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I & H BROWN

MAELOR WORKS, WREXHAM (SITE CODE 138S)

METHOD STATEMENT AND SPECIES PROTECTION PLAN: GREAT CRESTED NEWTS

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1. INTRODUCTION

1.1 Background to the Development

IKM Consulting Limited has been commissioned by I&H Brown Limited (IHB) to act as their designers for the Maelor Works, Wrexham Gasworks Remediation Project. The site is located near Marchweil, Wrexham, LL13 0UW, central grid reference SJ 38108 48134 (for a plan of the site see Figure 1: A1-13627-3050-0).

The work is part of a comprehensive remediation scheme for the site which has been impacted by its former use as a gas manufacturing site. Extensive site investigations and risk assessments have led to a remediation strategy that addresses the significant pollutant linkages identified on and around the site that have the potential to detrimentally impact statutorily protected receptor groups (human and environmental). The full details of the proposed remediation strategy are contained within a Risk Assessment and Remediation Design Report produced by IKM Consulting in September 2014 (IKM, 2014), see Appendix A. This report should be read in conjunction with this document. The remediation works are required in order to protect the current and future human site users, surface water courses flowing through and close to the site (Bedwell Brook and the River Clywedog), and a surface water pond (Pond 2) lying within the site boundary.

Evolution Ecology were commissioned by IHB to carry out the ecology work in relation to the development, prior to IKM Consulting's involvement with the ecology work. A Preliminary Ecological Appraisal of the site and further protected species surveys, including a presence/absence survey for great crested newts (*Triturus cristatus*), were completed by Evolution Ecology during 2013 and 2014 and the resulting reports must be read in conjunction with this document (Evolution Ecology, 2013 and Evolution Ecology, 2014, Appendix B and C respectively). There are two ponds within the boundaries of the site and numerous other ponds within 500m of the site boundaries. During the surveys, no evidence of great crested newts (GCN) was found although it appears that only the pond in the southern part of the site (Pond 2) was surveyed for GCN. Subsequently the Wrexham County Ecologist provided further GCN records for the surrounding area (see Figure 2).

These records indicate that there is a network of breeding ponds within 500m of the site, GCN have been recorded within 25m of the site boundary and there is high potential for the species to be present within suitable terrestrial habitats within the site.

During the 2014 survey carried out by Evolution Ecology evidence of otter (*Lutra lutra*) was found within the Bedwell Brook channel (footprints). No otter resting sites or other field sign (e.g. spraint, feeding remains) were identified within the site during the survey. The survey results indicate that this section of the brook is being used as a commuting corridor for otters moving along the Bedwell Brook. The Wrexham County Ecologist has requested that further consideration of otters be incorporated within any mitigation strategy for the site. This Method Statement therefore incorporates a strategy to minimise fragmentation of the Bedwell Brook habitat corridor and recommends further survey of the Bedwell Brook, within 200m upstream and downstream of the site to determine if there are otter resting sites that may be impacted upon by the proposed works. Full details of the action to be taken with regards to otters at the site is contained within the Species Action Plan in Section 5 of this report.

In order for works to proceed at the site, the Wrexham County Ecologist and Natural Resources Wales (NRW) have advised that a European Protected Species (EPS) Licence for GCN must be applied for and granted, prior to works commencing. This Method Statement and Species Protection Plan has been produced in support of the licence application.

1.2 Details of the Proposed Licensable Works

Remediation works proposed at the site include (see Figure 3 for a summary map of remediation works at the site):

- Remediation of historical soil and groundwater contamination originating from former use as a coal gas manufacturing site;

- Excavation of contaminated ground and soil with ex-situ treatment on site. These works will include localised excavation of contaminated soil and sediment from the pond located in the southern part of the site (Pond 2) and the temporary isolation and excavation of sediments from the Bedwell Brook channel and re-profiling of the banks;
- Recovery of contaminated groundwater and drain contents for off-site disposal;
- Excavation of contaminated surface water feature sediments with ex-situ treatment on site;
- Demolition of a surplus office building and works garage/store; and
- Replacement of a private drinking water supply pipeline.

A planning application has been submitted and NRW have stipulated that prior to planning being granted, an appropriate mitigation strategy for GCN is to be agreed.

The proposed schedule of works is summarised within Table 1 below (see Appendix A, *Risk Assessment and Remediation Design Report*, IKM (2014) for full details pertaining to each works detail). There will be no works within potential GCN habitat until the GCN licence has been granted and the associated Method Statement and Species Protection Plan have been adopted. Site clearance works in non-GCN habitat are due to commence in mid-February.

Table 1: Proposed schedule of works

Works	Commence	Complete
Site clearance (non-GCN habitat only)	16.02.15	20.02.15
Area AC1	23.02.15	15.05.15
Treatment area	16.03.15	22.04.15
Area AC2-1	23.02.15	20.04.15
Area AC2-2	03.03.15	29.04.15
Area AC2-3	06.03.15	27.04.15
Area AC2-4	03.03.15	29.04.15
Bedwell Brook / Pond 2 (no works until GCN licence granted)	23.02.15	10.03.15

Works	Commence	Complete
Water mains replacement (no works until GCN licence granted)	23.02.15,	23.03.15
Demolition of Former North East Wales District office	16.03.15	23.03.15

1.3 Actions Requiring Licensing

The proposed works to Pond 2 and Bedwell Brook corridor and the installation of the replacement water mains will result in the destruction of suitable GCN terrestrial and aquatic habitat within the site. The remainder of the works are to be carried out within habitat that holds low potential for use by of GCN (e.g. areas within the active work site). Although no evidence of GCN has been found within the site during surveys to date, there are terrestrial records of GCN within 25m of the site boundary and 16 known breeding ponds within 500m of the site boundary, with the closest situated 60m south-east of the site.

GCN spend most of the year on land, moving into breeding ponds to lay eggs around mid-March to mid-May. From May onwards adults will disperse gradually from breeding ponds into suitable terrestrial habitat (up to 500m from the pond). GCN hibernate around the period October to February within refuges that protect them from severe cold and flooding such as tree roots, mammal burrows and piles of rock, rubble and deadwood.

The habitat within the Bedwell Brook corridor and associated with Ponds 1 and 2 is suitable for use by GCN (see Figure 4 for a map of the site showing location of suitable GCN habitat, Pond 1, Pond 2 and the Bedwell Brook within the site). Due to the close proximity and connectivity of the site to a network of breeding ponds it is highly likely that GCN could be present within any suitable terrestrial habitat in the site. A mitigation strategy is to be adopted to minimise the risk of GCNs being killed or injured as a result of the works. The strategy is to include:

- Installation of temporary exclusion fencing;
- 30 day capture/exclusion programme within suitable habitat that is to be destroyed;

- Supervised works and hand dismantlement of refuges;
- Habitat creation – refugia to be created within Bedwell Brook corridor and adjacent to Ponds 1 and 2.

