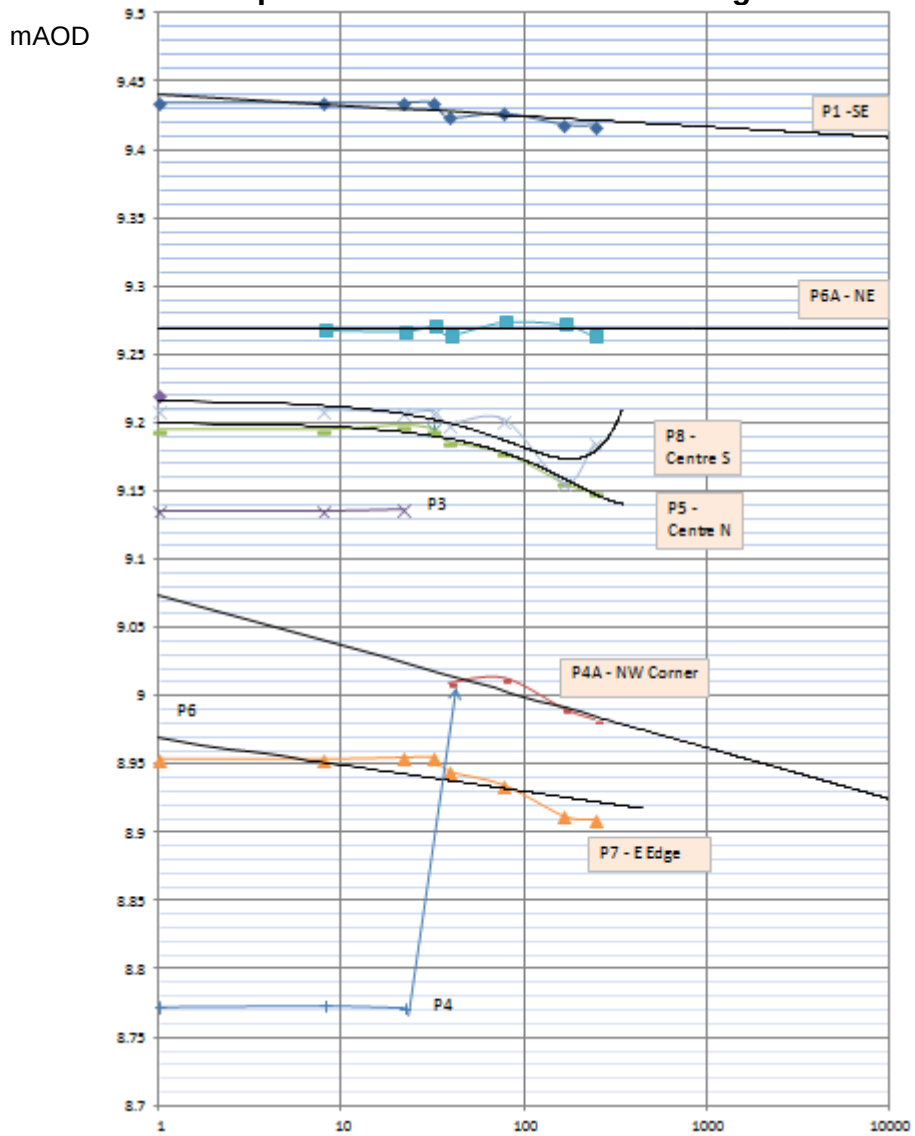
Following the current trend of settlement the above graph indicates at that levels may settle to 10.005mAOD after 10^4 days (~30years or 2045). With the last survey indicating levels of 10.043m a further 0.035m (35mm) should be anticipated under the current surcharge by 2045.

Settlement Monitoring (Continued)

Monitoring Pin 3

Unfortunately baseline conditions for Monitoring Pin 3 (located on the western edge of the site) were lost as the pin was destroyed following the placement of fill. Monitoring Pin 3A was similarly lost. It is considered that any attempt to assess future settlement from Monitoring Pin 3B would be open to too much error and inaccuracy to predict. It is however noted that having measured ~30mm settlement in 5 months that future settlement at this location may be greater than at Monitoring Pin 2A.

Graph 3.5 Settlement at Monitoring Pins



Days since 17/07/2015. (First survey of Settlement Pins) – Log base 10

* Note Original Pins of P4 and P6 were lost or damaged.

Monitoring Pin 1

Data for Monitoring Pin 1 (located near the South-eastern Corner of the site) is complete and to date indicates settlement of ~10mm over 8 months. Conjecturing future settlement from the data obtained indicates that levels may settle to 9.41mAOD after 10^4 days (~30years or 2045). With the last survey indicating levels of 9.42m a further 0.010m (10mm) should be anticipated under the current surcharge by 2045.

Settlement Monitoring (Continued)

Monitoring Pin 6

Unfortunately baseline conditions for Monitoring Pin 6 (located within the North-eastern corner of the site) were lost as the pin was destroyed. Monitoring Pin 6A has however recorded ~5mm of settlement over 7 months. Whilst the initial readings may be lost it may be possible to conjecture future settlement from the data obtained.

Following the current trend of settlement the above graph indicates at that levels may have settled at 9.27mAOD after 10^4 days (~30years or 2045). With the survey indicating fluctuating levels of 9.263m no further settlement is anticipated under the current surcharge by 2045.

Monitoring Pin 4

Unfortunately baseline conditions for Monitoring Pin 4 (located within the North-western corner of the site) were lost as the pin was destroyed. Monitoring Pin 4 recorded 1mm of settlement within a month before it was destroyed.

Like Monitoring Pin 3B it is considered that any attempt to assess future settlement from only 4 survey points at Monitoring Pin 4A would be open to too much error and inaccuracy to predict. It is however noted that following the current trend of settlement the graph indicates at that levels may settle to 8.920mAOD after 10^4 days (~30years or 2045). With the most recent survey indicating levels of 8.982mAOD a further 62mm settlement is anticipated under the current surcharge by 2045. However, this statement is based upon fewer readings.

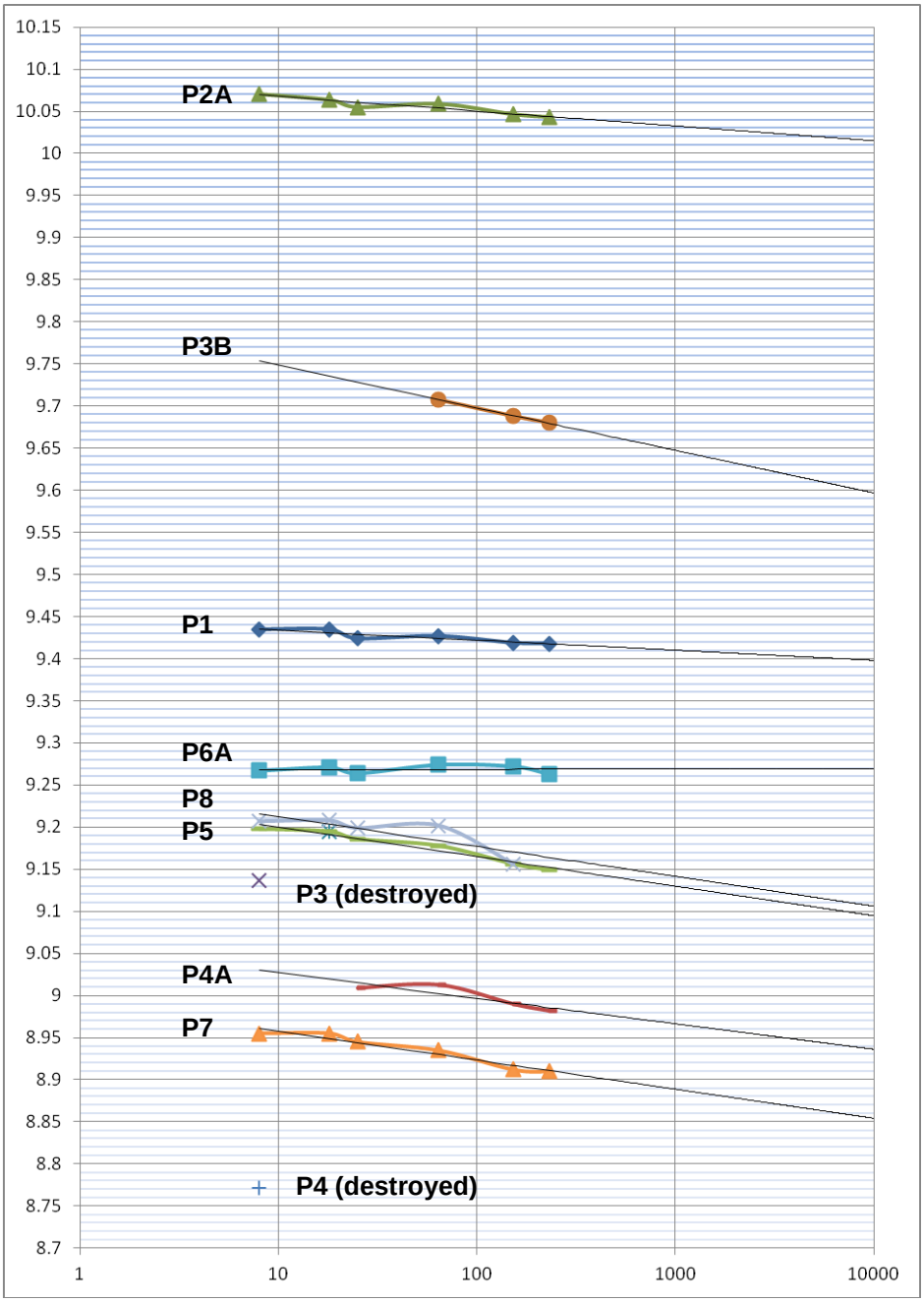
Monitoring Pin 5, Monitoring Pin 7 and Monitoring Pin 8

Data for Monitoring Pins 5, 7 and 8 do not appear to fit a logarithmic settlement curve suggesting that the start date may be out. No settlement was observed within the first two weeks. This could be a result of the earthworks taking longer than anticipated and the placement of fill in these areas being delayed. It has therefore been considered to discount the first two weeks of placement of the settlement pins since the correlation with a logarithmic settlement curve is closer.

Settlement Monitoring (Continued)

Data for Monitoring Pins 5, 7 and 8 do not appear to fit a logarithmic settlement curve as no settlement was observed within the first two weeks. This suggests that the start date may be out. Therefore Graph 3.6 shows settlement on a logarithmic scale starting on 31/7/2015, two weeks after the commencement of the earthworks. Settlement at Monitoring Pins 5 and 7 appear to be a closer fit as a result.

Graph 3.6 2 Week Adjusted fit of Logarithmic Settlement Curve due to Earthworks Delay



Days since 31/07/2015. (2 wks after first survey of Settlement Pins) – Log base 10

Settlement Monitoring (Continued)

Monitoring Pin 5,

Monitoring Pin 5 from the northern centre of the site follows a logarithmic settlement curve fairly closely. In an effort to predict settlement the existing trend, which may be inaccurate, indicate a possible settlement to ~9.1mAOD, a further ~50mm settlement from recent level.

Monitoring Pin 7

Monitoring Pin 7 from the eastern edge of the site follows a logarithmic settlement curve fairly closely. In an effort to predict settlement the existing trend, which may be inaccurate, indicate a possible settlement from ~8.91mAOD to ~8.85mAOD, a further ~60mm settlement from recent level.

Monitoring Pin 8

Monitoring Pin 8 from the southern centre of the site continues to deviate from a logarithmic settlement curve. It may be that the pin was damaged or that multiple phases of earthworks over an extended period mean that settlement cannot be traced from a single event. The most recent survey result indicates an increase in level, which suggests that the pin may be damaged and has been discounted from the estimate below.

In an effort to predict settlement the existing trend, which may be inaccurate, indicate a possible settlement to ~9.1mAOD, a further ~50mm settlement from recent level. It is noted however that the settlement prediction is comparable to Monitoring Pin 5 which is expected to be similar.

Settlement Monitoring (Continued)

Table 3.5 Summary of Predicted Settlements

Monitoring Pin	Initial Survey mAOD	Measured Settlement	Predicted Settlement after 10^4 days (2045)*		Predicted Settlement Remaining (2045)*
Monitoring Pin 1 (SE Corner)	9.435	-18mm (7 months)	- 25mm (approx)	9.410 mAOD	- 6mm (approx)
Monitoring Pin 2 (SW Corner)	10.069	Not Achieved	N/A		N/A
Monitoring Pin 2A (SW Corner)	10.071	-28mm (7 months)	-66mm (approx)	10.005 mAOD	- 38mm (approx)
Monitoring Pin 3 (W Edge)	N/A	+1mm (1 month)	N/A		N/A
Monitoring Pin 3A (W Edge)	9.195	Not Achieved	N/A		N/A
Monitoring Pin 3B (W Edge)	9.708	-28mm (5 months)	N/A		N/A
Monitoring Pin 4 (NW Corner)	8.772	-1mm (1 month)	N/A		N/A
Monitoring Pin 4A (NW Corner)	9.009	-27mm (7 months)	-89mm (v.approx)	8.920 mAOD	- 62mm (v. approx)
Monitoring Pin 5** (N Edge)	9.195	46mm (7 months)	-100mm (approx)	9.095 mAOD	- 54mm (approx)
Monitoring Pin 6 (NE Corner)	9.220	Not Achieved	N/A		N/A
Monitoring Pin 6A (NE Corner)	9.268	-5mm (7 months)	0mm (approx)	9.27 mAOD	0mm (approx)
Monitoring Pin 7** (E Edge)	8.954	44mm (7 months)	104mm (approx)	8.85 mAOD	- 60mm (approx)
Monitoring Pin 8** (Centre)	9.209	53mm (7 months)	99mm (v.approx)	9.11 mAOD	- 46mm (v.approx)

Assumptions:
Earthworks are instantiations with settlement beginning on Day 1.
Settlement is logarithmic

Known Inaccuracies:
Earthworks was not instantaneous and in reality took longer than anticipated
Earthworks has not occurred equally across the site, notably:

- Some areas have more fill placed than others.
- Additional fill has been placed during the settlement process sometimes months later through intermittent earthworks post supervision.

Notes:
Established base line levels filled green
* Assuming no further fill is placed
** Monitoring Pins 5, 7 and 8 do not conform with a logarithmic settlement curve. A better fit is achieved when the start date is set back 14 days. Estimates for Monitoring Pins therefore discount any settlement during the first two survey rounds.
N/A = Not achievable, insufficient baseline information.

SECTION 4 Chemical Validation of Imported Fill

The materials brought on to site for use as engineered fill was obtained from various sources and imported at different stages.

Soils were sampled and tested to ensure that no contamination was present, in accordance with Terra Firma (Wales) Limited Remediation Strategy Report.

The latest version (Version 4) of the Remediation Strategy Report is provided in **Annex B**. The report specifies that 1 sample per 250m^3 should be screened, per source. Both soil and leachate testing was performed.

Table 4.1 below summarises the imported fill details:

Table 4.1 Imported Fill Details

Soil Source	Estimated Volume (m^3)	Date Sampled and Submitted for Testing	Date Imported on to Site	Soil Validation Test Results
Upper Half of Riversee Limited Stockpile (Adjacent Herbert Road Site)	14,000	February 2015	Small portion imported and placed in south of site prior to July 2015 Remainder July 2015	DETS test certificates 27313-1 & 27519-2 **Annex C**
Lower Half of Riversee Limited Stockpile (Adjacent Herbert Road Site)	9000	July 2015	July 2015	DETS test certificates 40034-2 & 40314 **Annex C**
Taylor Wimpey Citivision Site	1000	September 2015 (Sampled on site)	August 2015	DETS test certificate 47308-1 **Annex C**
Taylor Wimpey Citivision Site	500	October 2015 (Sampled on site)	October 2015	DETS test certificate 46635 **Annex C**
Soils taken from are of site north of the drainage reen	Approx 500	October 2015	October 2015	**Not tested**

On occasion some soil samples failed where exceedences of chemicals above their respective soil or water threshold level were identified.

Newport City Council Environmental Protection officer and the NRW were contacted and acceptance of the soils sought in these instances. This was due to the fact that further fill will effectively bury this material and the location that imported soils were placed (i.e. away from the reen).

The Council have stated that any future imported fill should chemically adhere <u>strictly</u> to the relevant soil and leachate regulatory threshold levels and that any exceedences will render any imported soil source unsuitable.

SECTION 5.0 Verification of Fill Compaction

The Riversee Limited stockpile was geotechnically tested prior to import to enable an Earthworks Compaction Specification Report to be provided.

The Compaction Specification Reports for the top half of this stockpile (Report No. 12032/CS1, dated July 2015) and bottom half (Report No. 12032/CS2, dated July 2015) are provided in **Annex D**.

A small portion of the top of the Riversee Limited stockpile was imported on to site prior to official commencement of the earthworks. This was placed across the southern end of the site. This fill was subject to plate testing and sand replacement density (SRD) tests on the 24th July 2015. A number of tests were also performed on the in-situ ground across the northern part of the site at this time.

'North' of the site refers to the area north of the track (see original topographic plan in Figure 2.1). 'South' is the area below the track.

Also prior to earthworks a small mound of imported soils (also from the top of the Riversee Limited stockpile) had been placed in the northwest of the site.

As the fill levels were raised further plate load and SRD tests were completed.

The testing completed is summarised below:

Verification of Fill Compaction (Continued)

Table 5.1 Summary of In-situ Geotechnical Tests

Fill Location and Details	Source	Date Imported	Date Tested	Test Type
Pre earthworks fill placed in south of site and mound in northwest of site Max 600mm fill thickness	Top of Riversee Limited Stockpile	Pre July 2015	24.07.2015	Plate tests SRDs
400mm (2 layers) across north of site 200mm fill across southeast quadrant of site	Top of Riversee Limited Stockpile including previously imported bund	30.07.2015 – 04.08.2015	05.08.2015	Plate tests SRDs
Small mound placed along eastern half of southern site edge	Bottom of Riversee Limited Stockpile	05.08.2015		
Fill stockpiled then spread in southwest quadrant of site (400mm thick) Small mound in south spread over southeast quadrant (200mm thick)	Bottom of Riversee Limited Stockpile	07.08.2015		
Fill spread over north of site (200mm)	Bottom of Riversee Limited Stockpile	10.08.2015 – 11.08.2015		
Fill now 600mm in north and 400mm in south Eastern half of site tested following period of stipping / drying / replacing material previously tested and spread of mound in southeast quadrant 05.08.2015			18.08.2015 19.08.2015	Plate tests
Fill spread over eastern half of site	Bottom of Riversee Limited Stockpile	19.08.2015		
Fill stockpiled in northwest corner of site	First batch of Citivision soils	08.09.2015 – 10.09.2015		
Fill placed across the site, Northern area, the haul road and southern area.	- Fill from North/CV - Fill from S.pile - Fill from S.pile		11.09.2015	Plate tests
SRD 1 – Centre North SRD 2 – Southwest SRD 3 – South	- Fill from North - Fill from S.pile - Fill from S.pile		14.09.2015	SRDs
Placed in north of the site	Material taken from north of the reen	16.09.2015 – 18.09.2015	**Untested**	
Placed in central south of site	Bottom of Riversee Limited Stockpile	28.09.2015 & 02.10.2015	**Untested**	
Placed in south of the site	Second batch of Citi-vision soils	05.10.2015	**Untested**	

Test result certificates are provided in **Annex E**.

Where any unsatisfactory results were identified the fill was stripped or broken up to allow further drying before re-rolling and testing.

SECTION 6 Groundwater and Reen Water Monitoring

Sampling and testing of the deep groundwater and reen water was scheduled to be carried out prior to earthworks, and two rounds following completion of the intended Riversee Limited fill works or no later than 6 months of earthworks commencement (as detailed in the Remediation Strategy Report, **Section 3.7** – see **Annex B**).

Six water monitoring wells were installed, BH1 to BH6, as illustrated in **Figure 6.1** below.

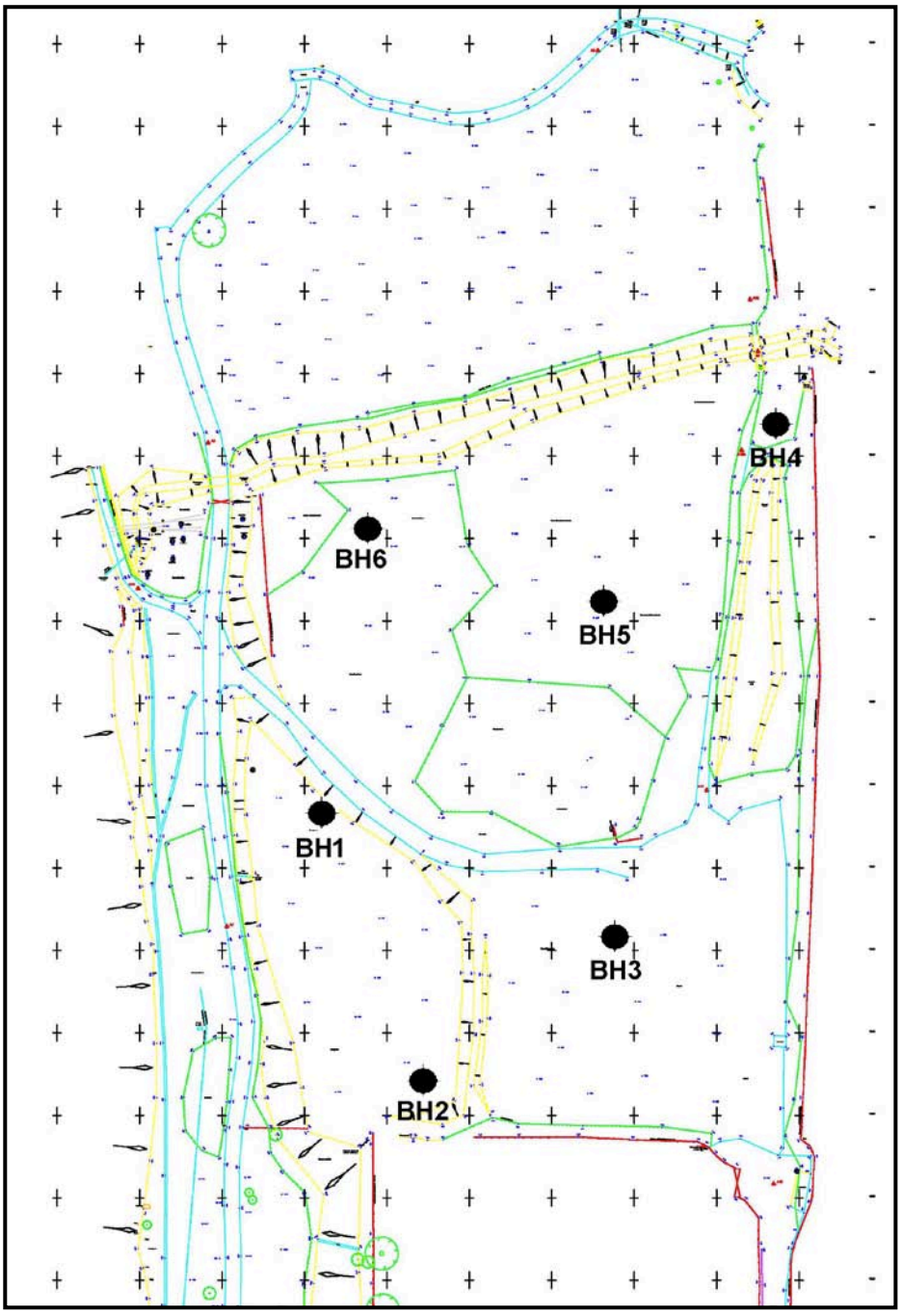


Figure 6.1: Water Monitoring Well Locations

The pre-earthworks monitoring round was carried out in **July 2015.**

The second monitoring round was undertaken in January 2016, and the third followed in February 2016.