In order for these works to be carried out an EPS licence must be applied for and granted by NRW.

There is no alternative to carrying out the proposed remediation works. The remediation scheme has been subject to rigorous optioneering to ensure that the most appropriate remediation actions / techniques are employed. This process incorporated consideration of protected species requirements alongside protection of other statutorily protected receptor groups based on the information provided in the previous ecological reports (Evolution Ecology, 2013 and 2014). If the remediation scheme does not proceed, the identified pollutant linkages associated with the past industrial use of the site will continue to impact site users and local controlled water receptors (and their inhabitants).

1.4 Disclaimer

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2. SURVEY AND SITE ASSESSMENT

2.1 Site Description

The Preliminary Ecological Appraisal report, by Evolution Ecology, 2013, Appendix B, should be referred to for a full site description including a Phase 1 Habitat map of the site.

In summary, Evolution Ecology concluded that the vast majority of the Maelor Works site is of minimal use to GCN, as it predominantly consists of buildings and hard standing. However, a number of scattered habitats were seen to provide some potential foraging, commuting, breeding and hibernation sites for GCN, including semi-natural broad-leaved woodland, dense/continuous scrub, poor semi-improved rough grassland and two standing water bodies.

The standing water body located in the northern part of the site (Pond 1, Photograph 1, Appendix D) will not be directly affected by the proposed works although the water main replacement works will go through suitable habitat in the vicinity of the pond. The second pond situated in the southern part of the site (Pond 2, Photograph 2, Appendix D) will be drained to remove contaminated sediment. On completion of these works it is proposed that the pond will be refilled and enhanced (removal of overhanging trees, to increase the daylight), which should ultimately improve this habitat for GCNs.

In addition to the two ponds located on site, there is a network of ponds surrounding the site many of which are known to support breeding populations of GCN as described within Section 2.3 and shown on Figure 2.

The Bedwell Brook, diverts from the River Clywedog and runs through a wooded area to the south-west of the site (Photograph 3, Appendix D). The area surrounding the watercourse provides good terrestrial habitat for GCN with fallen deadwood and debris providing suitable refugia and foraging habitat. The watercourse is to be excavated to remove contaminated sediment. This work will include removal of a 5m wide strip of vegetation either side of the watercourse.

2.2 Existing Information on Great Crested Newts at the Survey Site

For the full GCN survey results, refer to the Evolution Ecology reports in Appendix B and Appendix C of this report. Summarised below are the results of the surveys carried out to date at the site and additional information on GCN within the surrounding area, obtained from the Wrexham Borough Council ecologist.

2.3 Desk Study

Great crested newt records

A desk study completed by Evolution Ecology prior to field work completed in 2013 and 2014 found one record of GCN within 270m of the site.

Further to these desk study results, on 22.01.15, the Wrexham Borough Council ecologist provided a map of GCN records held by NRW. This map indicates that there are 16 known breeding ponds within 500m of the site, with the closest pond situated within 60m of the south-east boundary. There are two potential terrestrial records to the north-east of the site, one of which is within 25m of the site boundary. Within 2km of the site there are records of a further 32 breeding ponds. See Figure 2 for a map of the site boundary showing GCN records within 500m of the site.

Statutory Sites Notified for Great Crested Newts within 10km

There are no designated sites within 2km of the site. The River Dee and Bala Lake SSSI and SAC is located within 3.6km east of the site and the Sontley Marsh SSSI is located 4.1km west of the site. Neither sites are notified for GCN presence.

2.4 Field Survey Results

Habitat Suitability Assessment

Two waterbodies within the site were assessed by Evolution Ecology using the Habitat Suitability Index (Oldham *et al*, 2000). Pond 1, located in the northern part of the site is a small pond assessed as having an HSI score of 0.45 indicating 'poor suitability' for use by GCN. Pond 2, located in the southern part of the site was assessed as having an HSI score of 0.64 indicating 'average suitability' for use by GCN.

Field Survey Results

A presence/absence survey of Pond 2 was completed during May 2014. In summary, although palmate newts (*Lissotriton helveticus*) and smooth newts (*Lissotriton vulgaris*) were found to be present within the pond, no evidence of GCN presence was found during the survey period. Pond 1 was not surveyed during this time.

2.5 Evaluation of Survey Results

The results to date indicate that GCN were not present within Pond 2 at the time of the surveys carried out by Evolution Ecology in 2014. The survey was carried out at an appropriate time of year, under suitable weather conditions. No surveys of ponds outwith the site or Pond 1 were carried out, however, the records obtained from the county ecologist have confirmed there are numerous GCN breeding ponds surrounding the site.

Surveys of suitable terrestrial habitat within the site were not completed. Due to the connectivity of the site through suitable terrestrial habitat (woodland corridors, hedgerows and rough grassland) to known GCN breeding ponds, presence of GCN within areas of suitable terrestrial habitat in the site cannot be ruled out.

In order for works to proceed at the site, a mitigation and compensation strategy is to be devised that takes into account the high likelihood that GCN are present within the site to minimise the risk of GCN being killed or injured during works.

3. IMPACT ASSESSMENT

3.1 Short-term Impacts: Disturbance

The installation of artificial lighting, general site clearance works and initial ground investigation works adjacent to suitable terrestrial habitat within the site may cause temporary disturbance to any GCN present in these areas – **Low Impact at a population and individual level.**

3.2 Short-term Impacts: Killing or Injury to Individual GCN

Works within suitable terrestrial habitat including: excavation and removal of ground vegetation, general site clearance works and creation of access tracks, may result in the killing or injury of individual GCN without the appropriate mitigation strategy being in place – **High Impact at a population and individual level.**

3.3 Long-term Impacts: Site Loss and Modification

The excavation of contaminated soil and sediment from Pond 2 and Bedwell Brook corridor, and revegetation along the brook corridor will remove suitable terrestrial and aquatic habitat from the site. The aquatic habitats will be temporarily lost and subject to high levels of disturbance. On completion of works the pond and brook will be reinstated – **Medium Impact**

The replacement of the water mains to the north of the site will include the excavation of a trench past the water body in that location. There will be no alteration to the water body itself but suitable foraging habitat in the vicinity will be temporarily disturbed – **Low Impact**

The works will result in the small scale temporary loss of suitable terrestrial habitat situated between 50m and 250m from the nearest breeding pond. There is suitable terrestrial habitat outwith the site, closer to the breeding ponds which will be available to GCN during and post works – **Low Impact.**

3.4 Long-term Impacts: Fragmentation and Isolation

If GCN use the Bedwell Brook corridor to move between breeding ponds located to the south-east and west of the site this loss of habitat may cause temporary isolation due to the fragmentation of the corridor – **Medium Impact**.

3.5 Post-development Interference

The planned works include the installation of an outfall and gully pot interceptor with work area AC3. This has the potential to trap GCN if consideration is not taken within the design and installation of the gully pot - **High Impact**

3.6 Predicted Scale of Impact without Mitigation or Compensation

The predicted scale of impact of each of the above factors on species status (at within the site, 2km, 10km, county, regional and country levels) if no mitigation or compensation strategy is deployed, is summarised in Table 2 below based on the site providing '*suitable terrestrial habitat within 50 – 250m from a breeding pond(s)*' as per the mitigation guidelines (English Nature, 2001).

The mitigation guidelines note that '*the assessment relates to impacts on GCN habitats in terms of likely damage to population viability. It is not an assessment of the risk of killing or injuring individual newts. Depending on the activity there may be a high risk to individual newts depending on timing and methods deployed*' (English Nature, 2001).

Table 2: Predicted Scale of Impact without compensation or mitigation

Impact	Within Site		2km	10km	Local	County	Regional and Country
	Population	Individual GCN					
Short-term, Disturbance	Low	Low	Negligible	Negligible	Negligible	Negligible	Negligible

Impact	Within Site		2km	10km	Local	County	Regional and Country
	Population	Individual GCN					
Short-term, Killing or Injury of Individual GCN	High	High	Negligible	Negligible	Negligible	Negligible	Negligible
Long-term, site loss and modification	Medium		Negligible	Negligible	Negligible	Negligible	Negligible
Long-term, fragmentation and isolation	Medium		Negligible	Negligible	Negligible	Negligible	Negligible
Post development interference	High		None	None	None	None	None

4. MITIGATION AND COMPENSATION STRATEGY

4.1 Great Crested Newt Capture and Exclusion

The mitigation strategy focuses on three areas of the site that contain habitat suitable for use by GCN that are to be directly impacted upon by the proposed works (Figure 4):

- Mitigation Site 1 (M1) – Bedwell Brook corridor;
- Mitigation Site 2 (M2) – Pond 2; and
- Mitigation Site 3 (M3) – Pond 1.

An exclusion fence is to be installed around each mitigation site and pitfall traps and refuges are to be used within each area to remove GCN from the works area. The exclusion fence on the south boundary of M1 will be one way to allow any GCN present within the area to move south into suitable terrestrial habitat. This area of habitat to the south of M1 will be the receptor site (R1) for any GCN found during this stage. All other areas of suitable GCN habitat will be fenced off with appropriate ecological signage to ensure that no works or plant are carried out in these areas.

In addition, within M2, bottle-trapping will be used prior to draining down Pond 2 as an additional method to move any GCN (or small newt species/other amphibian species from the pond). Pond 1 will act as the receptor site (R2) for any newts encountered during this stage. The mitigation and receptor sites are shown on Figure 4.

4.1.1 Methodology - Exclusion Fencing and Trapping

See Figures 5, 6 and 7 for a plan of this mitigation strategy.

Proposed Timing of Mitigation: March/April (start time depending on weather);

- All works to be carried out by, and under the supervision of, a licensed GCN ecologist;

- Newt fencing to be installed as per Section 8.4.2 of the mitigation guidelines (English Nature, 2001) surrounding each mitigation site and also drift fencing is to be installed within Mitigation Areas M1 and M3 to further separate each area into compartments;
- A combination of pitfall traps and refuge tiles are to be placed along the newt fencing at 5m intervals (on both sides of the drift fencing);
- Traps are to be installed at a minimum density of 50 traps per hectare;
- Each area will be trapped for a minimum of 30 nights in suitable conditions (i.e. temperature >5°C), with 5 consecutive newt free nights before the survey can be complete;
- Traps will be checked each morning before 9 am;
- Mammal ladders will be provided in each trap to allow a means of escape and some form of shelter (e.g. a piece of bark or vegetation) will also be provided for any GCN that are trapped;
- All GCN caught will be logged noting sex and age class and moved into R1; and
- Fencing will be monitored for the duration of works and repairs made immediately to prevent the exclusion zones being breached.

4.1.2 Methodology - Bottle Trapping

See Figure 6 for plan of this mitigation strategy

Proposed Timing of Mitigation: March/April;

- All works to be carried out by and under the supervision of a licenced GCN ecologist;
- Bottle traps to be installed within Pond 2 at intervals of approximately 2m around the pond;

- 30 trapping nights (note this is a reduced survey effort to the bottle trapping effort recommended within GCN translocation guidelines (e.g. 90 days) as GCN were not recorded within pond during the 2014 surveys) to be completed in conjunction with the trapping of the terrestrial habitat within M2; and
- On completion of the trapping programme in M2 the pond is to be drained down as follows:
 - A fine mesh (<1.5mm) is to be fitted over the end of the over pump;
 - A small trench should be dug and water drained from this point to avoid draining directly from the pond; and
 - The Site Ecologist/EcoW will search through plants, debris and silt as the water level drops. Any GCN found will be moved to the receptor site at Pond 1.

4.1.3 Methodology - Destructive Search of Suitable Habitat

On completion of the above trapping methods the Site Ecologist/EcoW will also carry out a destructive search of each mitigation site ahead of works. A fingertip search of all suitable vegetation and hand dismantlement of any suitable refugia will be carried out.

The Site Ecologist/EcoW will also ensure that all areas of the site, including those deemed to be of low potential for use by GCN are confirmed to be clear of GCN prior to works.

Any GCN encountered will be moved to the receptors sites R1 and R2 as appropriate.

4.2 Great Crested Newt Habitat Compensation

Receptor site modification, creation or enhancement

Receptor site 1, located to the south-east of the site adjacent to M1 is the existing woodland corridor that runs along the south side of the Bedwell Brook. This habitat should provide suitable refugia in the form of tree roots, mammal burrows and fallen deadwood. The terrestrial habitat within R1 will be also enhanced through the construction of suitable refugia piles prior to works commencing. In addition, it is recommended that habitat piles be created within R1 during the de-vegetation works in the brook corridor.

Temporary loss and destruction of breeding sites, resting places

Pond 2 will be temporarily lost during the decontamination works. Surveys completed during 2014 found no evidence of GCN within the pond and therefore this pond is not a confirmed breeding site and direct compensation is not required. Pond 1 has been identified as a suitable receptor site in the unlikely event that GCN are found within Pond 2. It will also be used for small newt or other amphibian species found during the drainage works at Pond 2.

Suitable terrestrial habitat is to be temporarily lost through remediation works to the brook corridor, Pond 2 and the water main installation works. The Site Ecologist/EcoW will consult with the site manager to ensure that the loss of suitable terrestrial habitat is minimised.