The groundwater and reen chemical test result certificates are provided in **Annex F**.

All water results were acceptable, displaying no notable variation to the previously established water quality (see Terra Firma Geotechnical and Geo-environmental Report No. 12032, dated March 2013.

ANNEX A
Terra Firma (Wales) Limited Geo-environmental and Geo-technical Report No. 12032

GEOTECHNICAL AND GEO-ENVIRONMENTAL REPORT:

PROPOSED RESIDENTIAL DEVELOPMENT, LAND OFF HERBERT ROAD, NEWPORT

Prepared for:
GREENHILL CONSTRUCTION LIMITED

March 2013

Job No: 12032

terrafirma

REPORT TITLE	:	**Geotechnical and Geo-environmental Report: Proposed Residential Development, Land off Herbert Road, Newport**
REPORT STATUS	:	**Final**
JOB NUMBER	:	**12032**
DATE	:	**March 2013**
PREPARED BY	:	..... **Michael Watkins**
REVIEWED BY	:	..... **Louise J. Dow**
APPROVED BY	:	..... **Dr Gwyn C. Lake**

Executive Summary

Greenhill Construction is proposing the development of land off Herbert Road in Newport.

Historically, the site has been occupied by a clothing factory after 1937 until before 1993. Some small buildings were located across the south of the site during its history. A historic landfill site also occupies the far north of the site.

The geological map of the area shows the site to be underlain by the St Maughn's Formation of the Devonian Period. Marine and estuarine alluvium is shown to overlie the site. Made ground of variable thickness was also believed to overlie the site.

A geotechnical and geo-environmental site investigation was carried out between the 31st of October and the 8th of November 2012 comprising 19 trial pits and six cable percussive boreholes. Three in-situ soakaway tests were also undertaken during the site investigation.

The trial pits found made ground to a depth of 0.20m to 3.30m with soft grey and brown mottled clay to 3.90/10.30m. Peat; at a thickness of between 0.6m and 2.30m was found at variable depth, ranging from 3.90 and 10.3 metres depth. The peat overlies the sand and gravel, which is itself underlain by weathered mudstone (firm becoming very stiff red brown gravelly clay) to 10.0/12.7m. Competent mudstone was encountered until termination of the borehole at 10.2/12.9m.

Fifteen small disturbed representative soil samples were collected for laboratory chemical analysis. Several substances tested for were found to be above the Tier 1 threshold values for a residential development.

A number of contaminants were also found to be above EQS guidelines. However, it is interpreted that the groundwater beneath the site is isolated from the nearby River Usk and therefore not in hydrological continuity with the river. It is therefore believed that the low levels of contamination will not affect the aquatic environment.

A Radon (RPM) Report for the site states that basic radon protection measures are required for new dwellings.

Following two rounds of gas monitoring undertaken so far, it is preliminarily considered that Gas Characteristic Situation 3 prevention measures should be used at the site.

Precast concrete driven piles founded within the underlying very weak red brown and grey mudstone are recommended.

For a 275mm square precast concrete pile driven to an appropriate set within the underlying gravels a safe working load of typically 500kN should be achieved. Pile lengths should vary between 12m and 15m beneath current ground levels.

The estimated working loads, pile type and lengths should be confirmed by a specialist piling contractor. It may be prudent to test drive piles at select locations.

For the quoted pile size, founded within the competent gravels, total settlements should not exceed 10mm with differential movements between adjacent piles being less than half this value.

Floor slabs should be designed as suspended.

Network Rail may also require a bored pile solution close to the railway.

Consolidation settlements of between 100 and 200mm of settlement are estimated beneath areas that are to be raised by 1.0 and 2.0m.

As the building foundations are to be piled this will result in differential settlements between the development infrastructure and the buildings of a similar order.

Based upon the above results we recommend that all buried concrete should conform to Design Class DS-1, ACEC Class AC-1, of BRE Digest 1:2005.

Two of the soakaways tests recorded no infiltration and TP5 recorded a permeability of 8.86 x 10-5 m/s.

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SECTION 1 Introduction and Proposed Development

Greenhill Construction is proposing the development of land off Herbert Road in Newport.

Terra Firma (Wales) Limited have been commissioned to undertake a geotechnical investigation and geo-environmental assessment of the site.

The main objectives of the geotechnical site investigation were to:

- Determine the type, strength and bearing characteristics of the shallow superficial and underlying solid geology.
- Provide recommendations for a suitable and economic foundation/floor slab solution for the development.
- Provide recommendations with regard to any other geo-technical aspects pertaining to the development.
- Provide recommendations for any necessary supplementary site investigation works.

The main objectives of the geo-environmental assessment programme were to:

- Identify the potential environmental liabilities at the site associated with any soil and groundwater contamination.
- Provide a summary of the environmental conditions at the site, together with any necessary remediation works to render the site fit for its intended use.
- Provide recommendations with regard to any other geo-environmental aspects pertaining to the development.

In order to achieve the above objectives, Terra Firma (Wales) Limited carried out an assessment programme including a review of existing data, followed by a Phase I field investigation to confirm the prevailing ground conditions and also to collect and analyse soil samples from selected locations around the site.

A site investigation of an area, which encompasses the site has previously been undertaken and was reviewed by Integral Geotechnique in May 2007. A copy of the review is located in **Annex A** of the report and is discussed further in Section 2 of the report.

1.1 Limitations and Exceptions of Investigation

Greenhill Construction Ltd has requested that a Geotechnical Investigation (GI) and Geo-environmental Site Assessment (GSA) be performed in order to determine if contamination is present beneath the site and to determine a suitable foundation/floor slab solution for the development.

The GSA and GI were conducted and this report has been prepared for the sole internal reliance of Greenhill Construction Ltd and its design team. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Terra Firma (Wales) Limited. If an unauthorised third party comes into possession of this report they rely on it at their peril and the authors owe them no duty of care and skill.

The report represents the findings and opinions of experienced geotechnical and geo-environmental consultants. Terra Firma (Wales) Limited does not provide legal advice and the advice of lawyers may also be required.

The subsurface geological profiles, any contamination and other plots are generalised by necessity and have been based on the information found at the locations of the exploratory holes and depths sampled and tested.

The site investigation was limited by the following constraints;

- Underground utilities
- Dense vegetation
- Soft and waterlogged ground surface
- Topography
- Cycle track and pedestrians

SECTION 2 Review of Existing Data

2.1 Physical Setting, Current Use and Site Conditions

The site is a field located off Herbert Road in Newport at a National Grid Reference of 331690 189280. The location of the site is displayed in **Drawing 01**.

The site is irregular in shape and covers a total area of 4.52 hectares.

The site is currently unused with dense vegetation covering the centre and much of the south of the site. A cycle track passes from north to south along the west of the site. The north of the site is undulating and covered by short grass. The south east corner of the site is covered by rough hardstanding.

A drainage channel/reen passes from east to west at the north of the site, draining into the Usk, which is located to the immediate west of the site. A railway line runs along the east boundary of the site, a school to the north and commercial land to the south. hedgerows lining the north, south west and south east boundaries of the site. The site is part of a much larger field, which lies to the north east. Beyond the hedgerow to the south east is a housing estate on Cefn Coed, the A40 is located to the south west and another field is located to the north.

The site and general surrounding area is flat but undulating.

2.2 Review of Previous Reports

A Summary Report with Proposals for Land Remediation/Reclamation Works was undertaken by Integral Geotechnique in May 2007 for an area that encompassed the site.

A human health risk assessment compiled by White Young Green in 2003 recommended that the site be remediated to current soil guideline levels. The groundwater risk assessment concluded that River Usk was not at significant risk from contaminants at the site.

A ground gas risk assessment concluded that gas prevention measures are required at the site due to elevated levels of methane and carbon dioxide.

2.3 Site History

Historical maps of the site have been obtained from the Landmark Information Group and are presented in **Annex B** with the most relevant history maps summarised below.

1883 (1:2,500)
The site locates upon field land. A railway line is located to the immediate east of the site. A brick works is located approximately 115 metres south of the site and housing located within 320 metres south east of the site boundary. A rifle range is located on the opposite site of River Usk, approximately 160 metres west of the site. Two east two west reens/drainage channels cross the north and middle of the site.

1901-02 (1:2,500)
The 1901-02 maps shows no change to the site. The brick works to the south has seen some modification, with new building on the site and houses built upon some of the land. Land to the immediate east of the railway has become densely built upon by houses, churches and schools. A large excavation is located approximately 90 metres south of the site. The excavation is probably associated with the adjacent brick works. The rifle range no longer appears to be in existence.

2.2 Site History

1920 (Scale 1:2,500)
No change to the site has been made since the previous edition apart from a small rectangular building located at the far south of the site, on the present day cycle/walk path. Three saw mills are located along the west side of the railway, the closest of which is 80 metres east of the site. More houses have been built at the former brick works and to the east of the site. Allotment gardens are located to the south of the site.

1936-37 (Scale 1:2,500)
The 1936-37 editions again show no change to the site has been made apart from a series of small buildings located on the present day cycle track. The number of buildings at the saw mills to the south/east of the site has increased.

1955-57 (Scale 1:1,250)
The 1955-57 editions record a clothing factory at the south of the main portion of the site and at the top of Herbert Road. The drainage channel at the middle of the site has been removed/culverted. Houses have been built on some of the allotment gardens to the south of the site and the small building located upon the present day cycle/walk path have been replaced by two small buildings. The surrounding area continues to expand residentially.

1966-68 and 1969-70(Scale 1:2,500)
No change to the site has been made since the previous edition apart from the construction of a rectangular building at the north east of the site. To the south of the site, the land has become increasingly industrialised with engineering works, paint works and a light engineering works amongst the units. To the immediate north of the site is a sports stadium.

1993 (Scale 1:2,500)
The factory at the south of the site has been removed. Two tanks are located at the south east of the site and the far north of the site is known as St Julian's Glebelands Recreation Ground. A new building has also been built at the north east of the site. Some alteration has been made to the industrial units to the south of the site.

2012 (Scale 1:10,000)
No buildings are currently located on the site. A primary school has replaced the sports stadium to the immediate north of the site and many of the buildings to the south of the site have been removed.

2.4 Geology

The 1:50,000 scale geological map of the area (Sheet 249) shows the site to be underlain by the St Maughn's Formation of the Devonian Period. These rocks are interbedded argillaceous rocks with subordinated sandstone.

The solid geology is shown to be overlain by marine and estuarine alluvium.

Made ground of variable thickness is expected to overlie the site.

2.5 Hydrology & Hydrogeology

Surface runoff is likely to naturally drain into the soil underlying the site and chanel/reen vrossing the site which orientates towards the river Usk. Shallow groundwater is also likely to flow to the river.

Groundwater flow through the bedrock is likely to be heavily influenced by fractures within the rock, topography and bedding planes.

The Environment Agency website illustrates the bedrock beneath the site to be a Secondary A aquifer. These aquifers are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

The superficial material overlying the east of the site has also been classified as a Secondary A aquifer. The west portion of the site, along the bank of the River Usk is not classified as it is considered unproductive strata.

2.6 Radon

A British Geological Survey Radon Report obtained for the site confirms that **basic** radon protection is required for any new development. The radon report is presented in **Annex B**.

2.7 Environmental

The Environment Agency online 'What's in Your Back Yard' database was consulted. The relevant information is summarised below.

2.7.1 Industrial Operator Scores

There are no sites within a 1km radius of the site where pollution is regulated.

2.7.2 Industrial Pollution

There are no industrial pollution scores within a 1km radius of the site where pollution is regulated.

2.7.3 Pollution Incidents

There is one pollution incident within close proximity of the site. The incident took place in February 2004 approximately 250 metres south of the site. The incident caused a significant impact to land and involved 'specific waste materials'.

2.7.4 Landfills

Two historical landfill facilities are located within influencing distance of the site; one of which encroaches into the far north of the site.

Glebelands South is located at the far north of the site and beneath the school and playing fields to the north. The Environment Agency does not have any information in relation to the material disposed of, or the date that the facility was active.

Shaftsbury Park historic landfill is located approximately 120 metres west of the site. No information is provided regarding the date at which the landfill was active. Shaftsbury Park received industrial and household waste.

2.7.5 Flooding

The Environment Agency database confirms that the site is at risk from flooding from rivers, sea and reservoirs. The site does however benefit from flood defences.

2.7.6 Groundwater Source Protection Zones

The site does not locate within a groundwater protection zone.

SECTION 3 Preliminary Risk Assessment

The following sub-sections detail a preliminary risk assessment, based upon the desk study information.

3.1 General

The contaminated land regime is set out in Part IIA of the Environmental Protection Act (EPA) 1990 and was introduced on the 1st April 2000 in England and 1st July 2001 in Wales. A similar regime was introduced in Scotland on 14th July 2000.

Part IIA was introduced to achieve two aims:

(1) The identification of contaminated land
(2) The remediation of contaminated land that poses an unacceptable risk to human health and/or the environment

Under Part IIA the statutory definition of 'contaminated land' is:

"any land which appears to the local authority in whose area it is situated, to be in such a condition, by reason of substances in, on, or under the land, that:

(a) Significant harm is being caused or there is a significant possibility of such harm being caused; or
(b) Pollution of controlled waters is being, or is likely to be, caused."

For land to be classified as 'Contaminated Land' there must be a 'pollutant linkage'.

For our definitions of pollution linkage and how we define risk please refer to **Annex C** which includes our classifications of consequence and probability and risk assessment matrix.

3.2 Potential Sources of Contamination

The potential contamination beneath the site, whether in the matrix of soil or groundwater is related to the sites past use.

As identified on historical plans, the site has been occupied by a clothing factory after 1937 until before 1993. Some small buildings were located across the south of the site during its history. The demolished buildings may be a source of asbestos.

A historic landfill site also occupies the far north of the site.

Peat or organic clay/silt may be found within the alluvium beneath the site, potentially the source of ground gas.

3.3 Qualitative Preliminary Human Health and Environmental Risk Assessment

The qualitative preliminary Human Health and Environmental Risk Assessment and site conceptual model are based on findings of the desk study and site walk over and include all potential sources, pathways and receptors that may be present on site.

The risk assessment and site conceptual model will be evaluated and modified in accordance with the findings from the site investigation and chemical testing.

Table 3.1 - Qualitative Preliminary Human Health Risk and Environmental Risk Assessment

Source	Pathway	Receptor During Construction	Level of Risk	Receptor Post Construction	Level of Risk
Made Ground /Natural Soil	Ingestion, inhalation and dermal contact with soil and soil dust	Construction Workers Neighbouring Site Users	Very low to low	Residents, workers, neighbours and visitors	Medium to high
Made Ground /Natural Soil	Ingestion of site grown vegetables	N/A	N/A	Residents and visitors	Medium to high
Radon Gas	Inhalation	N/A	N/A	Residents, workers, neighbours and visitors	Negligible
Drinking water	Ingestion	Construction workers	Medium to high	Residents, workers, and visitors	Medium to high
Surface Water	Run-off Accidental spillage	Adjacent Sites	Medium	Adjacent Sites River Usk	Medium
Groundwater	Leaching and groundwater leaching	Bedrock: St Maughn's Group (Secondary A)	Medium	Bedrock: St Maughn's Group (Secondary A)	Medium
Made Ground /Natural Soil	Absorption and uptake of contaminated soil	Vegetation	Medium	Vegetation	Medium
Made Ground /Natural Soil	Aggressive Ground Conditions	Building materials	Low to medium	Building materials	Low to medium
Ground gases – No landfills, made ground and peat not expected	Gas migration into houses and inhalation of gas	N/A	N/A	Residents, workers, neighbours and visitors	Medium to high

3.4 Qualitative Preliminary Geotechnical Risk Assessment

Table 3.2 Preliminary Geotechnical Risk Assessment

Potential Hazard	Level of Risk
Made Ground	**Medium Risk** Made ground is anticipated beneath the site. Significant thickness of loose/soft or variable made ground may lead to differential or excessive settlement.
Former basements and old foundations	**Low Risk** Excavations may be troublesome following demolition of the existing buildings if the foundations are not completely removed. Basements may also be located beneath the existing buildings adding greater costs from infilling.
Problem Soils	**Medium Risk** Estuarine alluvium deposits are present beneath the entire site. These sediments are very soft and can give unacceptable settlements for structures founded upon it.

3.5 Preliminary Site Conceptual Model

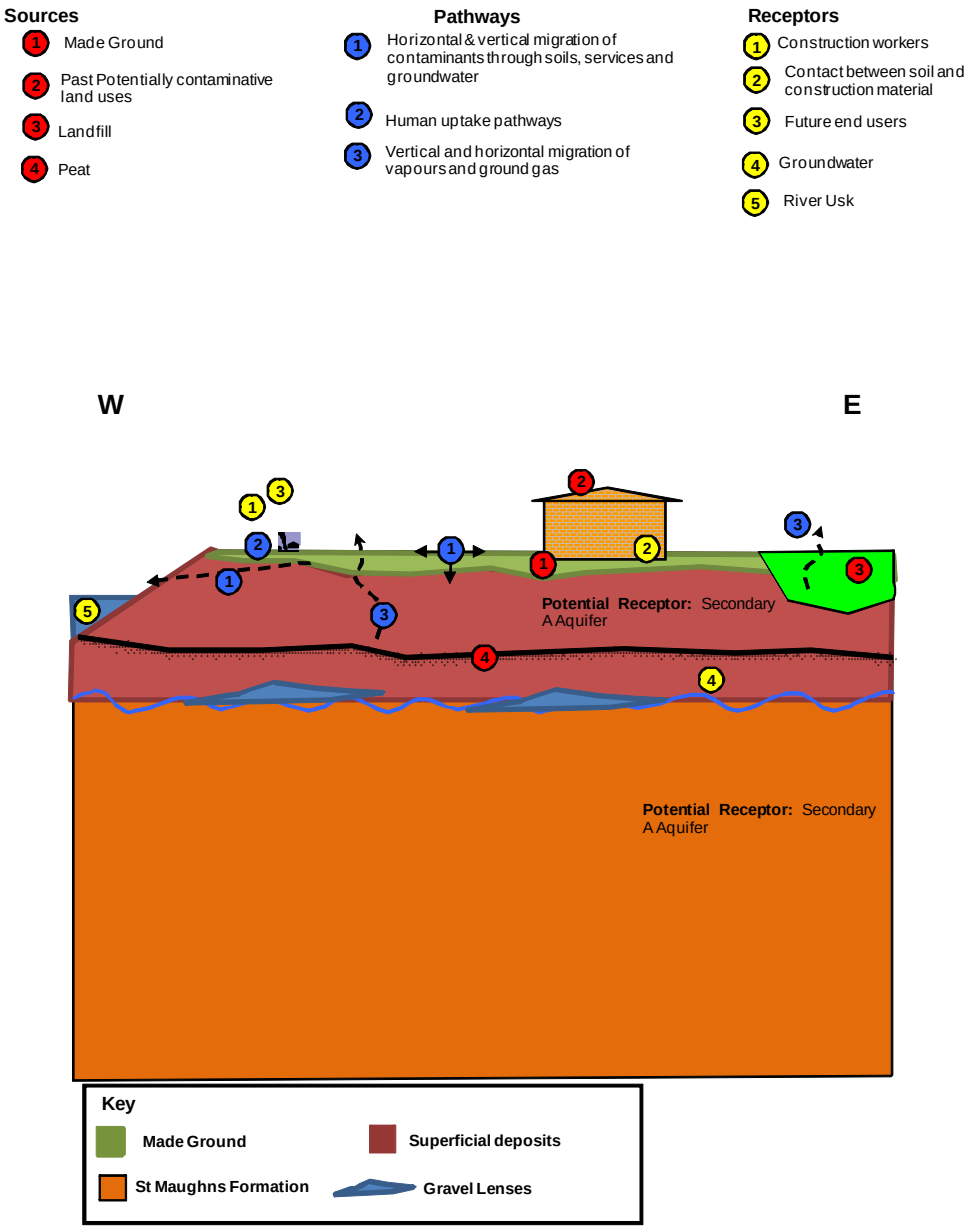

Figure 1 Preliminary Site Conceptual Model

SECTION 4 Field Investigation

4.1 Site Works

A geotechnical and geo-environmental site investigation was carried out between the 31st of October and the 8th of November 2012 comprising 19 trial pits and six cable percussive boreholes and three mini percussive boreholes. Three in-situ soakaway tests were also undertaken during the site investigation.

The trial pits were excavated using a JCB 3CX excavator.

The cable percussive boreholes, 200mm in diameter were sunk using a conventional drilling rig. Within the boreholes Standard/Cone (SPT/CPT) Tests were carried out at close and regular intervals. All of the boreholes were terminated within in-situ hard strata after a minimum of 1 hours chiselling in each hole for a nominal penetration.

The mini percussive boreholes were sunk using a Terrier 2000 mini percussive drilling rig. The mini percussive boreholes were sunk within the vicinity of the historic landfill at the north of the site. The holes were sunk for the installation of gas monitoring wells to check the ground gas potential from the landfill.

The fieldworks were supervised by Terra Firma (Wales) Limited. The trial pits and boreholes were logged to the requirements of BS5930:1999.

The trial pit logs, cable percussive logs and mini percussive borehole logs are presented in **Annex D, Annex E and Annex F** respectively and their positions are shown on **Drawing 02**.

4.2 Ground Conditions

The ground conditions encountered can in general be summarised as shown in **Table 4.1.**

Table 4.1 Summary of Ground Conditions

Depth (m)			Thickness (m)	Stratum
GL	-	0.20/3.30	0.20/3.30	**MADE GROUND**
0.30	-	3.90/10.30	2.20/8.40	Soft grey and brown mottled **CLAY**
3.90/10.30	-	4.10/8.60	0.60/2.30	**PEAT**
4.10/8.60	-	5.90/9.70	0.00/1.80	**SAND & GRAVEL (intermittent)**
5.90/10.30	-	10.00/12.70	0.50/4.10	Firm becoming very stiff red brown gravelly **CLAY**
10.00/12.70	-	>12.90	-	**MUDSTONE**

The basal Sand & Gravel layer was not encountered in BH1, BH2, BH4 and BH5.

Very loose red brown silty SAND and very soft red sandy SILT was encountered between 6.20m and 7.00m and 7.00m and 8.80m respectively.

Soft grey sandy SILT was encountered between 6.20m and 9.10m.

4.3 Summary of Groundwater/Gas Monitoring Standpipe Installations

Table 4.2 Groundwater/Gas Installations

Borehole	Full Installation Depth (m bgl)	Top of installation	Remaining installation depth (m)	Reaction Zone Strata(s)	Remainder of exploratory hole
BH1	GL – 10.6	9.0m plane pipe with bentonite surround	1.6m slotted pipe with gravel surround	Red brown gravelly **CLAY** **MUDSTONE**	Pipe to full depth, cap on base
BH2	GL – 12.9	2.5m plane pipe with bentonite surround	10.4m slotted pipe with gravel surround	Grey and brown mottled **CLAY** **PEAT** Red brown gravelly **CLAY** **MUDSTONE**	Pipe to full depth, cap on base
BH3	GL – 9.7	8.0m plane pipe with bentonite surround	1.7m slotted pipe with gravel surround	**SAND & GRAVEL**	Cap on base of standpipe, bentonite to base of borehole
BH4	GL – 10.2	9.2m plane pipe with bentonite surround	1.0m slotted pipe with gravel surround	**MUDSTONE**	Pipe to full depth, cap on base
BH5	GL – 8.0	4.6m plane pipe with bentonite surround	3.4m slotted pipe with gravel surround	Grey and brown mottled **CLAY** **PEAT**	Cap on base of standpipe, bentonite to base of borehole
BH6	GL – 10.3	7.0m plane pipe with bentonite surround	2.3m slotted pipe with gravel surround	**MUDSTONE**	Pipe to full depth, cap on base
WS1	GL – 3.0	1.0m plane pipe with bentonite surround	2.0m slotted pipe with gravel surround	**MADE GROUND**	Pipe to full depth, cap on base
WS2	GL – 3.0	1.0m plane pipe with bentonite surround	2.0m slotted pipe with gravel surround	**MADE GROUND**	Pipe to full depth, cap on base
WS3	GL – 3.0	1.0m plane pipe with bentonite surround	2.0m slotted pipe with gravel surround	**MADE GROUND**	Pipe to full depth, cap on base

4.4 Groundwater Strikes

A summary of groundwater strikes is presented below.

Table 4.3 Summary of Groundwater Strikes

Depth (m)	Description
BH1	Groundwater (medium) inflow at 3.70m rising to 3.00m after 20 min
BH3	Groundwater (slow) inflow at 2.60m rising to 2.40m after 20 mins
BH3	Groundwater (slow) inflow at 9.50m rising to 9.30m after 20 mins
BH4	Groundwater (medium) inflow at 5.80m rising to 4.30m after 20 mins
BH4	Groundwater (fast) inflow at 10.00m rising to 5.10m after 20 mins
BH5	Groundwater (medium) inflow at 4.00m rising to 3.80m after 20 mins
BH6	Groundwater (fast) inflow at 7.00m rising to 3.80m after 20 mins

Seasonal variability in the presence of groundwater can be expected.

Water levels may be shallower with proximity to the river and drainage channels.

4.5 Laboratory Soil Chemical Testing

4.5.1 Exploratory Strategy and Sampling Regime

During the intrusive investigation, small disturbed soil samples were collected. The sampling regime was conducted in accordance with BS5930: 1999. The methodology used is given in **Annex C**.

The sample locations and depths are listed in the following table.

Table 4.4 Soil Chemical Test Sample Locations and Depths

Sample	Depth (m)	MCerts Sample Description
TP2	0.90	Dark brown gravelly sandy CLAY
TP4	0.70	Dark brown gravelly sandy CLAY
TP5	1.30	Dark brown clayey gravelly SAND
TP6	0.60	Brown clayey gravelly SAND
TP6	1.80	Dark brown gravelly sandy CLAY with odd rootlets
TP7	0.20	Dark brown gravelly sandy CLAY with odd rootlets
TP8	0.50	Dark brown clayey gravelly SAND
TP9	1.00	Dark brown gravelly sandy CLAY
TP10	0.80	Dark brown gravelly sandy CLAY
TP12	0.40	Brown very gravelly SAND
TP13	0.60	Brown very gravelly SAND
TP14	0.40	Dark brown clayey gravelly SAND
TP15	0.40	Brown gravelly sandy CLAY with odd rootlets
TP17	0.15	Dark brown gravelly sandy CLAY with odd rootlets
TP18	0.50	Dark brown clayey gravelly SAND with odd rootlets

4.5.2 Laboratory Analysis of Soil

The soil samples taken were despatched to the laboratories of Derwentside Environmental Testing Services Limited for laboratory chemical testing. The following soil chemical tests were undertaken:

Metals and Metalloids
Lead
Arsenic
Mercury
Chromium
Copper
Nickel
Zinc
Selenium

In-Organics
Cyanide
Sulphate
Cadmium

Others
pH (acidity)
Organic Matter
Asbestos

Organic Chemicals
Phenols
Polycyclic Aromatic Hydrocarbons
Aromatic & Aliphatic Hydrocarbons
Polychlorinated Biphenyls

The laboratory soil chemical test results are presented in **Annex G**.

4.5.3 Laboratory Analysis of Groundwater

Samples of groundwater were collected from the boreholes and dispatched to the laboratories of Derwentside Environmental Testing Services Ltd. The following chemical testing was undertaken;

Metals and Metalloids
Lead
Arsenic
Mercury
Cadmium
Chromium
Copper
Nickel
Zinc
Selenium

In-Organics
Cyanide
Sulphate
Sulphide

Organic Chemicals
Phenols
Aromatic Petroleum Hydrocarbons (PAH)
Petroleum Hydrocarbons (aromatic/aliphatic split)
Polychlorinated Biphenyls

Others
pH (acidity)
Chemical Oxygen Demand
Biological Oxygen Demand
Conductivity
Hardness

The laboratory chemical test results are presented in **Annex G**.

4.6 In-Situ Soakaway Testing

During the site investigation, three in-situ soakaway tests were undertaken within TP2, TP2, and TP5. One fill was carried out per test.

The results of the tests are discussed further in Section 8.6 of the report and the results are presented in **Annex H**.

4.7 In-situ Gas Monitoring

Following the site investigation, to date, two rounds of gas monitoring have been undertaken. A further four gas monitoring visits will be undertaken on a roughly fortnightly basis.

The results of this monitoring are presented in **Annex I** of the report.

SECTION 5 Soil Analytical Results

5.1 General

See **Annex C** for the tiered approach to chemical testing methodology. All soil test results have been compared to thresholds for residential development as these are the most stringent guidelines. A summary of the soil chemical test results, which include the regulatory guidelines used in the Tier 1 assessment, are given in the tables on the following pages.

5.2 Soil Chemical Test Results

Table 5.1 Summary of Soil Chemical Test Results Standard Suite

Substance	SGV/ GAC (mg/kg)	Source	Measured Concentrations of Tested Substances (mg/kg)		95% UCL	Number of exceedences
			Minimum	Maximum		
Arsenic	32	CLEA	5.7	40	19.63	1
Cadmium	10	CLEA	0.4	6.2	1.82	0
Chromium III	3000	CIEH	7.9	100	46.45	0
Chromium	130	CLEA	7.9	100	46.45	0
Chromium VI	4.3	CIEH	1	1	1.00	0
Copper	2330^	CLEA	8.8	950	235.05	0
Lead	450	CLEA	10	290	132.69	0
Mercury	170	CLEA	0.05	1.9	0.65	0
Nickel	130	CLEA	7.7	69	39.82	0
Selenium	350	CLEA	0.5	1.4	0.71	0
Zinc	3750^	CIEH	45	440	256.17	0
Cyanide total	8	CLEA	0.1	10	2.49	1
Organic matter	-	-	0.8	23	8.64	-
Total Sulphate as SO_4	2400	BRE	200	2500	1500	1
Sulphate Aqueous Extract**	2400	BRE	160	160	-	-
pH	-	-	8.2	11.8	9.88	-
PAH	1.6*	-	<1.6	130	29.9	-
Phenol - Monohydric	420	CLEA	<0.3	0.5	0.35	0
Asbestos	-	-	Chrysotile – Loose Bundles		-	2

5.2 Soil Chemical Test Results (Continued)

Notes:

- CLEA - Soil Guideline Values for residential development
- CIEH - Generic Assessment Criteria for a residential setting, developed as Land Quality Management by the Chartered Institute of Environmental Health
- BRE - British Research Establishment (buried concrete risk assessment only, not human health related)
- A total of 15 samples were tested
- ^ CIEH copper and zinc thresholds based on 6% organic matter
- *Based upon laboratory detection limits for total PAH
- **One sample tested for Sulphate Aqueous Extract (mg/litre) in TP12 at 0.40m due to elevated level of Total Sulphate as SO_4

5.2 Soil Chemical Test Results (Continued)

TABLE 5.2 Summary of Soil Chemical Test Results Petroleum Hydrocarbons and PCBs

Substance	GAC (mg/kg)	Source	Measured Concentrations of Tested Substances (mg/kg)		95% UCL	Number of exceedences
			Minimum	Maximum		
Aliphatic						
PH C5 – C6 Ali	30	CEIH	<0.01	0.01	0.01	0
PH C6 – C8 Ali	73	CEIH	<0.01	0.01	0.01	0
PH C8 – C10 Ali	19	CEIH	<0.01	0.02	0.01	0
PH C10 – C12 Ali	93	CEIH	<1.5	<1.5	1.50	0
PH C12 – C16 Ali	740	CEIH	<1.2	16	4.76	0
PH C16 – C21 Ali	45000**	CEIH	<1.5	120	29.82	0
PH C21 – C35 Ali	45000**	CEIH	<3.4	340	88.23	0
Aromatic						
PH C5 – C7 Arom	0.33	CLEA	<0.01	<0.01	0.01	0
PH C7 – C8 Arom	610	CLEA	<0.01	<0.01	0.01	0
PH C8 – C10 Arom	27	CEIH	<0.01	0.05	0.02	0
PH C10 – C12 Arom	69	CEIH	<0.9	<0.9	0.90	0
PH C12 – C16 Arom	140	CEIH	<0.5	9.1	2.92	0
PH C16 – C21 Arom	250	CEIH	<0.6	50	19.67	0
PH C21 – C35 Arom	890	CEIH	<1.4	210	76.20	0
PCB	0.01	-	<0.01	0.16	0.06	2
2,4,4'-Trichlorobiphenyl	0.01	-	<0.01	0.12	0.03	1
2,2',5,5'-Tetrachlorobiphenyl	0.01	-	<0.01	0.05	0.02	1
2,2',4,5,5'-Pentachlorobiphenyl	0.01	-	<0.01	<0.01	0.01	0
2,3',4,4',5-Pentachlorobiphenyl	0.01	-	<0.01	0.02	0.01	1
2,2',4,4',5,5'-Hexachlorobiphenyl	0.01	-	<0.01	0.02	0.01	1
2,2',3,4,4',5'-Hexachlorobiphenyl	0.01	-	<0.01	0.05	0.02	1
2,2',3,4,4',5,5'-Heptachlorobiphenyl	0.01	-	<0.01	0.04	0.02	1

Notes:

- LQM/CIEH - Soil Guideline based upon 1% soil organic matter and residential land use
- CLEA - Soil Guideline Values (SGV) developed by the Contaminated Land Exposure Assessment - Residential with plant uptake
- * - Value used for Aromatic >5-7 (benzene)
- ** - Value used for Aromatic >7-8 (toluene)
- ***- Long term health advisory limit for a child based upon taste and odour (Environment Canada)
- Guidelines for PCBs based upon laboratory detection limits
- a soil organic matter content of 1%
- A total of 10 sample was tested for PCBs
- A total of 13 samples were tested for aromatic/aliphatic hydrocarbons

5.2 Soil Chemical Test Results (Continued)

Table 5.3 Summary of Soil Chemical Test Results Speciated Polycyclic Aromatic Hydrocarbons

Substance	GAC (mg/kg)	Source	Measured Concentrations of Tested Substances (mg/kg)		95% UCL	Number of exceedences
			Minimum	Maximum		
Acenaphthene	210	LQM/CIEH	<0.1	1.5	0.44	0
Acenaphthylene	170	LQM/CIEH	<0.1	1.4	0.51	0
Anthracene	2300	LQM/CIEH	<0.1	5.6	1.38	0
Benzo(a)anthracene	3.1	LQM/CIEH	<0.1	13	3.45	1
Benzo(a)pyrene	0.83	LQM/CIEH	<0.1	11	2.94	5
Benzo(b)fluoranthene	5.6	LQM/CIEH	<0.1	9	2.45	1
Benzo(k)fluoranthene	8.5	LQM/CIEH	<01	4.5	1.20	0
Benzo(g,h,i)perylene	44	LQM/CIEH	<0.1	8.7	2.23	0
Chrysene	6	LQM/CIEH	<0.1	13	3.45	1
Dibenzo(a,h)anthracene	0.76	LQM/CIEH	<0.1	1.6	0.48	1
Fluoranthene	260	LQM/CIEH	<0.1	22	5.65	0
Fluorene	160	LQM/CIEH	<0.1	2	0.52	0
Indeno(1,2,3-c,d)pyrene	3.2	LQM/CIEH	<0.1	7.5	2.07	1
Naphthalene	1.5	LQM/CIEH	<0.1	0.7	0.28	0
Phenanthrene	92	LQM/CIEH	<0.1	16	3.94	0
Pyrene	560	LQM/CIEH	<0.1	17	4.53	0

Notes:

- CIEH - Chartered Institute of Environmental Health Generic Assessment Criteria for a residential development
- A total of one sample was tested for Speciated PAH
- PAH - Polycyclic Aromatic Hydrocarbons
- Guidelines are based upon 1% soil organic matter
- Insufficient samples to form a statistical analysis

5.3 Groundwater Chemical Test Results

Two rounds of groundwater sampling have been carried out at the site on 08/01/2013 and 30/01/2013. Laboratory testing results for the first round of water sampling is presented below in **Table 5.4** to **5.7**.

Table 5.4 Summary of Groundwater Chemical Test Results – Standard Suite (dated 08/01/2013)

Substance	Thres-hold (mg/l)	Source	Measured Concentrations of Tested Substances (mg/l)		US95	Number of Exceedences
			Minimum	Maximum		
Arsenic	0.05	EQS (1)	0.00058	0.0054	0.0040	0
Cadmium	0.00008	EQS (2)	0.00003	0.00003	0.0000	0
Chromium	0.0034	EQS (3)	0.00039	0.001	0.0009	0
Copper	0.028	EQS (4)	0.0004	0.0018	0.0011	1
Lead	0.0072	EQS (2)	0.00009	0.0004	0.0003	0
Mercury	0.00005	EQS (2)	0.00001	0.00001	0.0000	0
Nickel	0.02	EQS (2)	0.0005	0.0049	0.0033	0
Selenium	0.01	EQS (5)	0.00025	0.0031	0.0018	BLDL
Zinc	0.008	EQS (4)	0.0013	0.0085	0.0049	1
Sulphate as SO4	250	EQS (5)	4.4	120	85.3729	0
BOD	-	-	4.9	22	14.4301	-
COD	-	-	10	160	137.8399	-
Cyanide total	0.05	EQS (6)	0.04	0.04	0.04	0
Conductivity	-	-	0.7	4.19	2.9425	-
Hardness	-	-	315	555	527.8708	-
Sulphide	0.00025	EQS (7)	0.01	0.01	0.01	BLDL
pH	-	EQS	0.0069	0.0074	0.0073	0
Phenol	0.0077	EQS (1)	0.0001	0.0001	0.0001	0

5.3 Groundwater Chemical Test Results (Continued)

Notes

- Twelve samples of perched water were tested.
- (1) Protection for Surface Water Quality (Good Standard for Rivers & Freshwater Lakes – Annual Mean)
- (2) Protection of Surface Water Quality (Inland Surface Water Environmental Quality Standard expressed as an annual average)
- (3) Protection for Surface Water Quality (Good Standard for Rivers & Freshwater Lakes – Annual Mean) – For Chromium VI
- (4) Protection of Surface Water Quality (Inland Surface Water Environmental Quality Standard expressed as an annual average for a water hardness $CaCO_3$ annual mean of >250mg)
- (5) Protection of Surface Waters Intended for the Abstraction of Drinking Water (A3 Waters – water needing intensive physical & chemical treatment, extended treatment & disinfection).
- (6) Protection of Surface Waters Intended for the abstraction of drinking water – Standard Value
- (7) Protection of Aquatic Life – Standard Value for Freshwater National Average (based upon Hydrogen Sulphide)
- BLDL - Below Laboratory Detection Limit

5.3 Groundwater Chemical Test Results (Continued)

Laboratory testing of a Speciated PAH was undertaken, the results of which are presented below in **Table 5.5**.

Table 5.5 Summary of Groundwater Chemical Test Results – Speciated PAH (dated 08/01/2013)

Substance	Thres-Hold (mg/l)	Source	Measured Concentrations of Tested Substances (mg/l)		US95	No. of exceedences
			Minimum	Maximum		
Acenaphthene	0.0002	TC	<0.00001	<0.00001	0.000010	0
Acenaphthylene	0.0002	TC	<0.00001	<0.00001	0.000010	0
Anthracene	0.0001	AA-EQS	<0.00001	<0.00001	0.000010	0
Benzo(a)anthracene	0.0002	TC	<0.00001	0.00007	0.000024	0
Benzo(a)pyrene	0.00005	AA-EQS	<0.00001	<0.00001	0.000010	0
Benzo(b)fluoranthene	0.00003	AA-EQS	<0.00001	<0.00001	0.000010	0
Benzo(k)fluoranthene	0.00003	AA-EQS	<0.00001	<0.00001	0.000010	0
Benzo(g,h,i)perylene	0.000002	AA-EQS	<0.00001	<0.00001	0.000010	BLDL
Chrysene	0.0002	TC	<0.00001	0.00002	0.000012	0
Dibenzo(a,h)anthracene	0.0002	TC	<0.00001	<0.00001	0.000010	0
Fluoranthene	0.0001	AA-EQS	<0.00001	<0.00001	0.000010	0
Fluorene	0.0002	TC	<0.00001	0.00001	0.000010	0
Indeno(1,2,3-c,d)pyrene	0.0002	TC	<0.00001	<0.00001	0.000010	0
Naphthalene	0.0024	AA-EQS	<0.00001	<0.00001	0.000010	0
Phenanthrene	0.0002	TC	<0.00001	0.00002	0.000012	0
Pyrene	0.0002	TC	<0.00001	0.00001	0.000010	0
Total PAH	-	-	<0.0002	<0.0002	0.0002	-

Notes:

- AA - EQS Annual Average Environmental Quality Standard. UK Standard, Protection of Surface Water Quality. Water Framework Directive.
- TC - Suggested Target concentration in absence of other standards.
- BLDL - Below Laboratory Detection Limit
- 6 samples were analysed

5.3 Groundwater Chemical Test Results (Continued)

Laboratory testing of Polychlorinated Biphenyls was undertaken, the results of which are presented below in **Table 5.6**.

Table 5.6 Summary of Groundwater Test Results – Petroleum Hydrocarbons with Aliphatic and Aromatic Split (dated 08/01/2013)

Substance	Thres-hold (mg/l)	Source EQS	Measured Concentrations of Tested Substances (mg/l)		95% UCL	Number of Exceedences
			Minimum	Maximum		
Aliphatic C5-C6	0.01	EQS	<0.0001	<0.0001	0.0001	0
Aliphatic C6-C8	0.01	EQS	<0.0001	<0.0001	0.0001	0
Aliphatic C8-C10	0.01	EQS	<0.0001	<0.0001	0.0001	0
Aliphatic C10-C12	0.01	EQS	<0.001	0.0035	0.0016	0
Aliphatic C12-C16	0.01	EQS	<0.001	0.017	0.0072	1
Aliphatic C16-C21	0.01	EQS	<0.001	0.037	0.0186	4
Aliphatic C21-C35	0.01	EQS	<0.001	0.42	0.1310	4
Aromatic C5-C7	0.03*	EQS	<0.0001	<0.0001	0.0001	0
Aromatic C7-C8	0.05**	EQS	<0.0001	<0.0001	0.0001	0
Aromatic C8-C10	0.03***	EQS	<0.0001	<0.0001	0.0001	0
Aromatic C10-C12	0.01	EQS	<0.001	0.0015	0.0011	0
Aromatic C12-C16	0.01	EQS	<0.001	0.014	0.0045	1
Aromatic C16-C21	0.01	EQS	<0.001	0.0024	0.0014	0
Aromatic C21-C35	0.01	EQS	<0.001	<0.001	0.001	0

Notes:

- A total of 6 samples were tested
- EQS – environmental quality standards – in the absence of actual guidelines, 0.01 mg/l has been used as a conservative assumption.
- * value used for benzene
- ** value used for toluene
- *** value used for xylene

5.3 Groundwater Chemical Test Results (Continued)

Laboratory testing of a petroleum hydrocarbons was undertaken, the results of which are presented below in **Table 5.6**.