Habitat Restoration and Enhancement

The remediation works within the Bedwell Brook corridor and Pond 2, and the installation of the water main past Pond 1 will result in a loss of an area of suitable terrestrial habitat. On completion of the remediation works, the habitat corridors will be restored and enhanced under the supervision and advice of the Site Ecologist/EcoW. The following are a list of potential actions and may be adapted as necessary to suit the site conditions:

- Clearance of shading tree or scrub cover around Pond 2;
- Planting of suitable aquatic plants within Pond 2;

- Enhancing aquatic planting in Pond 1;
- Planting of suitable terrestrial plant species within areas where loss of terrestrial habitat has fragmented potential dispersal corridors (along Bedwell Brook and connecting Pond 1 with suitable habitat to the west);
- Creating refuges and habitat piles within the restored areas of habitat at Bedwell Brook, around Pond 2 and along the route of the water main; and
- Desilting and leaf clearance of Pond 1 to improve habitat for GCN.

4.3 Biosecurity

Throughout works Biosecurity measures will be taken to avoid the spread or introduction of disease or non-invasive species within the site. The ARG-UK guidelines for UK fieldworkers (ARG, 2008) to prevent the spread of amphibian disease should be incorporated within site risk assessments prior to any works that may impact upon GCN or their habitats.

4.4 Predicted Scale of Impact with Mitigation and Compensation Strategy

The predicted scale of impact if the mitigation and compensation strategy as outlined above and within Section 5, Species Protection Plan, is implemented, is summarised in the Table 3 below.

Table 3: Predicted Scale of Impact with appropriate mitigation and compensation strategy

Impact	Within Site		2km	10km	Local	County	Regional and Country
	Population	Individual GCN					
Short-term, Disturbance	Low	Low	Negligible	Negligible	Negligible	Negligible	Negligible
Short-term, Killing or Injury of Individual GCN	Low	Low	Negligible	Negligible	Negligible	Negligible	Negligible

Impact	Within Site		2km	10km	Local	County	Regional and Country
	Population	Individual GCN					
Long-term, site loss and modification	Negligible		Negligible	Negligible	Negligible	Negligible	Negligible
Long-term, fragmentation and isolation	Negligible		Negligible	Negligible	Negligible	Negligible	Negligible
Post development interference	Negligible		None	None	None	None	None

5. SPECIES PROTECTION PLAN

5.1 Overview

Table 4 below provides a detailed Species Protection Plan (SPP) to ensure the delivery of the mitigation and compensation measures outlined within this report. This SPP should be copied to the site owner, contractors, sub-contractors, and all other persons whose work or presence on site may affect GCN.

Table 4: Species Protection Plan

EPS Licence Application to the Natural Resources Wales (NRW): There is high potential for GCN to be present within suitable terrestrial habitats within the site. The Wrexham County Ecologist and Natural Resources Wales (NRW) have advised that a European Protected Species (EPS) Licence for GCN must be applied for and granted prior to works commencing at the site. This Method Statement and Species Protection Plan has been produced in support of the licence application. No alteration to suitable terrestrial or aquatic habitat within the site should be made without a licence being in place. This Method Statement and Species Protection Plan forms part of the licence application and the mitigation and/or compensation described within must be complied with.			
Action Point	Method/Description Of Action	Date	Owner
AP1	EPS Licence for GCN European Protected Species (EPS) Licence for GCN must be applied for and granted prior to works commencing within suitable terrestrial and aquatic habitat within the site.	Prior to works commencing within suitable terrestrial and aquatic habitat	NRW IKM IHB
AP2	Ecological Clerk of Works (ECoW) An ECoW is to be appointed to ensure the conditions of the GCN licence and accompanying MS and SPP are adhered to. The ECoW will be responsible for carrying out the mitigation strategy outlined within this Method Statement.	Prior to works commencing on site	IKM IHB
AP3	Site Meeting A site meeting between IHB and IKM (including the ECoW) should be carried out to discuss the issues relating to GCN within the site, implementation of the mitigation and compensation strategy and the conditions of the MS/SPP and EPS licence that must be adhered to. <i>This meeting will also identify areas of the site that have no potential for GCN presence and can be worked within without the requirement for a GCN licence.</i>	Prior to works commencing on site	IKM IHB

Action Point	Method/Description Of Action	Date	Owner
AP4	Toolbox Talks All contractors working on the site must be given a Toolbox Talk (delivered by the ECoW) prior to works starting on the site to discuss the issues relating to GCN within the site, implementation of the mitigation and compensation strategy and the conditions of the MS/SPP and EPS licence that must be adhered to. <i>This meeting will also identify areas of the site that have no potential for GCN presence and can be worked within without the requirement for a GCN licence.</i>	Prior to works commencing on site and ongoing as required for new contractors.	IKM IHB Contr
AP5	Appointment of Contractor for Exclusion Fencing and Pitfall Trap Installation (including site meeting with ECoW) A contractor should be appointed for the installation of the areas of exclusion fencing and pitfall traps outlined in Section 4.1 and AP7/AP8 below.	Prior to 1 st March 2015	IHB, IKM
AP6	Receptor Sites R1 (south-east of M1) and R2 (Pond 1) The receptor sites will be clearly demarcated. Prior to AP6 additional refugia piles will be installed using piles of logs or large stones. All works to be carried out by and/or under the supervision of the ECoW or named Agent on the GCN licence.	Prior to AP7	IKM
AP7	Mitigation Areas M1, M2 and M3 - Installation of Exclusion fencing and Pitfall Traps Areas of suitable habitat to be ring fenced and trapped out as per Section 4.1 of this Method Statement. (Note the required extent of the exclusion fencing at each mitigation area is to be ground proofed by the ECoW and adapted as required to encompass all areas of suitable GCN habitat that will be impacted upon (e.g. the work area and access track). All works to be carried out by and/or under the supervision of the ECoW or named Agent on the GCN licence.	1 st March 2015 onwards on completion of AP1 – AP5	IKM Contr
AP8	Mitigation Area M2 – Bottle trapping of Pond 2 Pond to be bottle trapped as per Section 4.1 of this Method Statement. All works to be carried out by and/or under the supervision of the EcoW or named Agent on the GCN licence.	1 st March 2015 onwards on completion of AP1	IKM