Table 5.7 Summary of Groundwater Test Results – Polychlorinated Biphenyls and Phenol (08/01/2013)

Substance	Thres-hold (mg/l)	Source	Measured Concentrations of Tested Substances (mg/l)		95% UCL	Number of Exceedences
			Minimum	Maximum		
PCB	0.001	*	<0.001	<0.001	0.001	0
PCB 101	0.0003		<0.0003	0.0003	0.0003	0
PCB 138	0.0002		<0.0002	<0.0002	0.0002	0
PCB 153	0.0002		<0.0002	<0.0002	0.0002	0
PCB 180	0.0002		<0.0002	<0.0002	0.0002	0
PCB 28	0.0003		<0.0003	<0.0003	0.0003	0
PCB 52	0.0002		<0.0002	<0.0002	0.0002	0
PCB 118 + PCB 123	0.0006		<0.0006	<0.0006	0.0006	0
4-Chloro-3-methylphenol	0.04		<0.0001	<0.0001	0.0001	0
2,4-Dichlorophenol	0.02		<0.0001	<0.0001	0.0001	0
2,4-Dimethylphenol	0.00025		<0.0001	<0.0001	0.0001	0
p-cresol	0.00025		<0.0001	<0.0001	0.0001	0
2,6-Dimethylphenol	0.00025		<0.0001	<0.0001	0.0001	0
2,6-Dichlorophenol	0.00025		<0.0001	<0.0001	0.0001	0
2,4,6-Trichlorophenol	0.00025		<0.0001	<0.0001	0.0001	0

Notes:

- A total of 6 samples were tested
- * In the absence of actual guidelines, laboratory detection limits have been used as a conservative assumption.

5.3 Groundwater Chemical Test Results

Laboratory testing results for the second round of water sampling dated 30/01/2013 is presented below in **Table 5.8** to **5.11**.

Table 5.8 Summary of Groundwater Test Results – Standard Suite (dated 30/01/2013)

Substance	Thres-hold (mg/l)	Source	Measured Concentrations of Tested Substances (mg/l)		US95	Number of Exceedences
			Minimum	Maximum		
Arsenic	0.05	EQS (1)	0.0011	0.0092	0.0072	0
Cadmium	0.00008	EQS (2)	0.00003	0.00021	0.0002	3
Chromium	0.0034	EQS (3)	0.00025	0.00077	0.0006	0
Copper	0.028	EQS (4)	0.0004	0.003	0.0020	2
Lead	0.0072	EQS (2)	0.00009	0.0017	0.0009	0
Mercury	0.00005	EQS (2)	0.00001	0.000025	0.0000	0
Nickel	0.02	EQS (2)	0.00067	0.0046	0.0034	0
Selenium	0.01	EQS (5)	0.00025	0.0015	0.0011	BLDL
Zinc	0.008	EQS (4)	0.0013	0.018	0.0111	1
Sulphate as SO4	250	EQS (5)	0.0055	0.12	0.0972	0
BOD	-	-	0.0028	0.0066	0.0056	-
COD	-	-	0.019	0.11	0.0902	-
Cyanide total	0.05	EQS (6)	0.04	0.04	0.04	0
Conductivity	-	-	0.955	4.07	2.8609	-
Hardness	-	-	0.194	0.494	0.4526	-
Sulphide	0.00025	EQS (7)	0.01	0.01	0.01	BLDL
pH	-	EQS	0.007	0.0073	0.0073	0
Phenol	0.0077	EQS (1)	<0.0001	<0.00025	0.000175	0

5.3 Groundwater Chemical Test Results(Continued)

Notes

- Twelve samples of perched water were tested.
- (1) Protection for Surface Water Quality (Good Standard for Rivers & Freshwater Lakes – Annual Mean)
- (2) Protection of Surface Water Quality (Inland Surface Water Environmental Quality Standard expressed as an annual average)
- (3) Protection for Surface Water Quality (Good Standard for Rivers & Freshwater Lakes – Annual Mean) – For Chromium VI
- (4) Protection of Surface Water Quality (Inland Surface Water Environmental Quality Standard expressed as an annual average for a water hardness $CaCO_3$ annual mean of >250mg)
- (5) Protection of Surface Waters Intended for the Abstraction of Drinking Water (A3 Waters – water needing intensive physical & chemical treatment, extended treatment & disinfection).
- (6) Protection of Surface Waters Intended for the abstraction of drinking water – Standard Value
- (7) Protection of Aquatic Life – Standard Value for Freshwater National Average (based upon Hydrogen Sulphide)
- BLDL - Below Laboratory Detection Limit

5.3 Groundwater Chemical Test Results (Continued)

Laboratory testing of a Speciated PAH was undertaken, the results of which are presented below in **Table 5.9**.

Table 5.9 Summary of Groundwater Test Results – Speciated PAH

Substance	Thres-Hold (mg/l)	Source	Measured Concentrations of Tested Substances (mg/l)		US95	No. of exceedences
			Minimum	Maximum		
Acenaphthene	0.0002	TC	<0.00001	<0.00001	0.00001	0
Acenaphthylene	0.0002	TC	<0.00001	<0.00001	0.00001	0
Anthracene	0.0001	AA-EQS	<0.00001	<0.00001	0.00001	0
Benzo(a)anthracene	0.0002	TC	<0.00001	<0.00001	0.00001	0
Benzo(a)pyrene	0.00005	AA-EQS	<0.00001	<0.00001	0.00001	0
Benzo(b)fluoranthene	0.00003	AA-EQS	<0.00001	<0.00001	0.00001	0
Benzo(k)fluoranthene	0.00003	AA-EQS	<0.00001	<0.00001	0.00001	0
Benzo(g,h,i)perylene	0.000002	AA-EQS	<0.00001	<0.00001	0.00001	BLDL
Chrysene	0.0002	TC	<0.00001	<0.00001	0.00001	0
Dibenzo(a,h)anthracene	0.0002	TC	<0.00001	<0.00001	0.00001	0
Fluoranthene	0.0001	AA-EQS	<0.00001	<0.00001	0.00001	0
Fluorene	0.0002	TC	<0.00001	<0.00001	0.00001	0
Indeno(1,2,3-c,d)pyrene	0.0002	TC	<0.00001	<0.00001	0.00001	0
Naphthalene	0.0024	AA-EQS	<0.00001	<0.00001	0.00001	0
Phenanthrene	0.0002	TC	<0.00001	<0.00001	0.00001	0
Pyrene	0.0002	TC	<0.00001	<0.00001	0.000010	0
Total PAH	-	-	<0.0002	<0.0002	0.0002	-

Notes:

- AA - EQS Annual Average Environmental Quality Standard. UK Standard, Protection of Surface Water Quality. Water Framework Directive.
- TC - Suggested Target concentration in absence of other standards.
- BLDL - Below Laboratory Detection Limit
- 6 samples were analysed

5.3 Groundwater Chemical Test Results (Continued)

Laboratory testing of Polychlorinated Biphenyls was undertaken, the results of which are presented below in **Table 5.10**.

Table 5.10 Summary of Groundwater Test Results – Petroleum Hydrocarbons with Aliphatic and Aromatic Split

Substance	Thres-hold (mg/l)	Source EQS	Measured Concentrations of Tested Substances (mg/l)		95% UCL	Number of Exceedences
			Minimum	Maximum		
Aliphatic C5-C6	0.01	EQS	<0.0001	<0.0001	0.0001	0
Aliphatic C6-C8	0.01	EQS	<0.0001	<0.0001	0.0001	0
Aliphatic C8-C10	0.01	EQS	<0.0001	<0.0001	0.0001	0
Aliphatic C10-C12	0.01	EQS	<0.001	<0.0001	0.0001	0
Aliphatic C12-C16	0.01	EQS	<0.001	0.0057	0.0045	0
Aliphatic C16-C21	0.01	EQS	<0.001	0.01	0.0077	0
Aliphatic C21-C35	0.01	EQS	<0.001	<0.001	0.1310	0
Aromatic C5-C7	0.03*	EQS	<0.0001	<0.0001	0.0001	0
Aromatic C7-C8	0.05**	EQS	<0.0001	<0.0001	0.0001	0
Aromatic C8-C10	0.03***	EQS	<0.0001	<0.0001	0.0001	0
Aromatic C10-C12	0.01	EQS	<0.001	0.0011	0.0011	0
Aromatic C12-C16	0.01	EQS	<0.001	0.0062	0.0036	0
Aromatic C16-C21	0.01	EQS	<0.001	0.002	0.0015	0
Aromatic C21-C35	0.01	EQS	<0.001	<0.001	0.001	0

Notes:

- A total of 6 samples were tested
- EQS – environmental quality standards – in the absence of actual guidelines, 0.01 mg/l has been used as a conservative assumption.
- * value used for benzene
- ** value used for toluene
- *** value used for xylene

5.3 Groundwater Chemical Test Results (Continued)

Laboratory testing of a petroleum hydrocarbons was undertaken, the results of which are presented below in **Table 5.11**.

Table 5.11 Summary of Groundwater Test Results – Polychlorinated Biphenyls

Substance	Thres-hold (mg/l)	Source	Measured Concentrations of Tested Substances (mg/l)		95% UCL	Number of Exceedences
			Minimum	Maximum		
PCB	0.001	TC	<0.001	<0.001	0.001	0
PCB 101	0.0003	TC	<0.0003	0.0003	0.0003	0
PCB 138	0.0002	TC	<0.0002	<0.0002	0.0002	0
PCB 153	0.0002	TC	<0.0002	<0.0002	0.0002	0
PCB 180	0.0002	TC	<0.0002	<0.0002	0.0002	0
PCB 28	0.0003	TC	<0.0003	<0.0003	0.0003	0
PCB 52	0.0002	TC	<0.0002	<0.0002	0.0002	0
PCB 118 + PCB 123	0.0006	TC	<0.0006	<0.0006	0.0006	0
4-Chloro-3-methylphenol	0.04	TC	<0.0001	<0.00025	0.000135	0
2,4-Dichlorophenol	0.02	TC	<0.0001	<0.00025	0.000135	0
2,4-Dimethylphenol	0.00025	TC	<0.0001	<0.00025	0.000135	0
p-cresol	0.00025	TC	<0.0001	<0.00025	0.000135	0
2,6-Dimethylphenol	0.00025	TC	<0.0001	<0.00025	0.000135	0
2,6-Dichlorophenol	0.00025	TC	<0.0001	<0.00025	0.000135	0
2,4,6-Trichlorophenol	0.00025	TC	<0.0001	<0.00025	0.000136	0

Notes:

- A total of 6 samples were tested
- TC - Suggested Target Concentration in absence of other standards

5.4 Contaminants of Concern in Soils

A number of substances tested for were found to be above their respective threshold levels. These exceedances are summarised in Table 5.7 below.

Table 5.12 Summary of Soil Exceedances

Hole and depth (m bgl)	Chemical	Guideline (mg/kg)	Exceedance (mg/kg)
TP5 1.30m	Arsenic	32	40
TP2 0.90m	Cyanide	8	10
TP8 0.50m	Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Chrysene Dibenzo(a,h)anthracene Indeno(1,2,3-c,d)pyrene	3.1 0.83 5.6 6 0.76 3.2	13 11 9 13 1.6 7.5
TP4 0.70m	Benzo(a)pyrene	0.83	0.90
TP6 0.60m	PCB 2,3',4,4',5-Pentachlorobiphenyl 2,2',4,4',5,5'Hexachlorobiphenyl 2,2',3,4,4',5'Hexachlorobiphenyl 2,2',3,4,4',5,5'Heptachlorobiphenyl	0.01 0.01 0.01 0.01 0.01	0.15 0.02 0.02 0.05 0.04
TP6 1.80m	Chrysotile – Loose Bundles	-	-
TP7 0.20m	Benzo(a)pyrene Chrysotile – Loose Bundles	0.83 -	1.90 -
TP9 1.00m	Benzo(a)pyrene	0.83	1.30
TP10 0.80m	Benzo(a)pyrene	0.83	1.50
TP13 0.60m	PCB 2,4,4'-Trichlorobiphenyl 2,2',5,5'-Tetrachlorobiphenyl	0.01 0.01 0.01	0.16 0.12 0.05

5.5 Contaminants of Concern in Groundwater

A number of substances tested for were found to be above their respective threshold levels. These exceedances are summarised in Table 5.8 below.

Table 5.13 Summary of Groundwater Exceedances

Borehole	Chemical	Threshold (mg/l)	Exceedance (mg/l)
BH1 (08/01/2013)	Aliphatic C16-C21 Aliphatic C21-C35	0.01 0.01	0.11 0.14
BH2 (08/01/2013)	Aliphatic C16-C21 Aliphatic C21-C35	0.01 0.01	0.037 0.19
BH3 (08/01/2013)	Aliphatic C12-C16 Aliphatic C16-C21 Aliphatic C21-C35 Aromatic C12-C16	0.01 0.01 0.01 0.01	0.017 0.031 0.42 0.014
BH4 (30/01/13)	Cadmium Copper Zinc	0.00008 0.001 0.008	0.00021 0.003 0.018
BH5 (08/01/2013)	Copper Zinc	0.001 0.008	0.0018 0.0085
BH5 (30/01/2013)	Cadmium	0.00008	0.00015
BH6 (08/012013)	Aliphatic C16-C21 Aliphatic C21-C35	0.001 0.001	0.03 0.011
BH6 (30/01/2013)	Cadmium Copper	0.00008 0.001	0.00014 0.0019

SECTION 6 Quantitative Risk Assessment/Mitigation Measures

6.1 Summary of Human Health Risks

A Quantitative Risk Assessment on the potential human health effects is detailed below:

Table 6.1 - Human Health Risk Assessment

Source	Pathway	Target	Risk Assessment	Mitigation Measures
In-Situ Soils	Dermal contact with soil/dust Inhalation of soil/dust/vapours Ingestion of soil/dust	Construction workers	**Moderate to high risk** to construction workers involved in excavation phase of development	COSHH assessment and good level of PPE/ hygiene by site workers/ staff; dust suppression measures if required.
	Inhalation of fugitive soil dust/vapours Ingestion of soil dust Dermal contact with soil dust	Passersby, neighbouring site occupants	**Moderate to high risk** during construction phase	The site should be managed well including screening and dust suppression measures if required
	Dermal contact with soil dust Inhalation of soil/dust/vapours Ingestion of soil/dust	Site end users, visitors	**Moderate to high risk** to future site users in an assumed residential scenario	The site should be capped. This will be achieved by the up filling of the site by up to 2m required as part of a flood prevention scheme.
	Adsorption into potable water plastic pipes	Site end users-residents	**Moderate to high risk**	Suitable materials should be selected and used for the water supply in accordance with UKWIR guidance.
Radon Gas	Inhalation	Site end users-residents	**Moderate Risk**	Basic radon protection measures are required
Ground gases from made ground	Gas migration into houses and inhalation of gas	Site end users-residents	**Moderate Risk** Made ground is a maximum of 1.70m thickness with little organic content	Preliminary – Gas Characteristic Situation 3 (see Section 7)
Hydrocarbon Vapours	Inhalation	Site end users-residents	**Low risk**	Installation of vapour barrier beneath buildings depending due to PCB contamination

6.1 Summary of Human Health Risks (Continued)

If during the development materials are encountered that are significantly different to those encountered in the investigation, the occurrence should be reported to the Engineer and appropriate action taken prior to continuing with the works.

In accordance with EC Regulation 1272/2008 and Environment Agency Guidance WM2 (v. 2.3/2011) soils and other materials destined for off-site disposal should be classified on the basis of their hazard phrases prior to disposal. Soils are classified as a mirror entry waste and should be classified on the basis of their specific chemical properties. Terra Firma Wales Ltd offer this service if required.

All imported material should be inspected and certified as inert prior to use.

During the ground works, the contractor should comply with all current Health and Safety regulations.

6.2 Summary of Risks to the Aquatic Environment

A Quantitative Risk Assessment on the potential effects to the aquatic environment is detailed in **Table 6.2.**

Table 6.2 Risks to the Aquatic Environment

Source	Pathway	Target	Risk Assessment	Mitigation Measures
Site soils Construction materials	Surface water run-off	River Usk Neighbouring sites Existing drainage channel/reen	**Low Risk during construction**	Measures to avoid accidental spillage of materials, and to control surface run off
Petroleum Hydrocarbons and heavy metals from surrounding and past industrial processes and made ground	Leaching	Groundwater	**Negligible Risk** (see below)	No mitigation measures necessary (see below)
Groundwater	Downward migration of groundwater	Bedrock: St Maughn's Group (Secondary A Aquifer) and superficial deposits (Secondary A)		
Groundwater	Groundwater migration	River Usk, St Maughn's Group (Secondary A Aquifer) and superficial deposits (Secondary A)		

It was discussed in Section 5.4 of the report that laboratory chemical testing shows low level contamination of the groundwater by petroleum hydrocarbons and some heavy metals.

It is clear that the initial slight hydrocarbon contamination was from contamination from the drilling process. Following purging of the boreholes on the second round of water sampling all hydrocarbons were below guideline values.

The nearest river/estuarine body to the site is the River Usk, which runs along the west boundary of the site. Throughout much of Newport, the River Usk is in hydrological continuity with the water-bearing alluvial gravels, which typically underlie the alluvial clay in the area. However, only small lens of gravel was encountered during the investigation and it is considered that the small intermittent lenses will be isolated from the River Usk.

6.2 Summary of Risks to the Aquatic Environment (Continued)

The groundwater inflows encountered within the alluvial clay (generally within and around the peat layers) were also sporadic. This groundwater is also not to be considered in hydrological continuity with the nearby River Usk. Therefore it is considered that as the levels of contamination are very low and the risk of the contamination reaching the nearby river body are so remote, there is a negligible risk posed to the aquatic environment from contamination at the site.

With regards to the drainage channel/reen that crosses the site, it is considered that as the near surface contamination is low and that the site is to be raised by up to 2m of inert materials there will be no risk to the river Usk from groundwater entering the river form this source.

6.3 Refined Site Conceptual Model

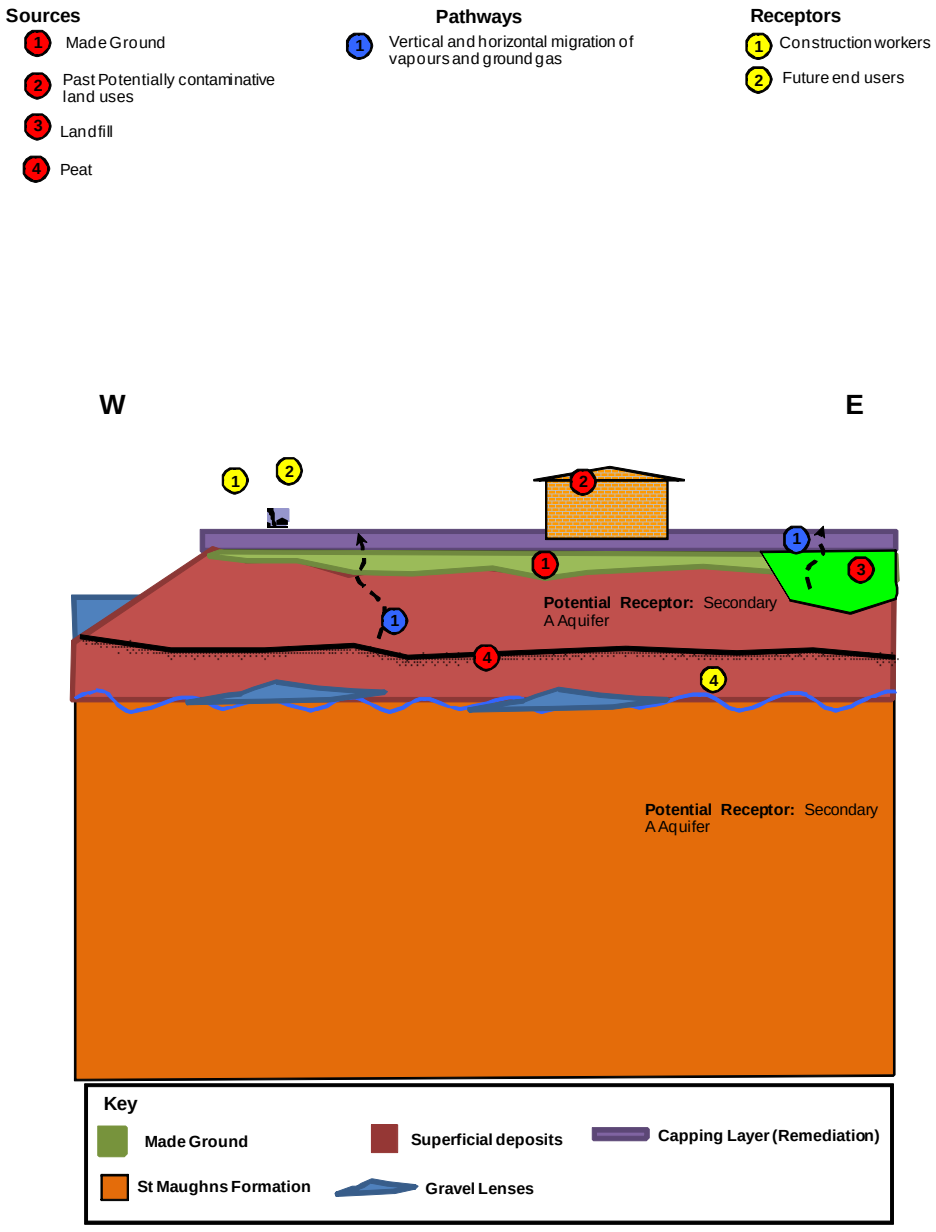

Figure 2 Refined Site Conceptual Model

SECTION 7 Evaluation of In-situ Gas Monitoring Results

Nine gas monitoring wells were installed and a programme of gas monitoring for the presence of methane, carbon dioxide and oxygen has been undertaken at the above site.

Two of the six proposed gas monitoring visits has been undertaken thus far.

No positive flow rate has been encountered.

The gas monitoring undertaken has identified a maximum methane concentration of 67.4% within the nine gas monitoring wells. The gas screening value (GSV) for Methane can thus be calculated as:

- 0.674 x 0.1 = 0.0674 litres/hour of CH_4

A maximum carbon dioxide value of 11.2% was encountered. The gas screening value (GSV) for Carbon Dioxide can thus be calculated as:

- 0.112 x 0.1 = 0.0112 litres/hour of CO_2

With reference to Table 8.5 of CIRIA Publication C665 (2007) the Gas Screening Value characterises the site as Gas Characteristic Situation 2

However, due to the methane and carbon dioxide values being so high, it is recommended that the site should be preliminarily characterised as **Characteristic Situation 3**.

The following protection measures should be undertaken;

a] Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft) with at least 2000 g DPM and under-floor venting

b] Beam and block or pre-cast concrete and 2000 g DPM/reinforced gas membrane and under-floor venting

c] All joints and penetrations must be sealed with propriety gas resistant membrane and passively ventilated or positively pressurised under-floor sub-space.

The Gas Monitoring Results are located within **Annex I** of the report. An addendum letter, which includes the remainder of the gas monitoring results will be compiled following the completion of the gas monitoring programme.

SECTION 8 Engineering Recommendations

8.1 General

In the following sections a number of foundation recommendations are given. However, as the works are to be carried out in close proximity to a main line railway, the views and approval of Network Rail Engineers needs to be gained.

Should Network Rail have any objections to the foundation recommendations given in the following sections then an alternative approach may need to be considered.

It is also likely that stringent measures will be put in place by Network Rail in order to guarantee the safety and integrity of the rail operations.

8.2 Preparation of Site

All grass and surface vegetation including all roots and any trees not under a preservation order beneath the underside of the proposed building, and any hard standing areas should also be excavated and removed from the site.

Any reduced levels should be brought up to the required levels with well, compacted imported granular materials. Department of Transport (DoT) Type 2 sub-base or similar may be used and should be compacted in layers, in accordance with the Specification for Highway Works. Alternatively, appropriate selected inert imported fill could be used.

Allowances should be made for removing any ‘soft spots/area’ and their replacement with well compacted granular materials.

Contingencies should be allowed for any necessary temporary and/or permanent support works to the existing roads and services and buildings made necessary as a result of the proposed works.

Contingencies should be in place for the protection/diversion of any underground services present beneath the site brought about as a result of the proposed works.

All materials to be removed from site should be taken to an appropriately licensed tip.

As part of the preparation works in order to comply with flood prevention levels, the site is to be raised by 1 to 2m. The materials used for the raising are to be inert mainly granular materials conforming to Type 6F2 or similar and should be compacted in layers to the Specification for Highway Works.

These works should be supervised on a full time basis by a qualified geotechnical engineer situ. In-situ testing of the filling as it progresses should be carried out. These tests should include in-situ density testing and plate load tests.

Contamination testing of the materials used of the filling should also be undertaken to the Newport City Council Protocol at source and once placed.

8.3 Foundation and Floor Slab Solution

Due to the presence of soft clay bands beneath the site traditional shallow foundations are not recommended. Such foundations are likely to lead to high total and differential settlements.

A piled foundation is advised for the proposed residential properties. Precast concrete driven piles founded within the underlying very weak red brown and grey mudstone are recommended.

For a 275mm square precast concrete pile driven to an appropriate set within the underlying gravels a safe working load of typically 500kN should be achieved. Based upon the site investigation data, pile lengths should vary between 12m and 15m beneath current ground levels. Following placement of the fill piles lengths will be increase to approximately 14 and 17m.

The estimated working loads, pile type and lengths should be confirmed by a specialist piling contractor. It may be prudent to test drive piles at select locations.

For the quoted pile size, founded within the competent gravels, total settlements should not exceed 10mm with differential movements between adjacent piles being less than half this value.

Allowances should be made for re-driving piles should buried obstructions be encountered.

Floor slabs should be designed as suspended.

Measurements should be kept on pile vibrations during driving. Measures should also be taken to dampen such vibrations. If, however, vibrations exceed permissible values then consideration should be given to using a contiguous flight auger (cfa)/bored pile solution.

Network Rail may also require a bored pile solution close to the railway.

As stated in Section 8.2, the site is to be raised by between 1.0 and 2.0m. Consolidation settlements of between 100 to 200mm have been estimated.

As the building foundations are to be piled this will result in differential settlements between the development infrastructure and the buildings of a similar order.

Therefore either the development is designed to accommodate this level of differential settlement with flexible constructions and service entries into buildings or alternatively the fill is placed prior to development and allowed to settle prior to construction. The settlement process can be speeded up by surcharging the site by ‘over filling’. Should this be the desired option then appropriate instrumentation should be installed to determine when 90% consolidation has been achieved.

8.4 Excavations and Formations

All of the shallow excavations should be possible with normal soil excavating machinery. However, hydraulic breakers may be necessary when excavating hardstanding and buried objects.

The shallow excavations are likely to encounter perched water/groundwater inflows. Inflows together with rainwater infiltration should be dealt with by conventional pumping techniques. It should also be noted that during periods of heavy rainfall, a higher groundwater table may be encountered.

The sides of any excavations deeper than 1.0m should be supported by planking and strutting or other proprietary means.

Precautions should be made for running sand conditions within the superficial material.

The sub-formations/formations will be extremely susceptible to loosening, softening and deterioration by exposure to weather (rain, frost and drying conditions), the action of water (flood water or removal of groundwater) and site traffic.

Formations should never be left unprotected and continuously exposed to rain causing degradation, or left exposed/uncovered overnight, unless permitted by a qualified engineer.

Construction plant and other vehicular traffic should not be operated on unprotected formations.

As a minimum the formation/excavation surfaces must be protected by blinding concrete or a minimum thickness of 300mm of hard cover immediately after exposure.

Allowances should be made for trimming, re-trimming and re-compaction if necessary.

Allowances should be made for the removal of soft spots and their replacement with well compacted granular materials.

Allowances should be made for special precautions to prevent formation deterioration in addition to the above.

It is recommended that approval be gained from a qualified engineer of the formation condition before covering them with any subsequent construction.

8.5 Roads and Car Parking Areas

The proposed development is to include the raising of the site as part of the flood prevention measures.

Following adequate compaction of the imported fill, a California Bearing Ratio (CBR) Value of 5% is likely to be acceptable for design purposes.

It should be noted that the local Highway Authority will require field in-situ CBR tests to be carried out at formation level of the roads to be adopted.

8.6 Protection of Buried Concrete

The laboratory soil chemical analysis reported concentrations of total sulphate of between 200 and 2500 mg/kg and pH of between 8.2 and 11.8 pH units.

Due to an elevated level of total sulphate in TP12 at 0.40m below ground level, sulphate aqueous extract was undertaken. A value of 160 mg/litre was recorded.

The classification should be based upon mobile water being present.

Based upon the above results we recommend that all buried concrete should conform to Design Class DS-1, ACEC Class AC-1, of BRE Digest 1:2005.

8.7 In-situ Soakaway Testing

During the investigation three in-situ soakaway tests were undertaken. The tests were not carried out strictly to the requirements of BRE 365.

Two of the soakaways tests recorded no infiltration and TP5 recorded a permeability of 8.86 x 10^{-5} m/s.

The in-situ soakaway test results are presented in **Annex H**.

ANNEX A
Landmark Historical Maps

Historical Mapping Legends

Ordnance Survey County Series 1:10,560

Gravel Pit
Sand Pit
Other Pits
Quarry
Shingle
Orchard
Osiers
Reeds
Marsh
Mixed Wood
Deciduous
Brushwood
Fir
Furze
Rough Pasture
Arrow denotes flow of water
Trigonometrical Station
Site of Antiquities
Bench Mark
Pump, Guide Post, Signal Post
Well, Spring, Boundary Post
285 Surface Level
Sketched Contour
Instrumental Contour
Main Roads
Fenced
Un-Fenced
Minor Roads
Fenced
Un-Fenced
Sunken Road
Raised Road
Road over Railway
Railway over River
Railway over Road
Level Crossing
Road over River or Canal
Road over Stream
Road over Stream
County Boundary (Geographical)
County & Civil Parish Boundary
Administrative County & Civil Parish Boundary
Co. Boro. Bdy. County Borough Boundary (England)
Co. Burgh Bdy. County Burgh Boundary (Scotland)
R.D. Bdy. Rural District Boundary
Civil Parish Boundary

Ordnance Survey Plan 1:10,000

Chalk Pit, Clay Pit or Quarry
Gravel Pit
Sand Pit
Disused Pit or Quarry
Refuse or Slag Heap
Lake, Loch or Pond
Dunes
Boulders
Coniferous Trees
Non-Coniferous Trees
Orchard
Scrub
Coppice
Bracken
Heath
Rough Grassland
Marsh
Reeds
Saltings
Building
Direction of Flow of Water
Shingle
Sand
Glasshouse
Pylon
Pylon
Electricity Transmission Line
Sloping Masonry
Cutting
Embankment
Standard Gauge Multiple Track
Road Under
Road Over
Level Crossing
Foot Bridge
Standard Gauge Single Track
Siding, Tramway or Mineral Line
Narrow Gauge
Geographical County
Administrative County, County Borough or County of City
Municipal Borough, Urban or Rural District, Burgh or District Council
Borough, Burgh or County Constituency
Shown only when not coincident with other boundaries
Civil Parish
Shown alternately when coincidence of boundaries occurs

BP, BS	Boundary Post or Stone	Pol Sta	Police Station
Ch	Church	PO	Post Office
CH	Club House	PC	Public Convenience
F E Sta	Fire Engine Station	PH	Public House
FB	Foot Bridge	SB	Signal Box
Fn	Fountain	Spr	Spring
GP	Guide Post	TCB	Telephone Call Box
MP	Mile Post	TCP	Telephone Call Post
MS	Mile Stone	W	Well

1:10,000 Raster Mapping

Gravel Pit
Refuse tip or slag heap
Rock
Rock (scattered)
Boulders
Boulders (scattered)
Shingle
Mud
Sand
Sand Pit
Slopes
Top of cliff
General detail
Underground detail
Overhead detail
Narrow gauge railway
Multi-track railway
Single track railway
County boundary (England only)
Civil, parish or community boundary
District, Unitary, Metropolitan, London Borough boundary
Constituency boundary
Area of wooded vegetation
Non-coniferous trees
Non-coniferous trees (scattered)
Coniferous trees
Coniferous trees (scattered)
Positioned tree
Orchard
Coppice or Osiers
Rough Grassland
Heath
Scrub
Marsh, Salt Marsh or Reeds
Water feature
Flow arrows
MHW(S) Mean high water (springs)
MLW(S) Mean low water (springs)
Telephone line (where shown)
Electricity transmission line (with poles)
BM 123.45 m Bench mark (where shown)
Triangulation station
Point feature (e.g. Guide Post or Mile Stone)
Pylon, flare stack or lighting tower
Site of (antiquity)
Glasshouse
General Building
Important Building

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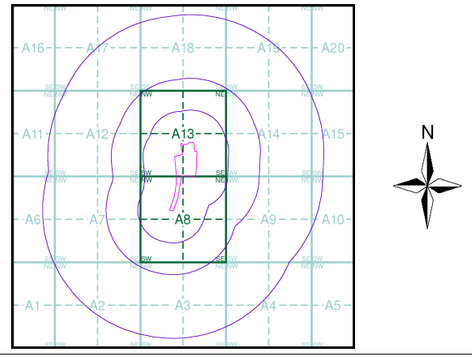
Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Monmouthshire	1:10,560	1886	3
Monmouthshire	1:10,560	1902	4
Monmouthshire	1:10,560	1922	5
Monmouthshire	1:10,560	1938	6
Historical Aerial Photography	1:10,560	1947	7
Historical Aerial Photography	1:10,560	1947	8
Monmouthshire	1:10,560	1954	9
Ordnance Survey Plan	1:10,000	1964 - 1965	10
Ordnance Survey Plan	1:10,000	1972 - 1973	11
Ordnance Survey Plan	1:10,000	1981 - 1983	12
Newport	1:10,000	1983	13
Ordnance Survey Plan	1:10,000	1987	14
10K Raster Mapping	1:10,000	2006	15
10K Raster Mapping	1:10,000	2012	16

Historical Map - Slice A



Order Details

Order Number: 41914630_1_1
Customer Ref: 12044
National Grid Reference: 331690, 189280
Slice: A
Site Area (Ha): 4.52
Search Buffer (m): 1000

Site Details

., Herbert Road, NEWPORT, Gwent, NP19 7BH

Landmark Information Group
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk

Russian Military Mapping Legends

1:5,000 and 1:10,000 mapping

a. Not drawn to scale b. Drawn to scale

- Government and Administrative Buildings
- Military and Industrial Buildings
- Military and Communication Areas
- Subway Entrance
- Fireproof Building
- Prominent Fireproof Building
- Non-fireproof Building
- Non-fireproof Building (non-dwelling)
- Factory, mill, and flour mill, with chimneys
- Factory, mill, and flour mill, without chimneys
- Power Station, drawn to scale
- Hydroelectric Power Station
- Radio Station, drawn to scale
- Telephone Station, drawn to scale
- Abandoned Open-pit Mine or Quarry
- Open-pit Salt Mine
- Pit
- Oil Deposit or Well
- Oil Seepage
- Tailings Pile
- Fuel Storage Tanks
- Natural Gas Tank
- Bench Mark
- Drill Hole
- Burial Mound
- Triangulation Point on Burial Mound
- Single-track Railroad
- Double-track Railroad and Station Building
- Coniferous Forest
- Deciduous Forest
- Mixed Forest
- Lawns
- Citrus Orchard
- Wet Ground
- Scattered Vegetation

243,8 — Values for prominent elevations

186.0 — Numbers for spot elevations, depth soundings, contour lines, etc.

0,2 — Velocity of the current, width of river bed, depth of river

Fractional terms: length and capacity of bridges; depth of fords and condition of the river bottom; height of forest and the diameter of trees

Russian Alphabet (For reference and phonetic interpretation of map text)

А а (A)	З з (Z)	П п (P)	Ч ч (CH)
Б б (B)	И и (I)	Р р (R)	Ш ш (SH)
В в (V)	Й й (Y)	С с (S)	Щ щ (SHCH)
Г г (G)	К к (K)	Т т (T)	ъ (–)
Д д (D)	Л л (L)	У у (U)	ы (Y)
Е е (E)	М м (M)	Ф ф (F)	ь (')
Ё ё (YO)	Н н (N)	Х х (KH)	Э э (E)
Ж ж (ZH)	О о (O)	Ц ц (TS)	Ю ю (YU or IU)
			Я я (YA or IA)

1:25,000 mapping

a. Not drawn to scale b. Drawn to scale

- Government and Administrative Buildings
- Military and Industrial Buildings
- Military and Communication Areas
- Subway Entrance
- Partly Demolished Buildings
- Demolished Buildings
- Built-Up Area with Fireproof Buildings Predominant
- Built-Up Area with Non-Fireproof Buildings Predominant
- Individual Fireproof Building
- Prominent Industrial Building
- Individual Dwelling, Fireproof
- Ruins of an Individual Dwelling
- Factory or Mill Chimney
- Factory or Mill with Chimney
- Factory or Mill without Chimney
- Mine or Open Pit Mine
- Operating Shaft or Mine
- Non-Operating Shaft or Mine
- Salt Mine
- Tailings Pile
- Pit
- Stone Quarry
- Gas Pump or Service Station
- Fuel Storage or Natural Gas Tank
- Oil or Natural Gas Derrick
- Small Hydroelectric Power Station
- Power Station
- Transformer Station
- Cemetery
- Burial Mound (height in metres)
- Triangulation Point on Burial Mound
- Triangulation Point
- Bench Mark
- Bench Mark (monumented)
- Telegraph Office
- Telephone Station
- Radio Station
- Radio Tower
- Airfield or Seaplane Base
- Landing Strip
- Main Highway
- Highway under Construction
- Improved Dirt Road (former truck road)
- Double-track Railroad with First Class Station
- Dismantled Railroad
- Railroad Under Construction
- Shore Embankment
- River or Ditch with Embankment
- Direction and velocity of current
- Well
- Water Reservoir or Rain Water Pit
- Spring
- Isobath with value
- Heavy (Index) Contour Line
- Contour Line and Value
- Half Contour Line
- Spot Elevation Value
- Coniferous
- Deciduous
- Mixed
- Scrub

Key to Numbers on Mapping

ST38NW_Newport

No.	Description
15	Factory (Gas)
16	Factory (Gas)
21	Factory (Machinery)
23	Factory (Metals)
35	Factory (Non-Ferrous Metals)
40	Council/Government Buildings/Courts
44	Police Station/Headquarters
58	Post Office
59	Warehouses (Use Unknown)
63	Warehouses (Use Unknown) And Port Buildings
73	Railway Station

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Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Monmouthshire	1:10,560	1886	3
Monmouthshire	1:10,560	1902	4
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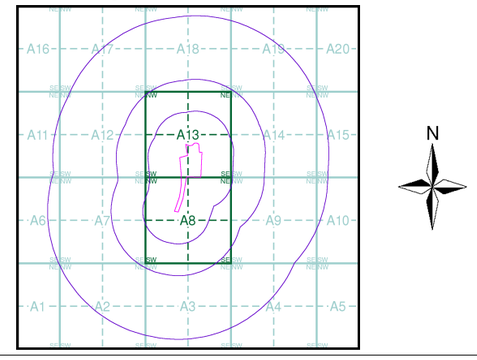
Russian Map - Slice A



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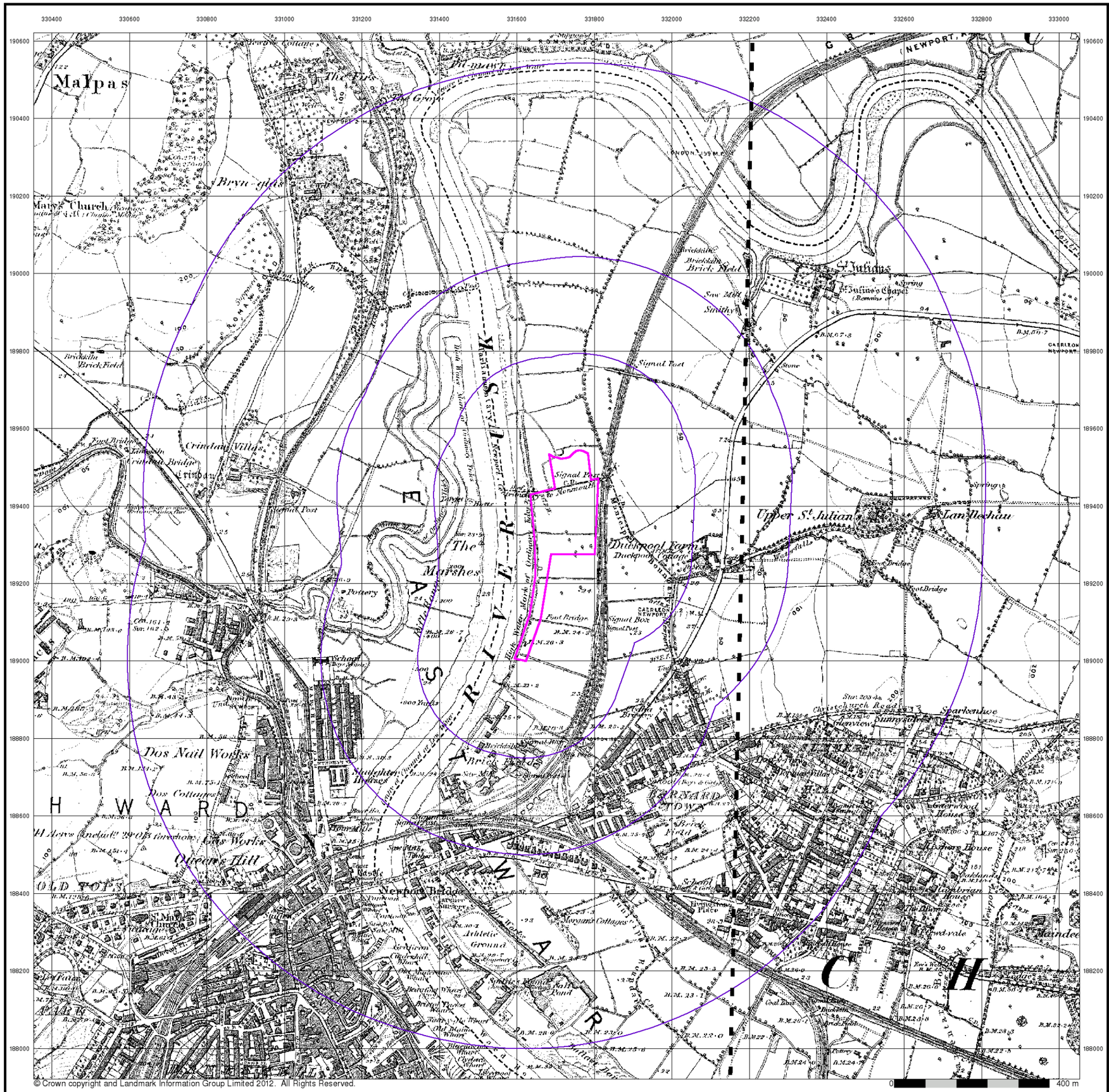

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Monmouthshire

Published 1886

Source map scale - 1:10,560

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)