Action Point	Method/Description Of Action	Date	Owner
AP9	Mitigation Areas M1, M2 and M3 – Destructive Search The EcoW will carry out a destructive search of each mitigation site ahead of works. A fingertip search of all suitable vegetation and hand dismantlement of any suitable refugia will be completed. Any GCN encountered will be moved into an appropriate receptor site.	On completion of AP7 and AP8 and immediately prior to works within each mitigation area.	IKM
AP10	Restoration and Enhancement of the Bedwell Brook and Pond 2 The EcoW will advise on the restoration and enhancement of these habitats on completion of the remediation works. This may include the creation of suitable refugia habitat along the water course and planting of suitable GCN habitat within the pond.	On completion of remediation works within M1 and M2.	IKM IHB
AP11	Gully pot installation, Work Area AC3 The ECoW is to be consulted prior to the installation of the gully pot interceptor at the outfall to ensure appropriate mitigation is in place to prevent GCN accessing this feature.	During works in work area AC3	IKM IHB
AP12	Removal of Exclusion Fencing and Pitfall Traps All mitigation material to be removed on completion of works. All voids to be infilled to avoid inadvertent trapping of GCN. Works should be overseen by ECoW.	On completion of all remediation works within the site.	IKM IHB Contr
AP13	Otter – Survey and Compensation The ECoW is to carry out further survey of the Bedwell Brook corridor 200m upstream and downstream of the site to determine presence of otter resting sites that may be impacted upon by the proposed works. Artificial resting site On completion of works within the Bedwell Brook corridor an artificial resting site is to be installed, in consultation with the ECoW, to compensate for the loss of suitable resting site locations within the habitat removed at this location.	Survey On appointment of ECoW Artificial resting site On completion of works within the Bedwell Brook	IKM IHB Contr

Action Point	Method/Description Of Action	Date	Owner
AP14	Biosecurity Works should proceed as per the 'ARG-UK Advice Note 4: Amphibian Disease precautions: a guide for UK fieldworkers' (ARG, 2008) to prevent the spread of non-native species and disease onto or off the site.	Duration of Works	IKM IHB Contr
Abbreviations: IHB – I&H Brown Ltd IKM – IKM Consulting Ltd NRW – Natural Resources Wales Contr – Contractors involved in works			

6. REFERENCES

ARG-UK (2008). Advice Note 4: Amphibian Disease precautions: a guide for UK fieldworkers. Amphibian and Reptile Group (UK).

Evolution Ecology Ltd (2014). Protected Species Survey Report, Maelor Works, Wrexham. Evolution Ecology Ltd.

Evolution Ecology Ltd (2013). Preliminary Ecological Appraisal Report (Extended Phase 1 Habitat Survey Report), Maelor Works, Wrexham. Evolution Ecology Ltd.

English Nature (2001). Great Crested Newt Mitigation Guidelines. English Nature.

IKM (2014). Risk Assessment and Remediation Design Report. IKM Consulting Ltd.

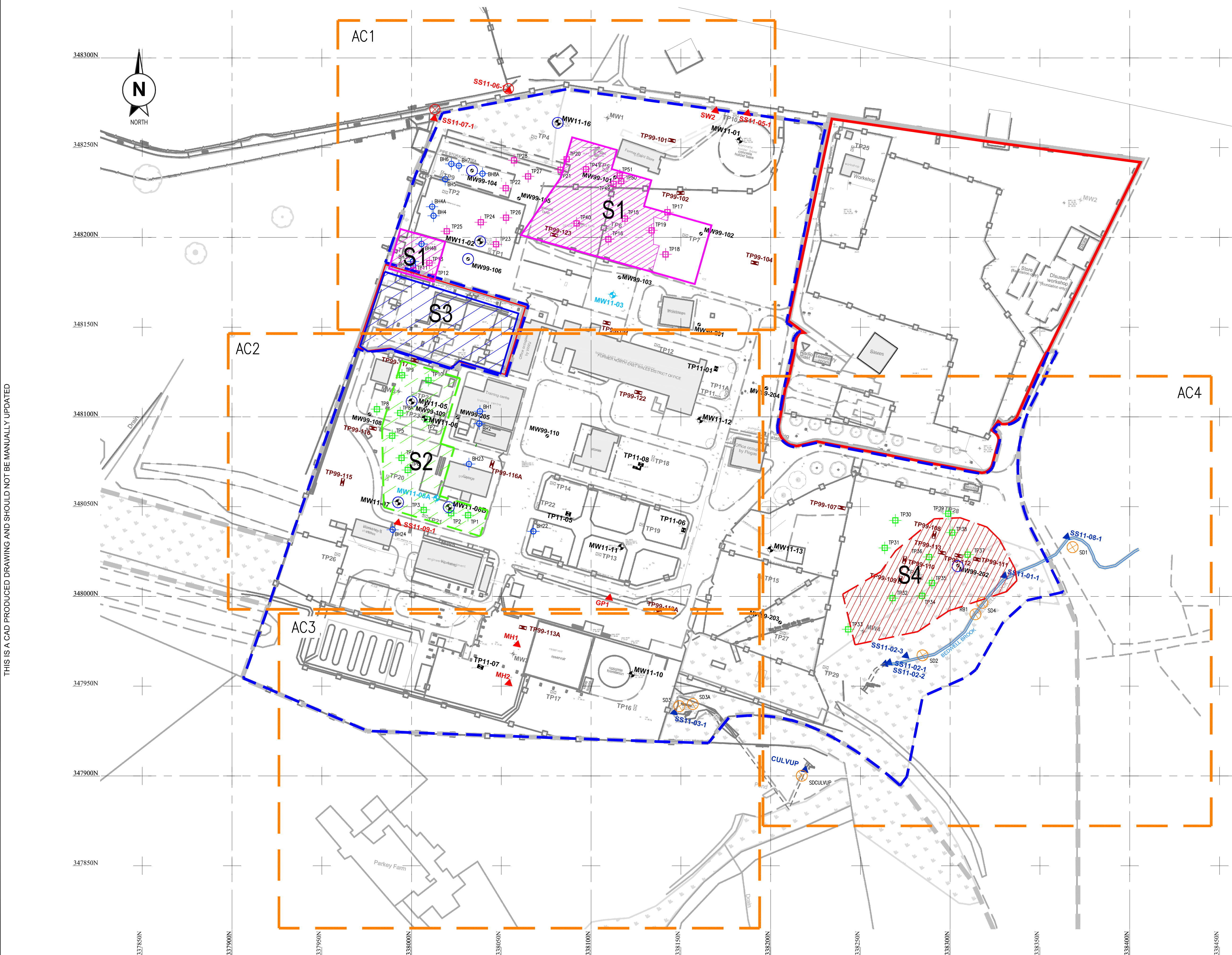
Oldham, R. S., Keeble, J., Swan, M. J. S. & Jeffcote, M. (2000). Evaluating the suitability of habitat for the Great Crested Newt (*Triturus cristatus*). Herpetological Journal 10(4), 143 -155

FIGURES

Figure 1
Site Plan (Drawing Ref: A1-13627-3050-0)