Historical Map - Slice A

Order Details

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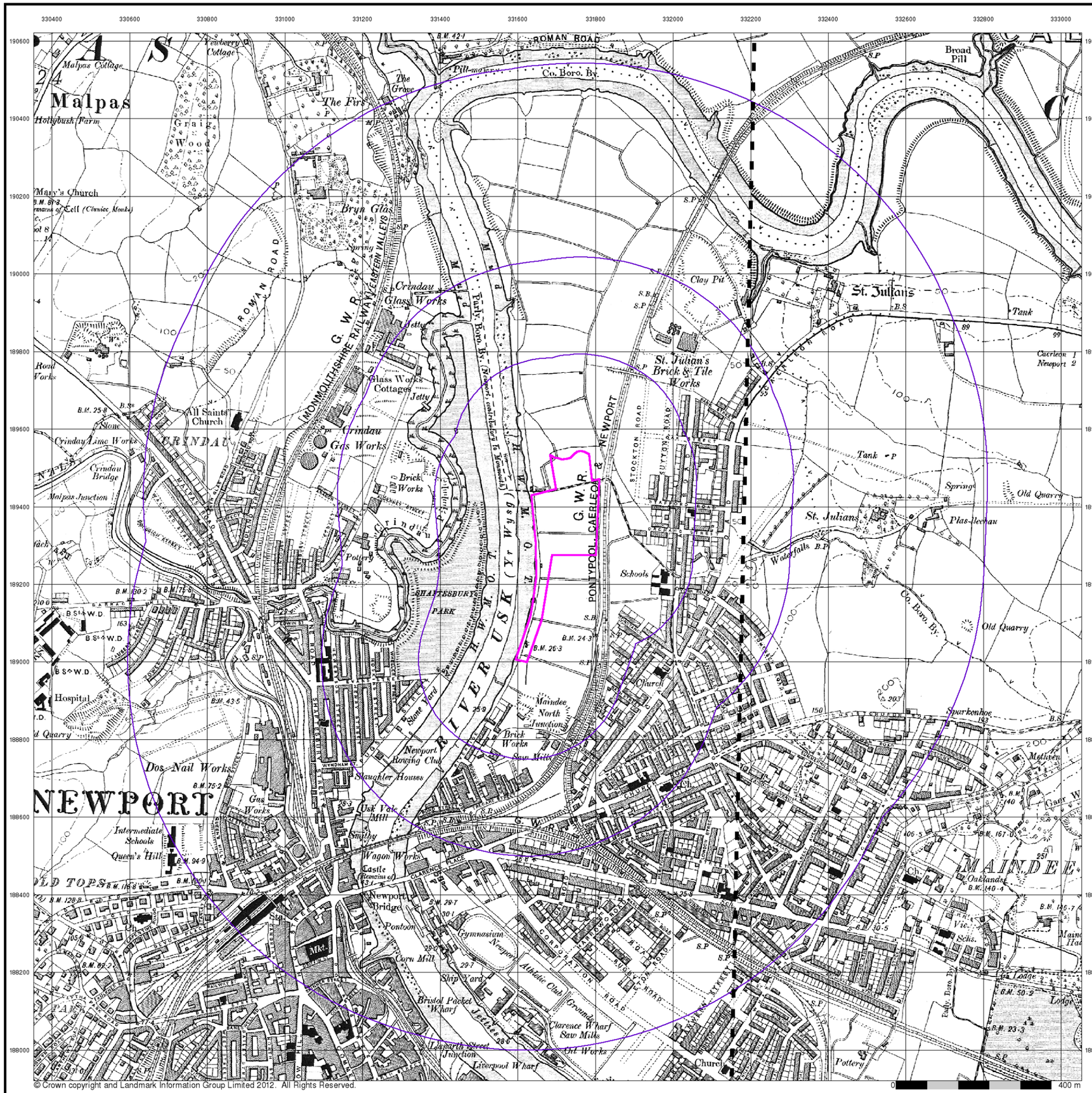
Fax:	0844 844 9951
Web:	www.envirocheck.co.uk



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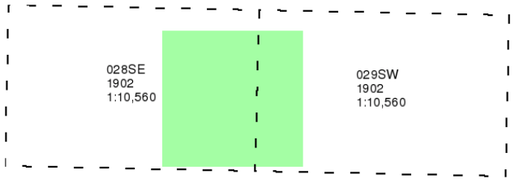
Monmouthshire

Published 1902

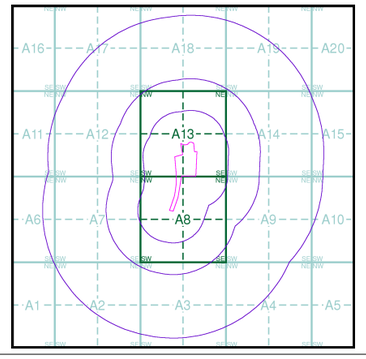
Source map scale - 1:10,560

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

Order Number:	41914630_1_1
Customer Ref:	12044
National Grid Reference:	331690, 189280
Slice:	A
Site Area (Ha):	4.52
Search Buffer (m):	1000

Site Details

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Monmouthshire

Published 1922

Source map scale - 1:10,560

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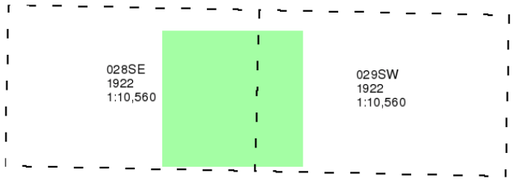
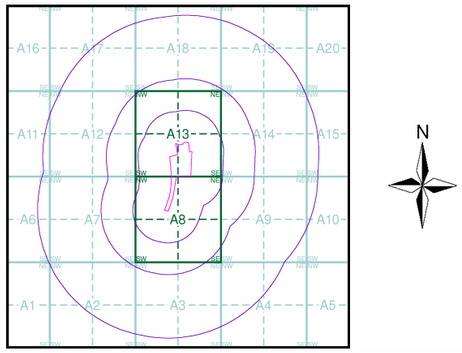
Map Name(s) and Date(s)



Historical Map - Slice A



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Slice:	A
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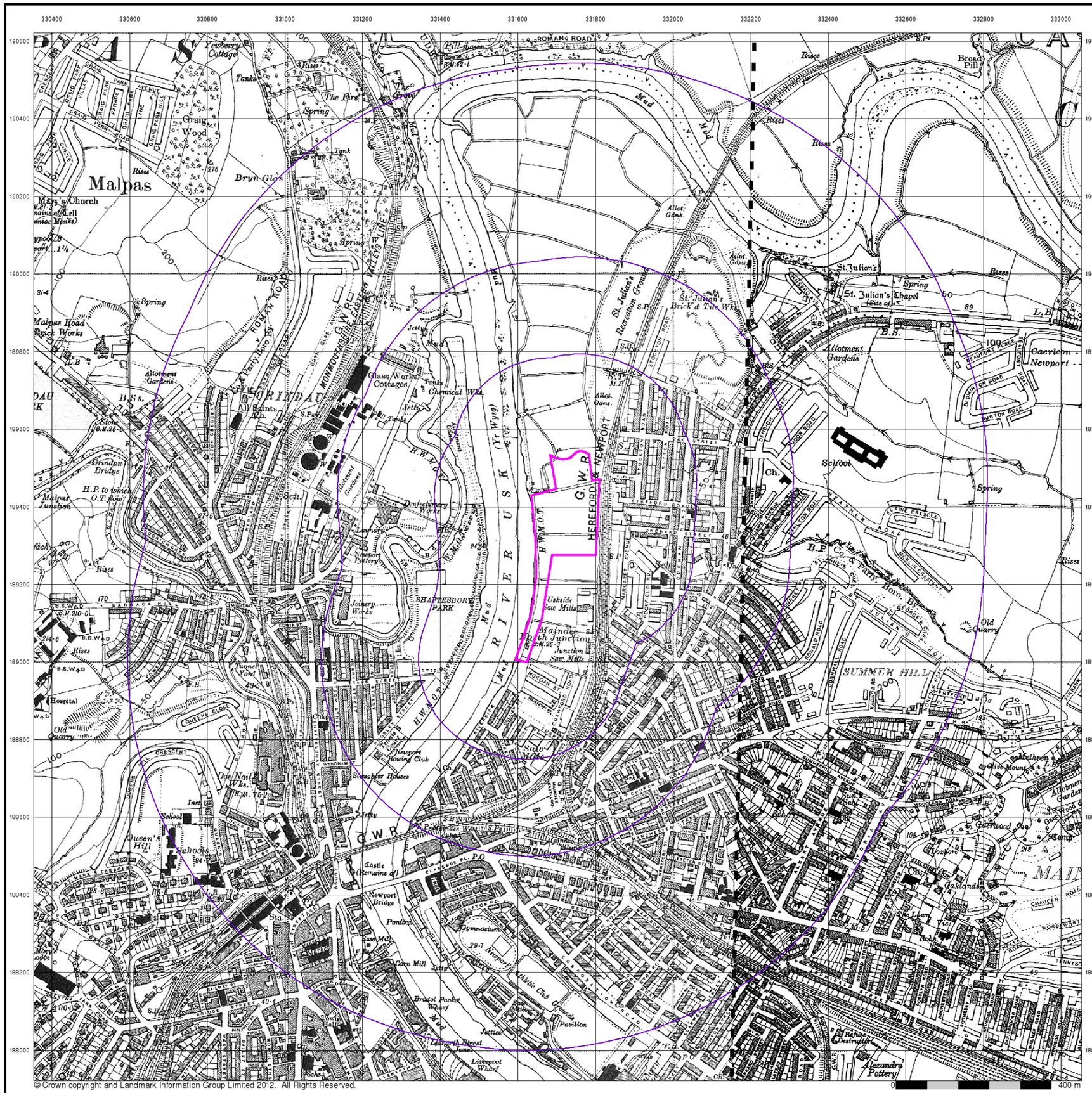

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Monmouthshire

Published 1938

Source map scale - 1:10,560

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)

Historical Map - Slice A

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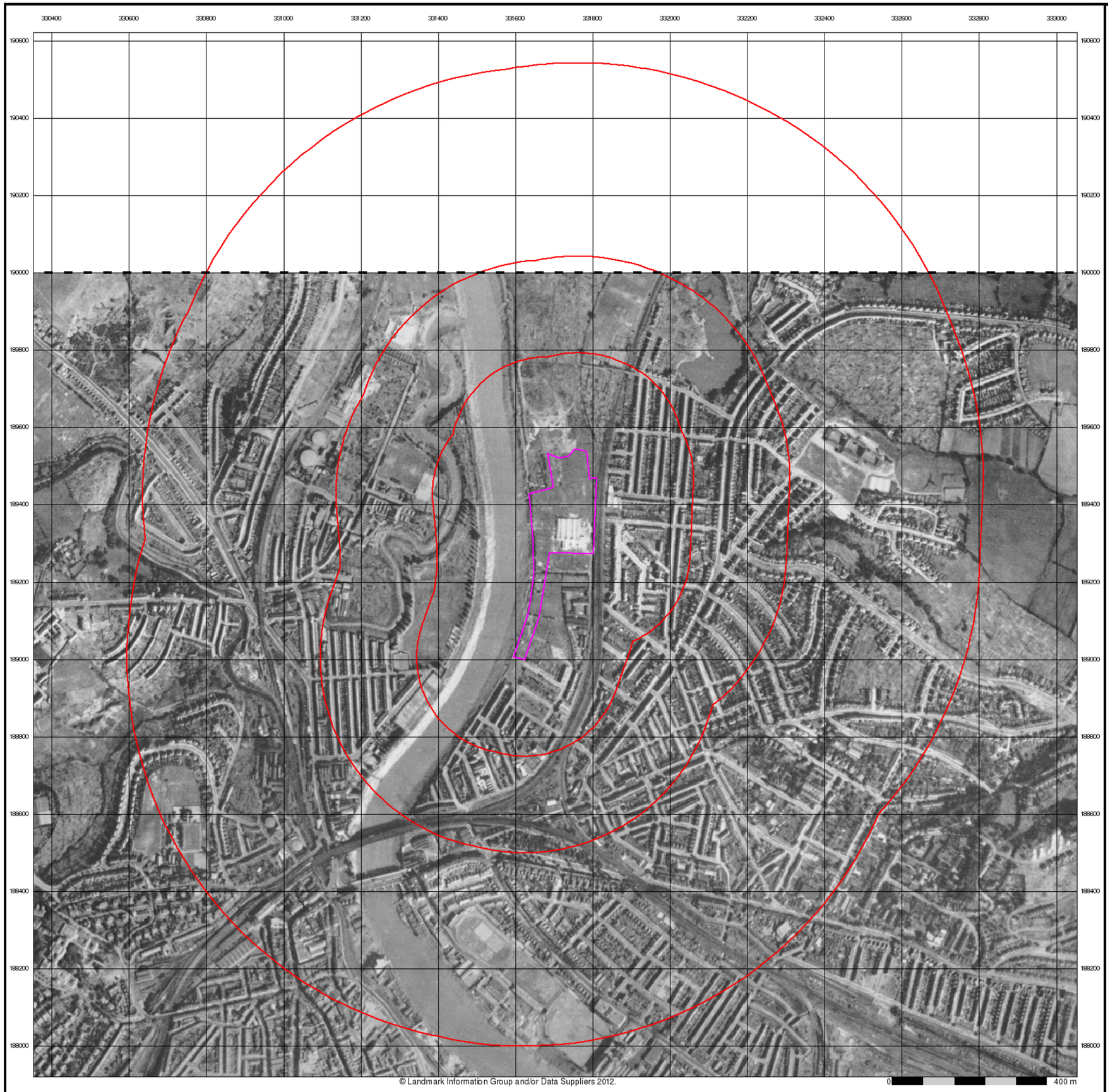

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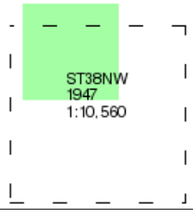
Historical Aerial Photography

Published 1947

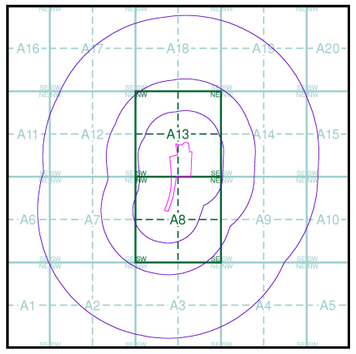
Source map scale - 1:10,560

The Historical Aerial Photos were produced by the Ordnance Survey at a scale of 1:1,250 and 1:10,560 from Air Force photography. They were produced between 1944 and 1951 as an interim measure, pending preparation of conventional mapping, due to post war resource shortages. New security measures in the 1950's meant that every photograph was re-checked for potentially unsafe information with security sites replaced by fake fields or clouds. The original editions were withdrawn and only later made available after a period of fifty years although due to the accuracy of the editing, without viewing both revisions it is not easy to spot the edits. Where available Landmark have included both revisions.

Map Name(s) and Date(s)



Historical Aerial Photography - Slice A



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Order Details

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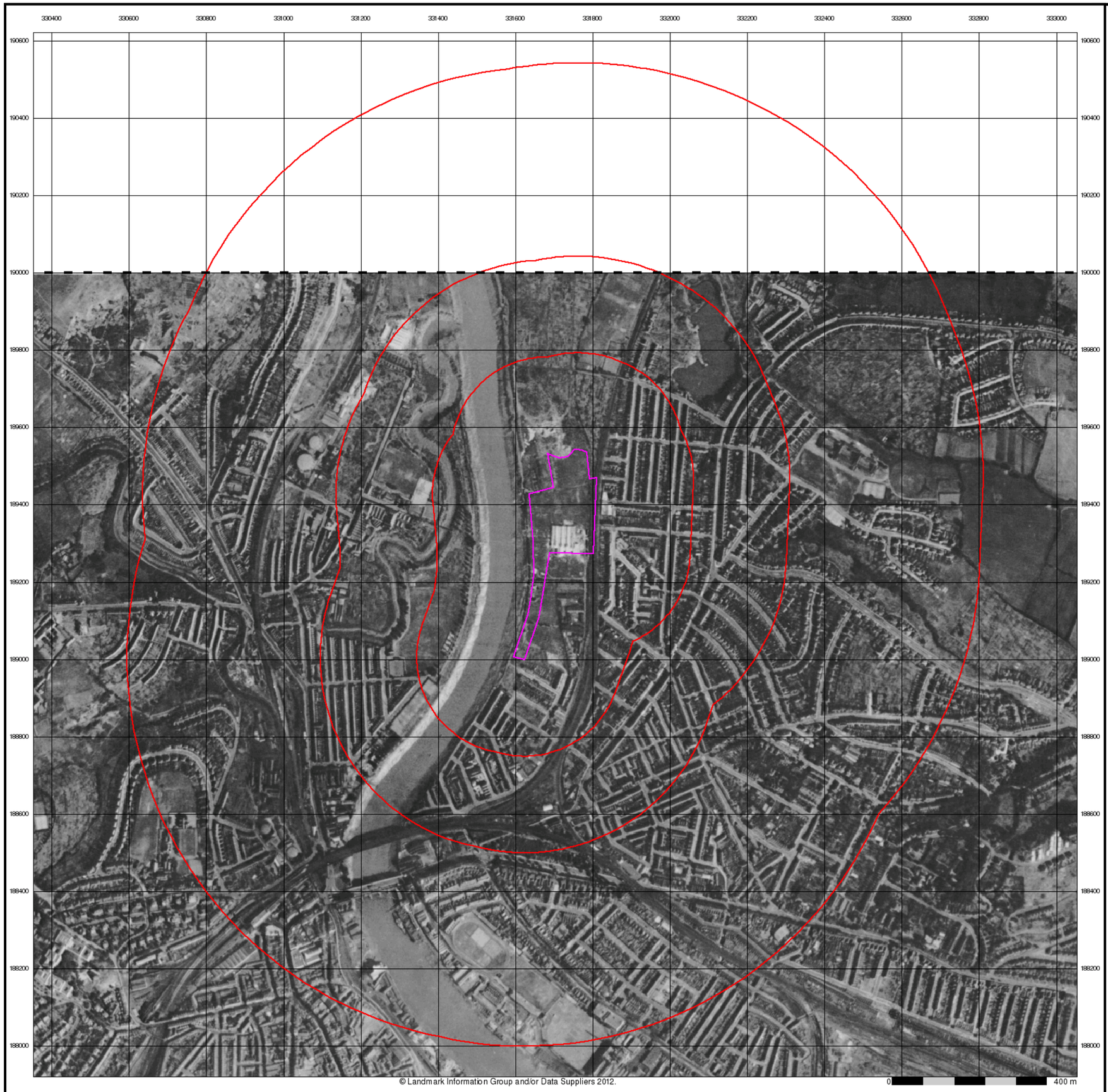

terrafirma

Historical Aerial Photography

Published 1947

Source map scale - 1:10,560

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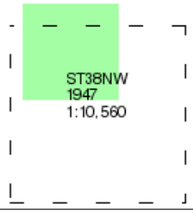
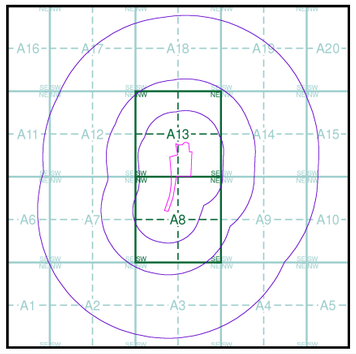


Historical Aerial Photography - Slice A



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0 400 m

Monmouthshire

Published 1954

Source map scale - 1:10,560

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Map Name(s) and Date(s)

Historical Map - Slice A

Order Details

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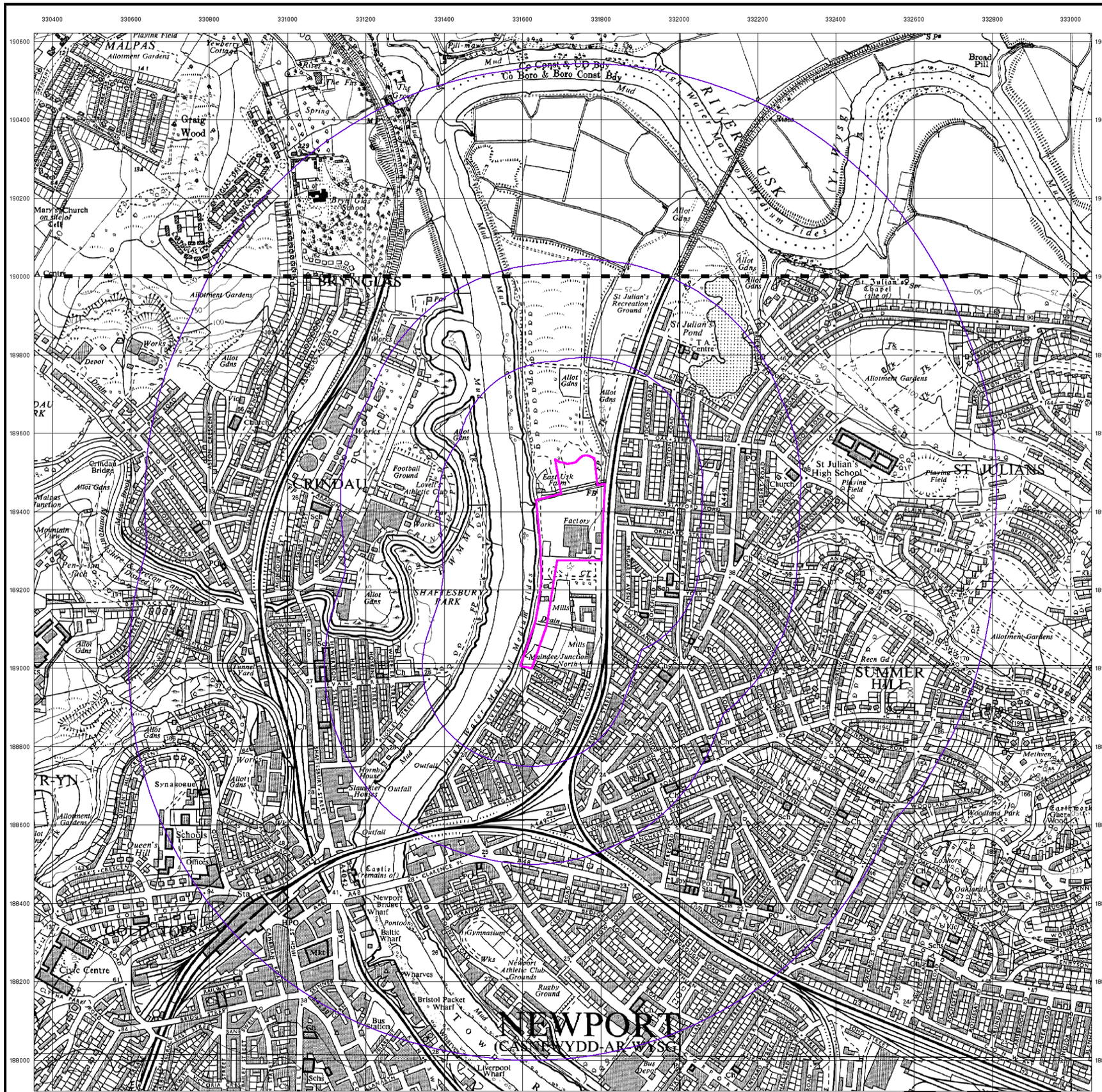

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Ordnance Survey Plan

Published 1964 - 1965

Source map scale - 1:10,000

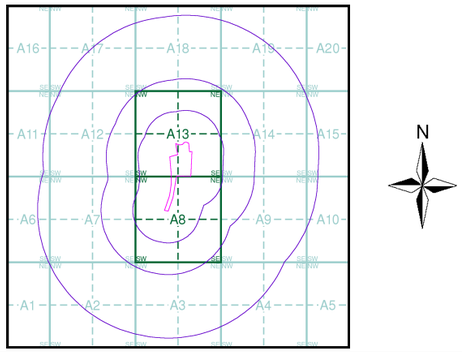
The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)

ST39SW
1964
1:10,560

ST38NW
1965
1:10,560

Historical Map - Slice A



Order Details

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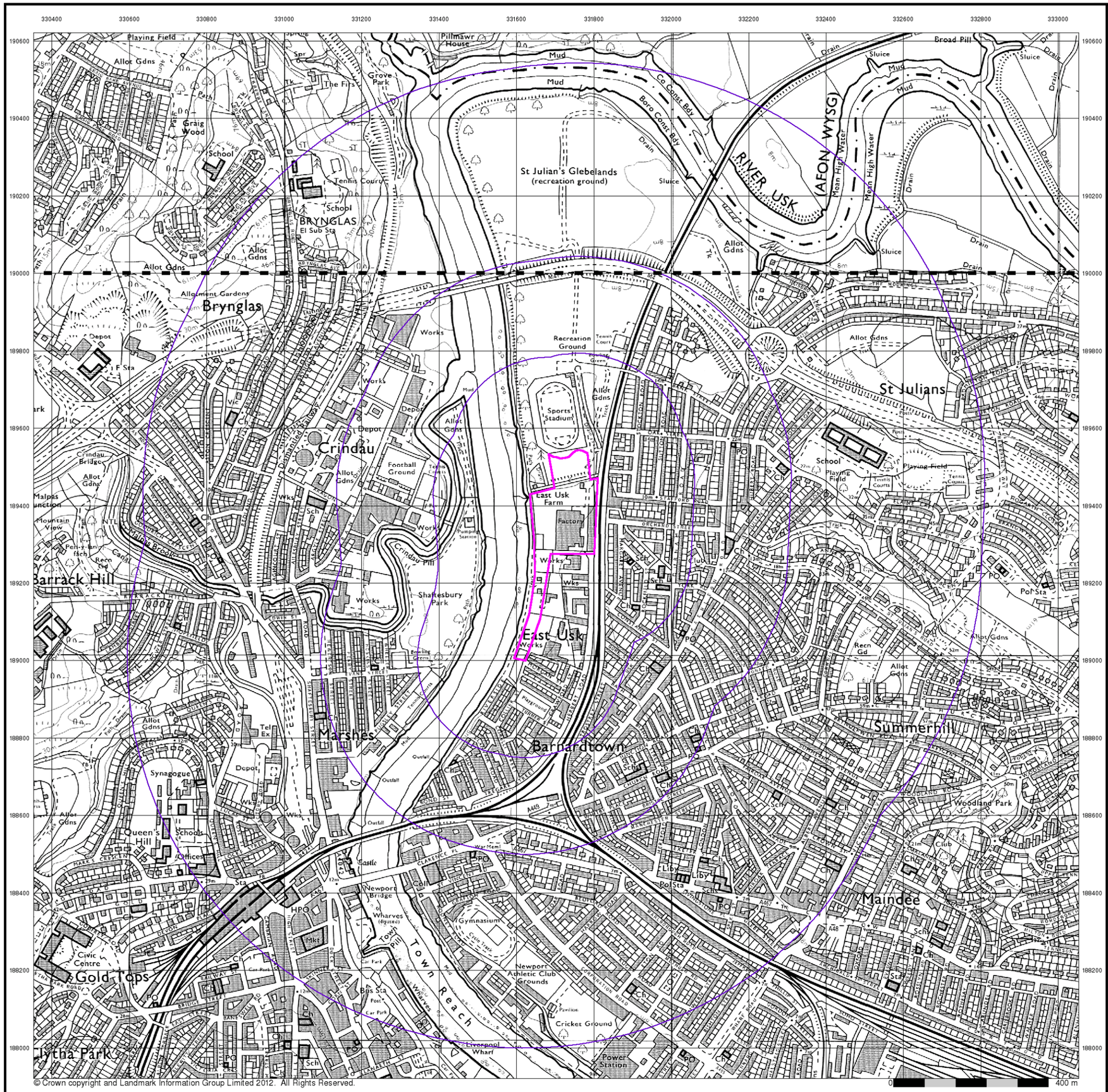

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Ordnance Survey Plan

Published 1972 - 1973

Source map scale - 1:10,000

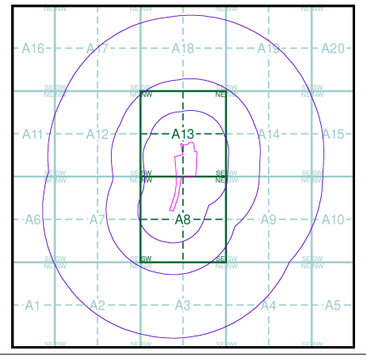
The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)

ST39SW
1972
1:10,000

ST38NW
1973
1:10,000

Historical Map - Slice A



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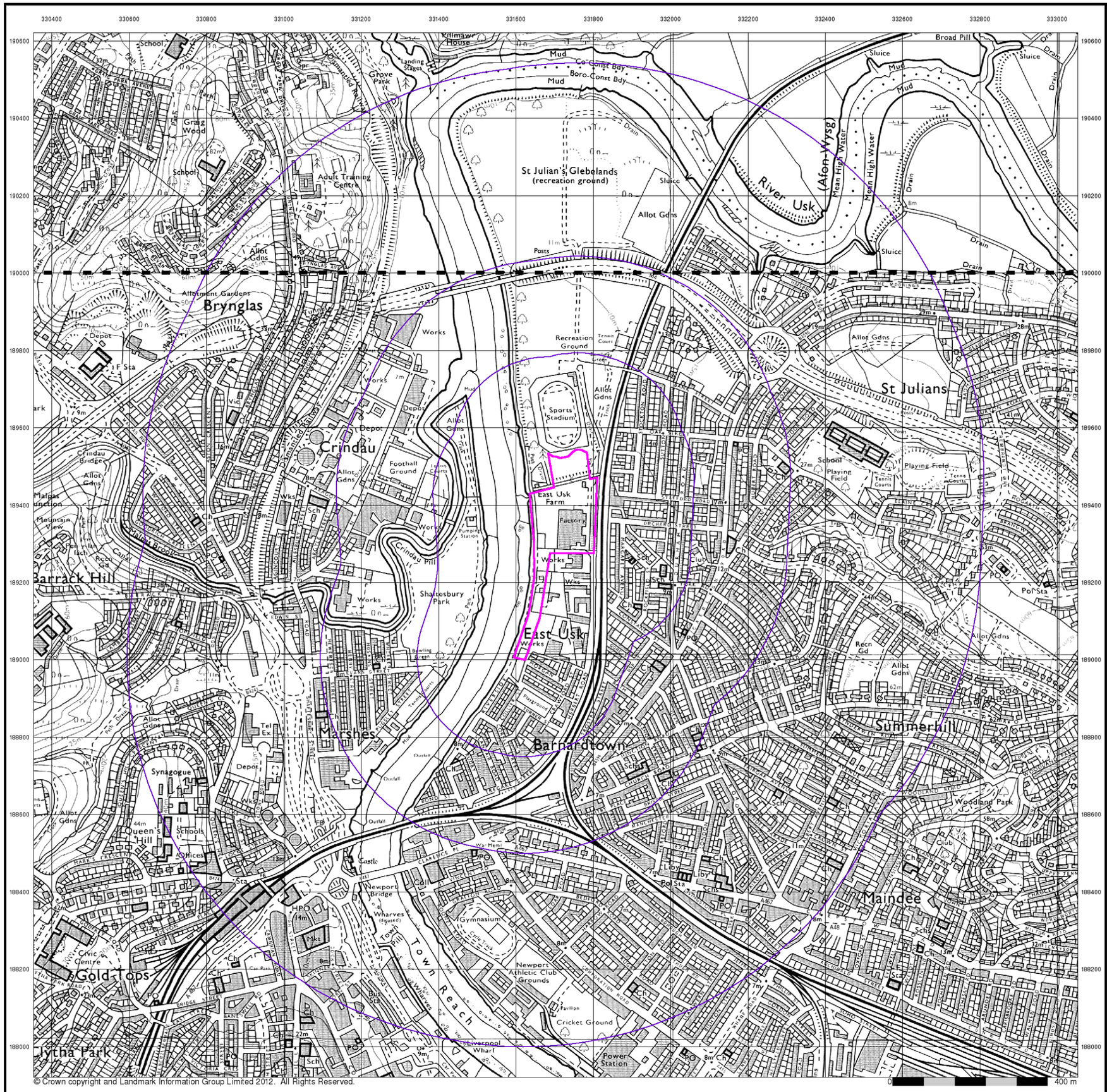

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Ordnance Survey Plan

Published 1981 - 1983

Source map scale - 1:10,000

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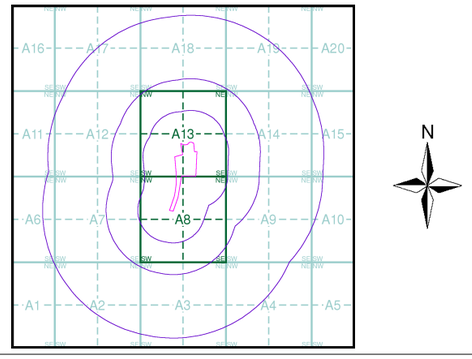
Map Name(s) and Date(s)

ST39SW
1983
1:10,000

ST38NW
1981
1:10,000

Historical Map - Slice A



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Site Details

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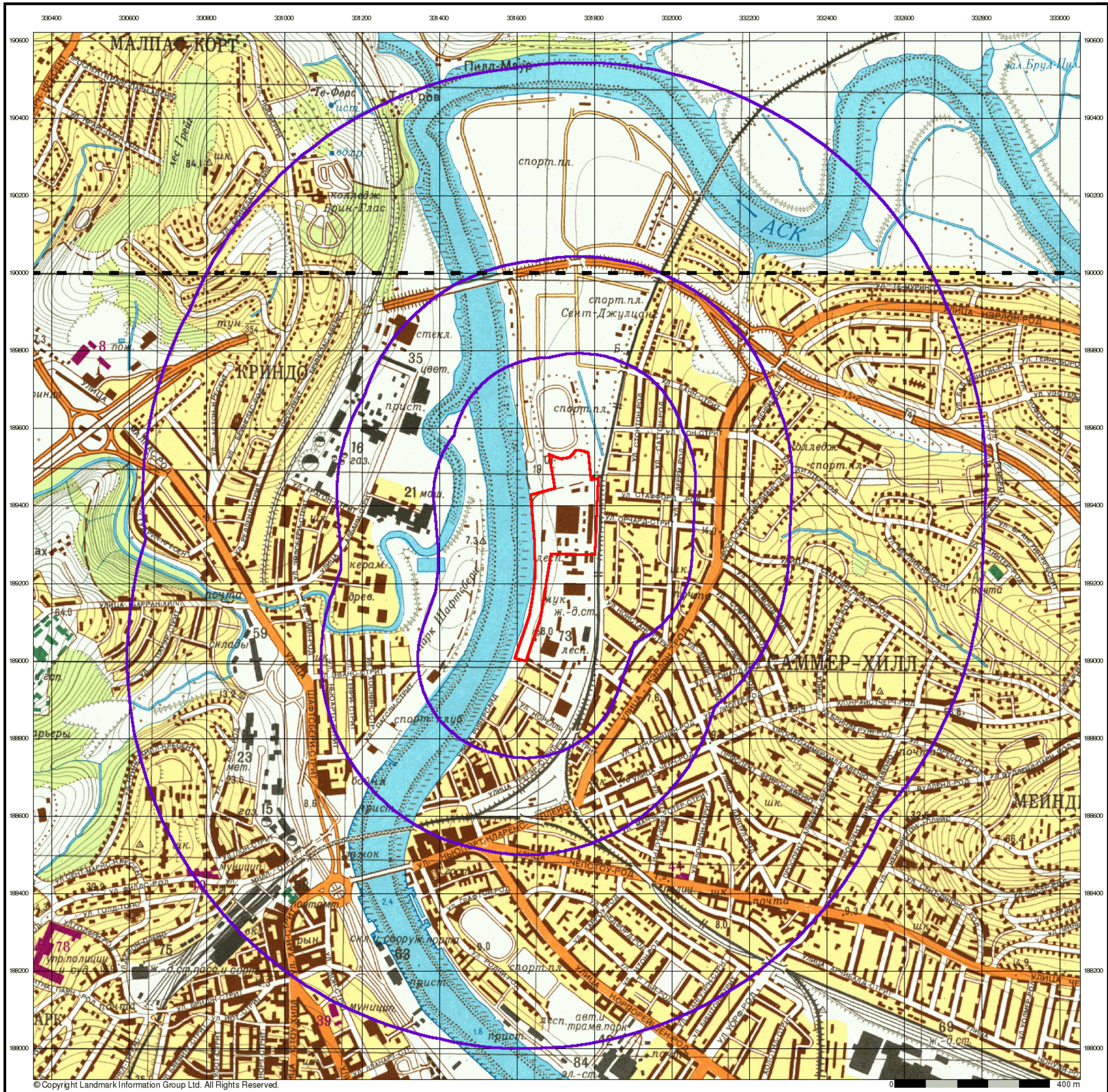


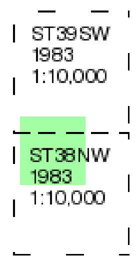
Newport

Published 1983

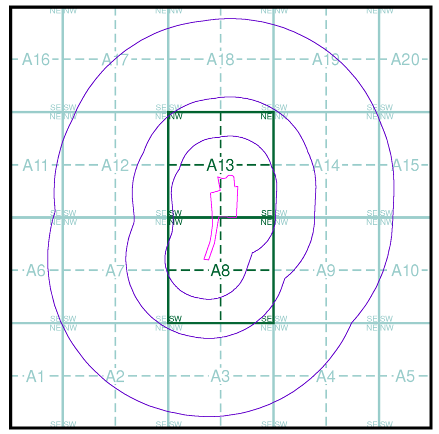
Source map scale - 1:10,000

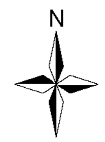
These maps were produced by the Russian military during the Cold War between 1950 and 1997, and cover 103 towns and cities throughout the U.K. The maps are produced at 1:25,000, 1:10,000 and 1:5,000 scale, and show detailed land use, with colour-coded areas for development, green areas, and non-developed areas. Buildings are coloured black and important building uses (such as hospitals, post offices, factories etc.) are numbered, with a numbered key describing their use.
They were produced by the Russians for the benefit of navigation, as well as strategic military sites and transport hubs, for use if they were to have invaded the U.K. The detailed information provided indicates that the areas were surveyed using land-based personnel, on the ground, in the cities that are mapped.

Map Name(s) and Date(s)



Russian Map - Slice A





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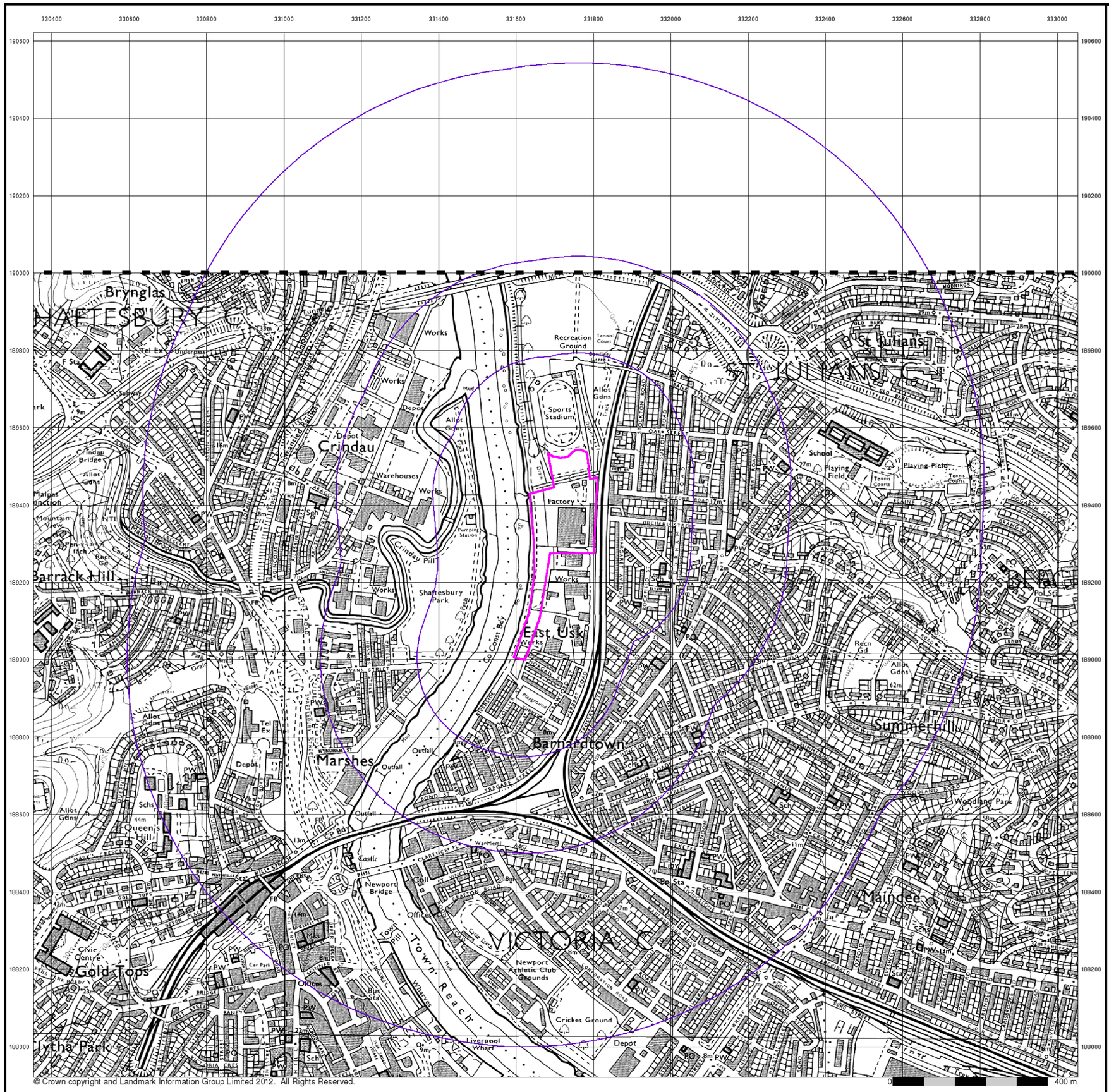

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Ordnance Survey Plan

Published 1987

Source map scale - 1:10,000

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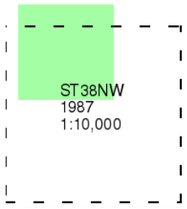
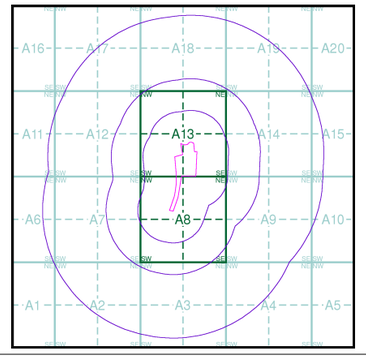


Historical Map - Slice A



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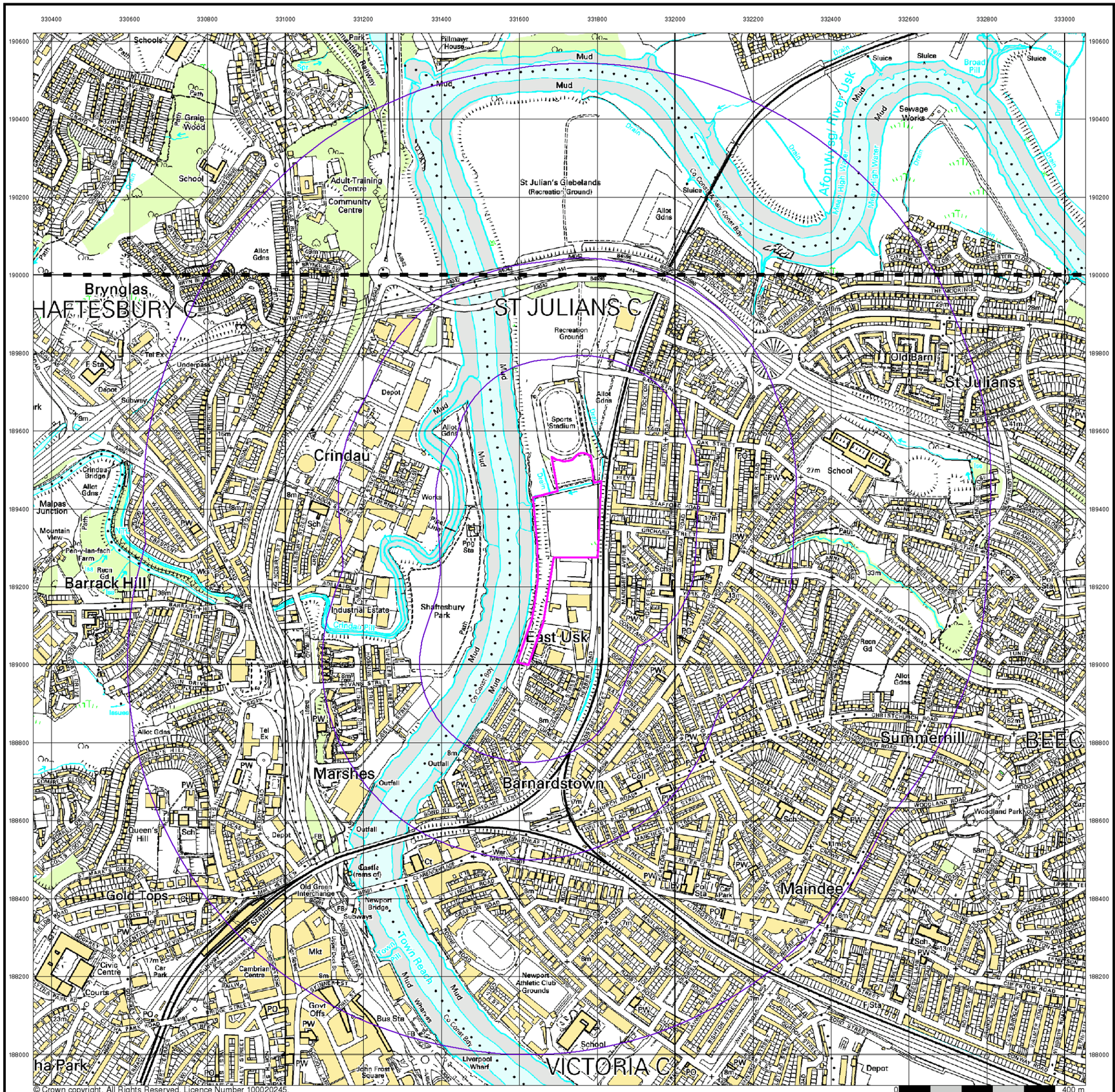

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10k Raster Mapping

Published 2006

Source map scale - 1:10,000

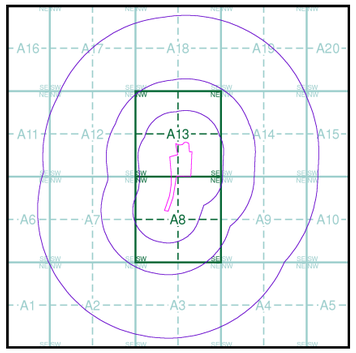
The historical maps shown were produced from the Ordnance Survey`s 1:10,000 colour raster mapping. These maps are derived from Landplan which replaced the old 1:10,000 maps originally published in 1970. The data is highly detailed showing buildings, fences and field boundaries as well as all roads, tracks and paths. Road names are also included together with the relevant road number and classification. Boundary information depiction includes county, unitary authority, district, civil parish and constituency.