THIS IS A CAD PRODUCED DRAWING AND SHOULD NOT BE MANUALLY UPDATED

A1



EXTERNAL REFERENCES: BELOW IS A LIST OF EXTERNALLY REFERENCED DRAWINGS REQUIRED TO VIEW AND PLOT THIS DRAWING.
O:\PROJECTS\.....DWG

GENERAL NOTES:

1. THIS DRAWING MUST BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS
2. IT IS THE CONTRACTORS RESPONSIBILITY TO CHECK AND VERIFY ALL DIMENSIONS ON SITE. ANY DISCREPANCIES TO BE REPORTED TO THE ENGINEER IMMEDIATELY.
3. IT IS THE CONTRACTORS RESPONSIBILITY TO ENSURE FULL COMPLIANCE WITH THE BUILDING REGULATIONS
4. DO NOT SCALE FROM THIS DRAWING, USE FIGURED DIMENSIONS AND SETTING OUT DETAILS FROM THE ARCHITECT
5. ALL DIMENSIONS ARE IN MILLIMETERS

LEGEND:

- NATIONAL GRID PROPERTY HOLDINGS LTD BOUNDARY
- WALES & WEST UTILITIES BOUNDARIES
- CURRENT STRUCTURES
- FENCELINE

WORKLEY PARSONS

SITE INVESTIGATION LOCATIONS 2011:

- TP11-01 TRIAL PITS
- MW11-01 MONITORING WELL LOCATION
- MW11-03 SHALLOW SAMPLE FROM VACUUM EXCAVATION (MONITORING WELL NOT INSTALLED)
- SW11-01 DRAINAGE SAMPLE LOCATION (APPROX.)

FORMER SITE INVESTIGATION LOCATIONS:

- TP99-106 KOMEX TRIAL PIT (1999)
- MW99-204 KOMEX MONITORING WELL (1999)
- MW2 KOMEX MONITORING WELL (1995)
- TP2 KOMEX TRIAL PIT (1995)

IKM SITE INVESTIGATION LOCATIONS 2013:

- GROUND WATER SAMPLING EXISTING WELL
- NORTHERN DISCHARGE SURFACE WATER SAMPLING
- SEDIMENT SAMPLING
- SPENT OXIDE "LOOK-SEE" TRIAL PITS
- TRIAL PITS
- BOREHOLES
- SURFACE WATER / STREAM OUTFALL SAMPLING
- DRAINAGE WATER SAMPLING / INSPECTION

SOURCES:

- S1 = SPENT OXIDE
- S2 = FREE PHASE TAR & HYDROCARBON IMPACTED SOILS.
- S3 = AMMONIA & CYANIDE IMPACTED SOILS, WITH GROUNDWATER PLUME.
- S4 = END TIPPED DEBRIS OF FILL & TAR.

RESIDUAL RISK REGISTER

IN ADDITION TO THE HAZARDS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, PLEASE NOTE THE FOLLOWING :

IDENTIFIED RISK / HAZARD	DESCRIPTION
-	-
IDENTIFIED RISK / HAZARD	DESCRIPTION
-	-

IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT PERSON WORKING, TO AN APPROVED SAFE SYSTEM OF WORK

STATUS

FOR INFORMATION

0	11.03.14	CR	JF	ISSUED FOR INFORMATION
REV	DATE	BY	CHKD	DESCRIPTION



CLIENT I & H BROWN

PROJECT MAELOR WORKS WREXHAM

DRAWING CONCEPTUAL SITE MODEL

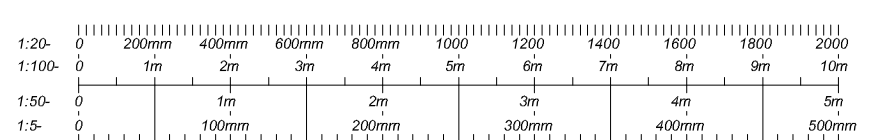
DRAWING No.

A1-13627-3050

REV

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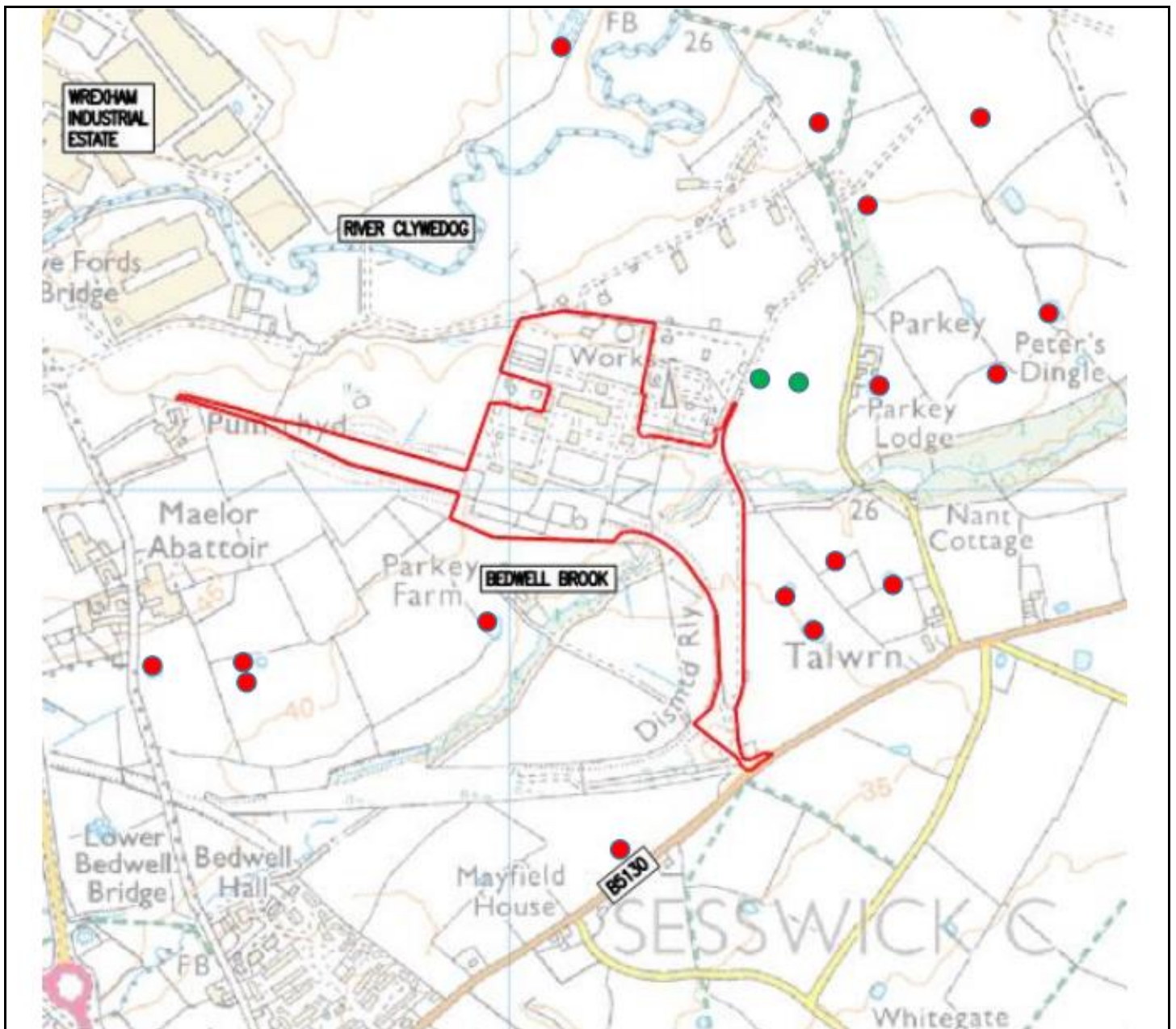
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CONCEPTUAL SITE MODEL