Map Name(s) and Date(s)

ST39SW
2006
1:10,000

ST38NW
2006
1:10,000

Historical Map - Slice A



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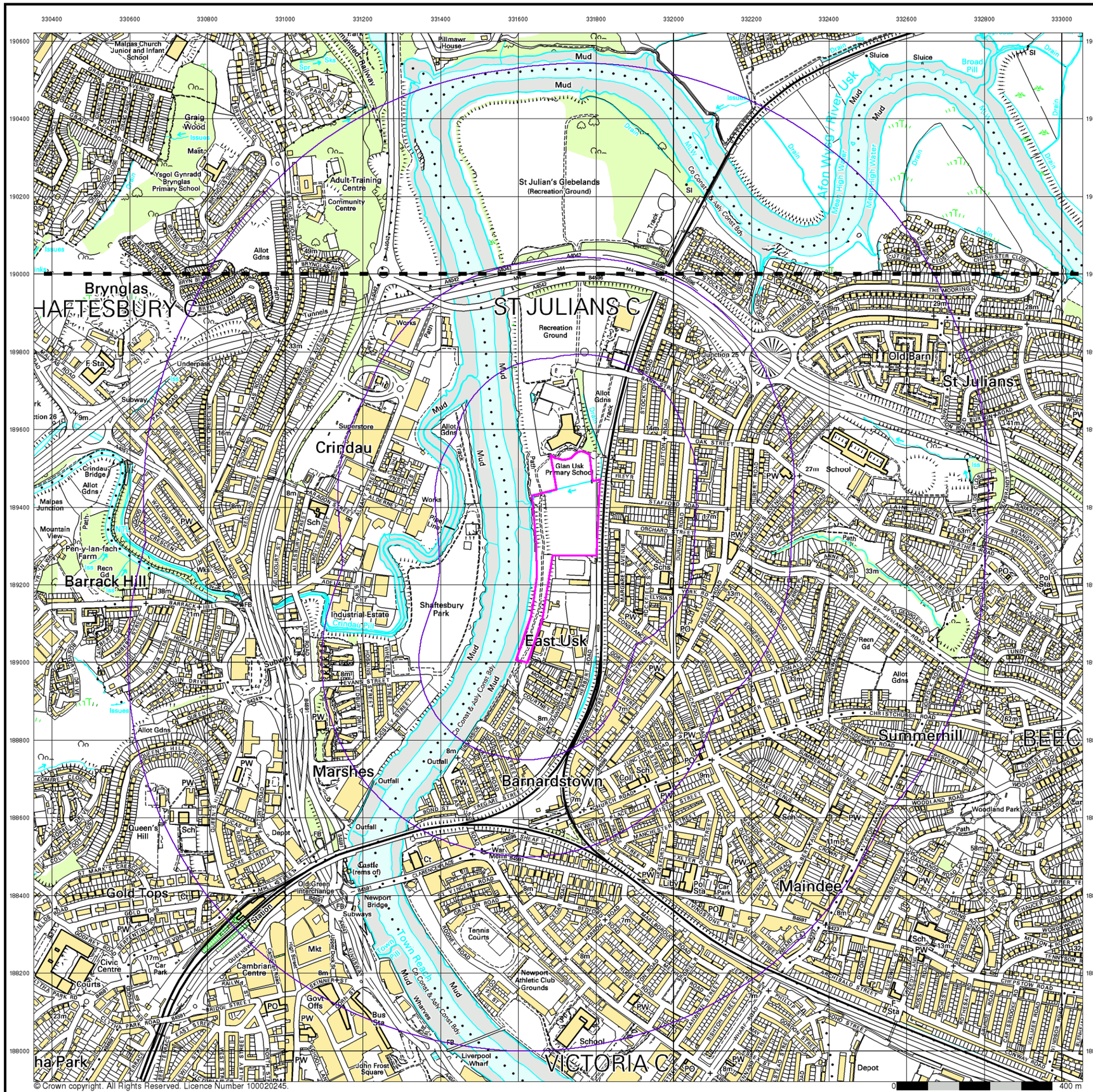

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10k Raster Mapping

Published 2012

Source map scale - 1:10,000

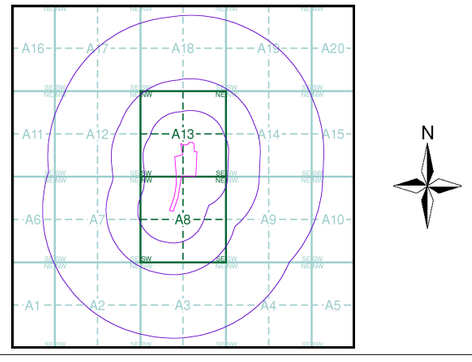
The historical maps shown were produced from the Ordnance Survey`s 1:10,000 colour raster mapping. These maps are derived from Landplan which replaced the old 1:10,000 maps originally published in 1970. The data is highly detailed showing buildings, fences and field boundaries as well as all roads, tracks and paths. Road names are also included together with the relevant road number and classification. Boundary information depiction includes county, unitary authority, district, civil parish and constituency.

Map Name(s) and Date(s)

ST39SW
2012
1:10,000

ST38NW
2012
1:10,000

Historical Map - Slice A



Order Details

Order Number:	41914630_1_1
Customer Ref:	12044
National Grid Reference:	331690, 189280
Slice:	A
Site Area (Ha):	4.52
Search Buffer (m):	1000

Site Details

., Herbert Road, NEWPORT, Gwent, NP19 7BH

Landmark Information Group

Tel: 0844 844 9952
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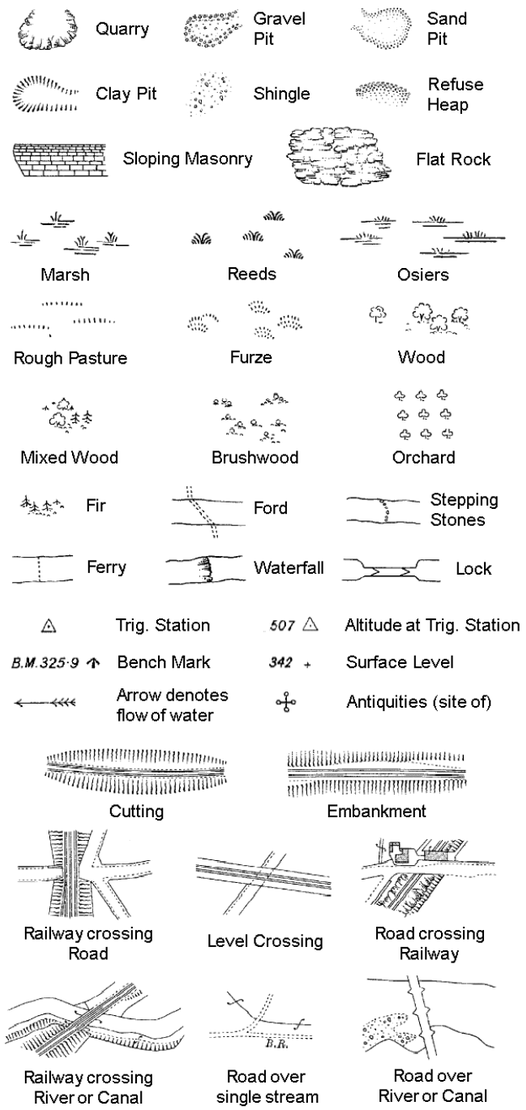
Web: www.envirocheck.co.uk

Historical Mapping Legends

Ordnance Survey County Series and Ordnance Survey Plan 1:2,500



County Boundary (Geographical)

County & Civil Parish Boundary

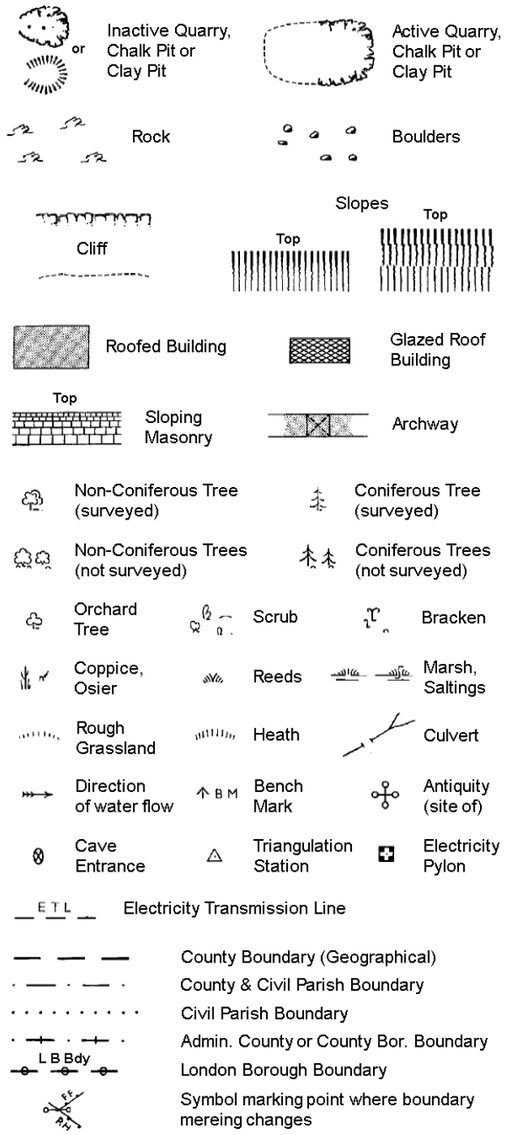
Administrative County & Civil Parish Boundary

Co. Boro. Bdy. County Borough Boundary (England)

Co. Burgh Bdy. County Burgh Boundary (Scotland)

B P B S	Boundary Post or Stone	P.C.B	Police Call Box
B.R.	Bridle Road	P	Pump
E.P	Electricity Pylon	S.P	Signal Post
F.B.	Foot Bridge	St.	Sluice
F.P.	Foot Path	Sp.	Spring
G.P	Guide Post or Board	T.C.B	Telephone Call Box
M.S	Mile Stone	Tr.	Trough
M.P M.R	Mooring Post or Ring	W	Well

Ordnance Survey Plan, Additional SIMs and Supply of Unpublished Survey Information 1:2,500 and 1:1,250



County Boundary (Geographical)

County & Civil Parish Boundary

Civil Parish Boundary

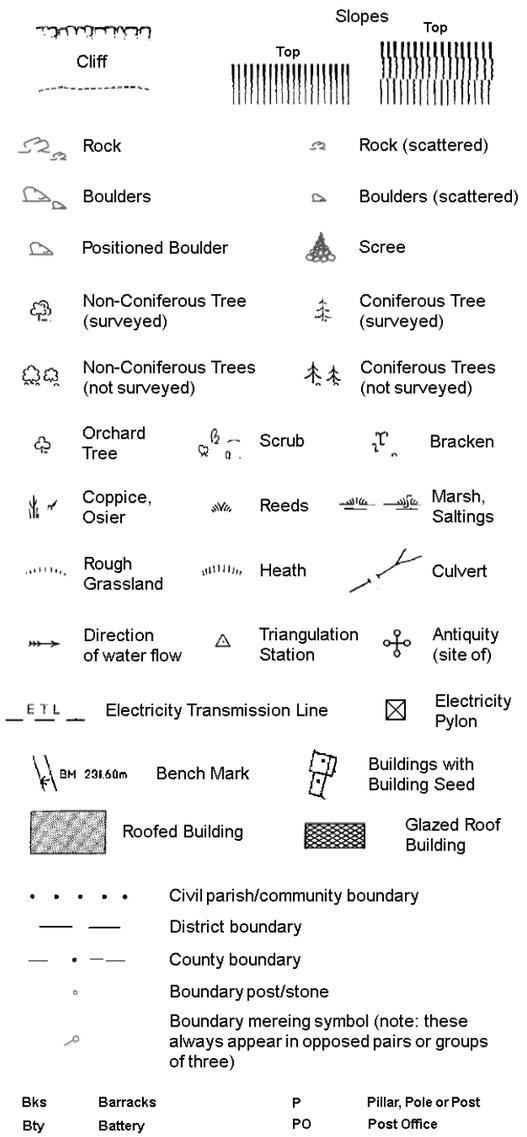
Admin. County or County Bor. Boundary

L B Bdy London Borough Boundary

Symbol marking point where boundary mereing changes

BH	Beer House	P	Pillar, Pole or Post
BP, BS	Boundary Post or Stone	PO	Post Office
Cn, C	Capstan, Crane	PC	Public Convenience
Chy	Chimney	PH	Public House
D Fn	Drinking Fountain	Pp	Pump
El P	Electricity Pillar or Post	SB, S Br	Signal Box or Bridge
FAP	Fire Alarm Pillar	SP, SL	Signal Post or Light
FB	Foot Bridge	Spr	Spring
GP	Guide Post	Tk	Tank or Track
H	Hydrant or Hydraulic	TCB	Telephone Call Box
LC	Level Crossing	TCP	Telephone Call Post
MH	Manhole	Tr	Trough
MP	Mile Post or Mooring Post	Wr Pt, Wr T	Water Point, Water Tap
MS	Mile Stone	W	Well
NTL	Normal Tidal Limit	Wd Pp	Wind Pump

Large-Scale National Grid Data 1:2,500 and 1:1,250



Civil parish/community boundary

District boundary

County boundary

Boundary post/stone

Boundary mereing symbol (note: these always appear in opposed pairs or groups of three)

Bks	Barracks	P	Pillar, Pole or Post
Bty	Battery	PO	Post Office
Cemy	Cemetery	PC	Public Convenience
Chy	Chimney	Pp	Pump
Cis	Cistern	Ppg Sta	Pumping Station
Dismtd Rly	Dismantled Railway	PW	Place of Worship
El Gen Sta	Electricity Generating Station	Sewage Ppg Sta	Sewage Pumping Station
El P	Electricity Pole, Pillar	SB, S Br	Signal Box or Bridge
El Sub Sta	Electricity Sub Station	SP, SL	Signal Post or Light
FB	Filter Bed	Spr	Spring
Fn / D Fn	Fountain / Drinking Ftn.	Tk	Tank or Track
Gas Gov	Gas Valve Compound	Tr	Trough
GVC	Gas Governer	Wd Pp	Wind Pump
GP	Guide Post	Wr Pt, Wr T	Water Point, Water Tap
MH	Manhole	Wks	Works (building or area)
MP, MS	Mile Post or Mile Stone	W	Well

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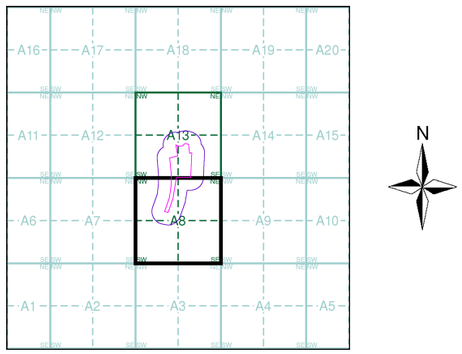
Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Monmouthshire	1:2,500	1883	2
Monmouthshire	1:2,500	1902	3
Monmouthshire	1:2,500	1920	4
Monmouthshire	1:2,500	1937	5
Ordnance Survey Plan	1:1,250	1955 - 1957	6
Ordnance Survey Plan	1:2,500	1955 - 1957	7
Additional SIMs	1:1,250	1957 - 1992	8
Ordnance Survey Plan	1:1,250	1966 - 1976	9
Ordnance Survey Plan	1:2,500	1969 - 1970	10
Supply of Unpublished Survey Information	1:1,250	1974	11
Additional SIMs	1:1,250	1978 - 1991	12
Additional SIMs	1:1,250	1989	13
Large-Scale National Grid Data	1:1,250	1993	14
Large-Scale National Grid Data	1:1,250	1994 - 1997	15
Large-Scale National Grid Data	1:1,250	1997	16

Historical Map - Segment A8



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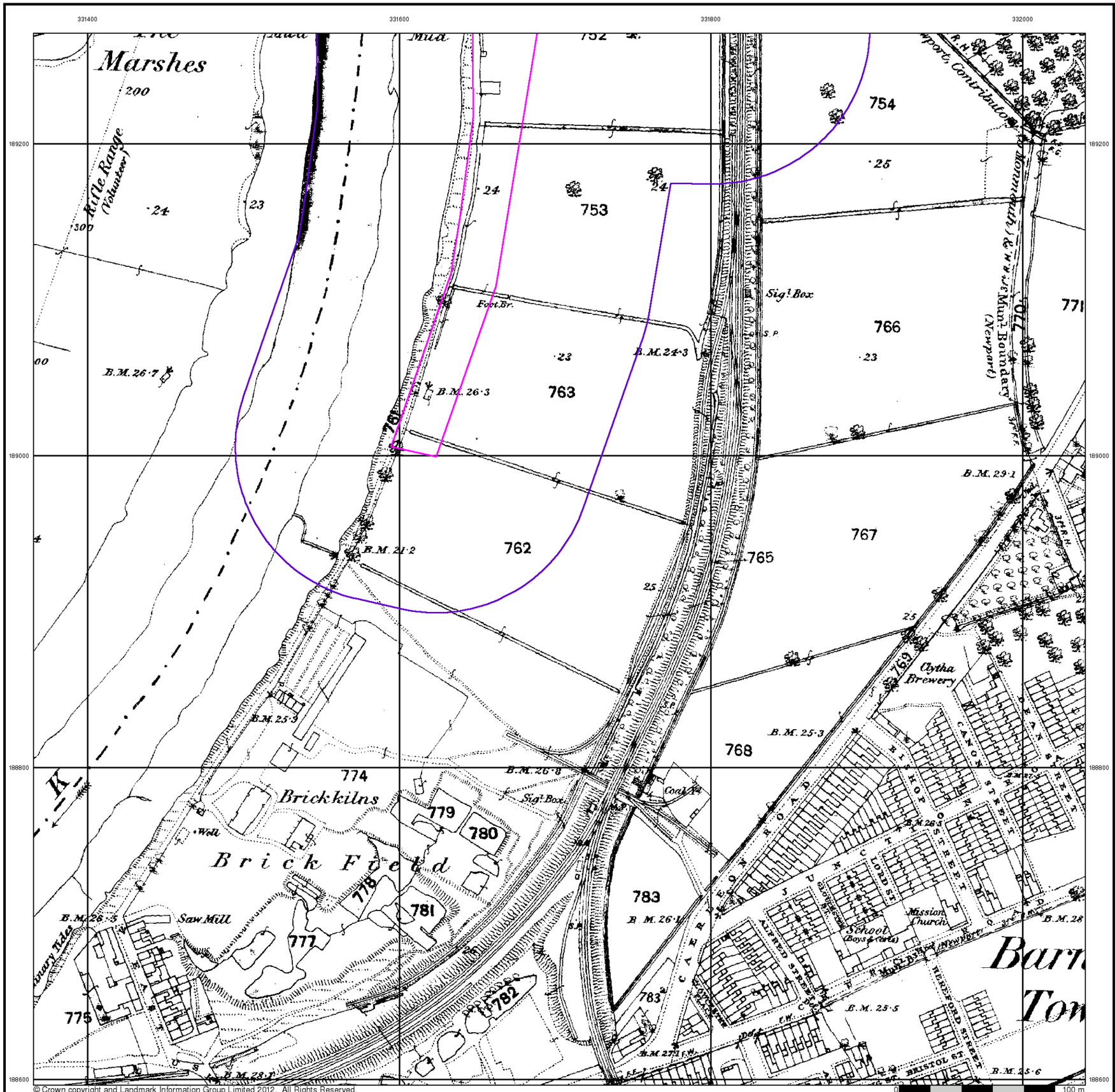

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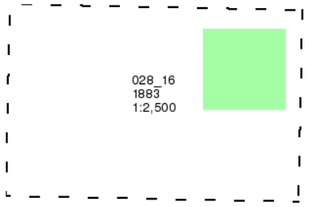
Monmouthshire

Published 1883

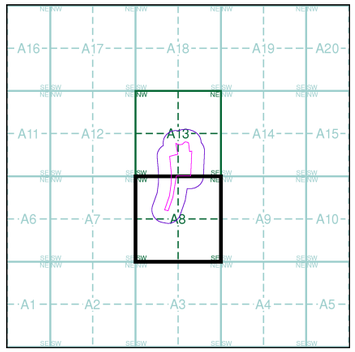
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A8



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