SCALE 1:1000

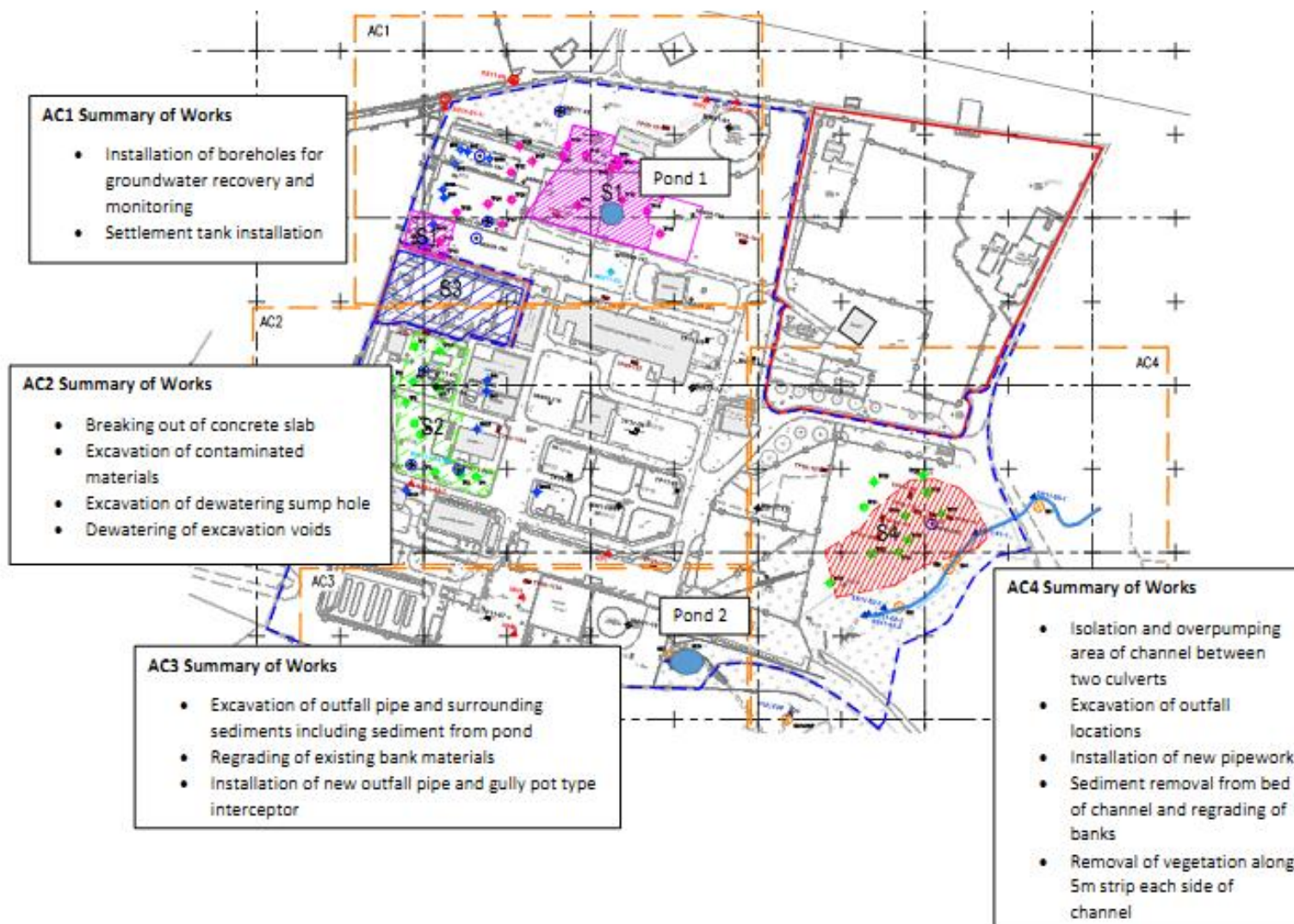
Figure 2
GCN Record Map



- = Breeding Pond
- = Potential terrestrial record
- = Site Boundary

	CLIENT:		I&H Brown	
	PROJECT:		National Grid Wrexham Gasworks	
	TITLE:		GCN Record Map	
	DRAWING No:		Figure 2	
	JOB No:	13627	SCALE:	N.T.S

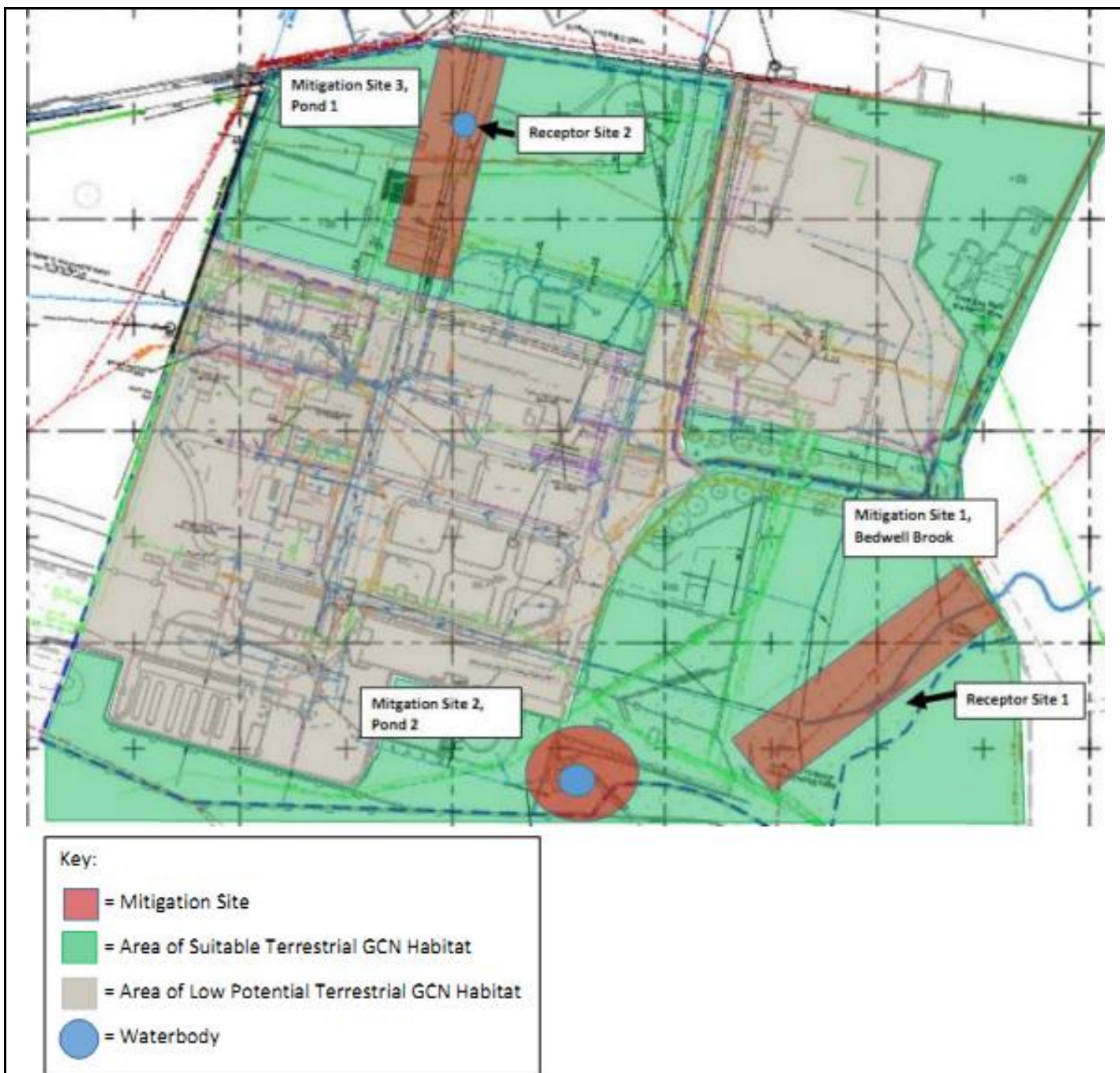
Figure 3
Overview of Proposed Remediation Works



CLIENT:	I&H Brown	TITLE:	Proposed Remediation Works
PROJECT:	National Grid Wrexham Works	DRAWING No:	Figure 3
JOB No:	13627	SCALE:	N.T.S

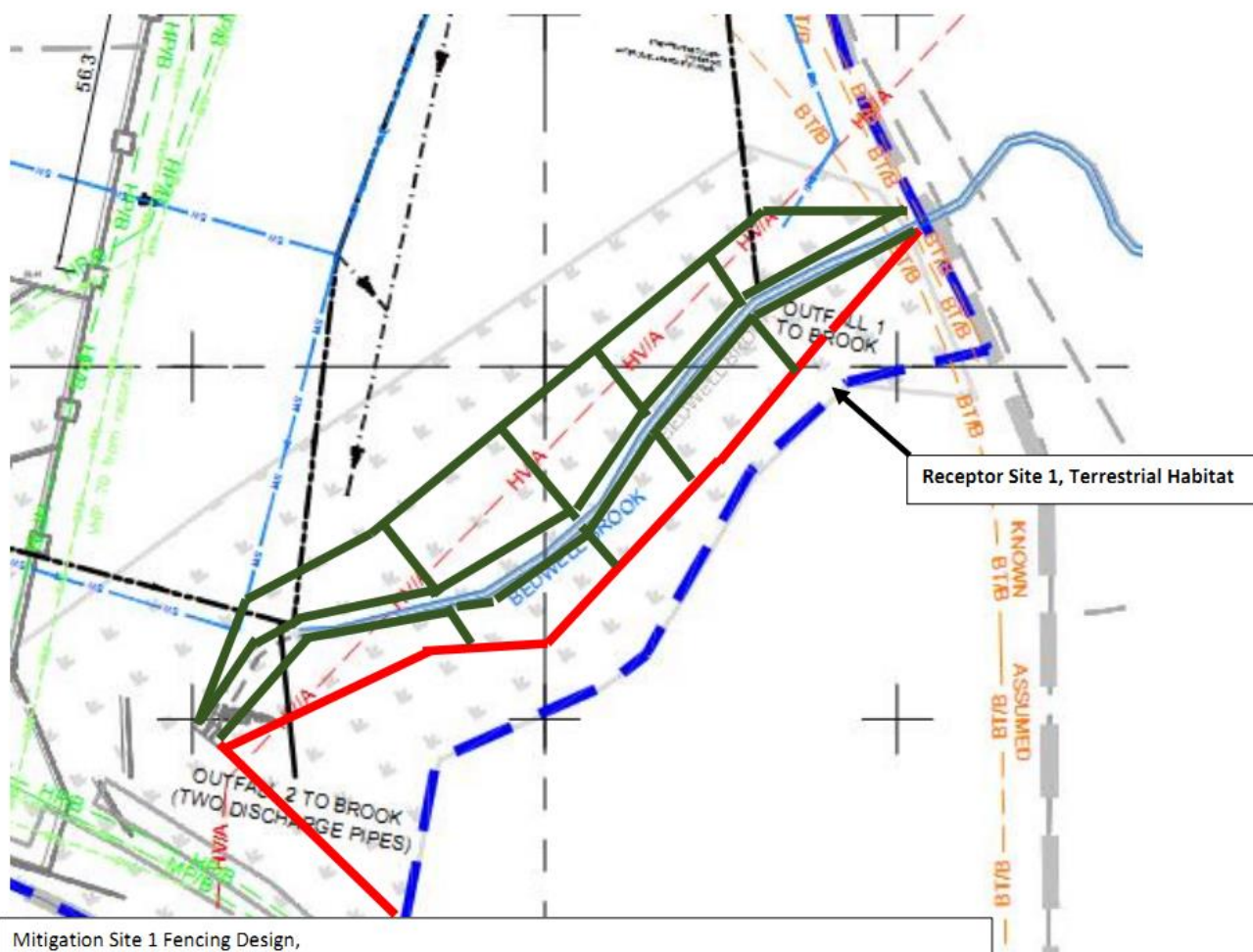
O:\Projects\13627 - I&H Brown -National Grid Wrexham Gasworks\04. Reports\GCN\Proposed Remediation Works.doc

Figure 4
Overview of Mitigation Sites



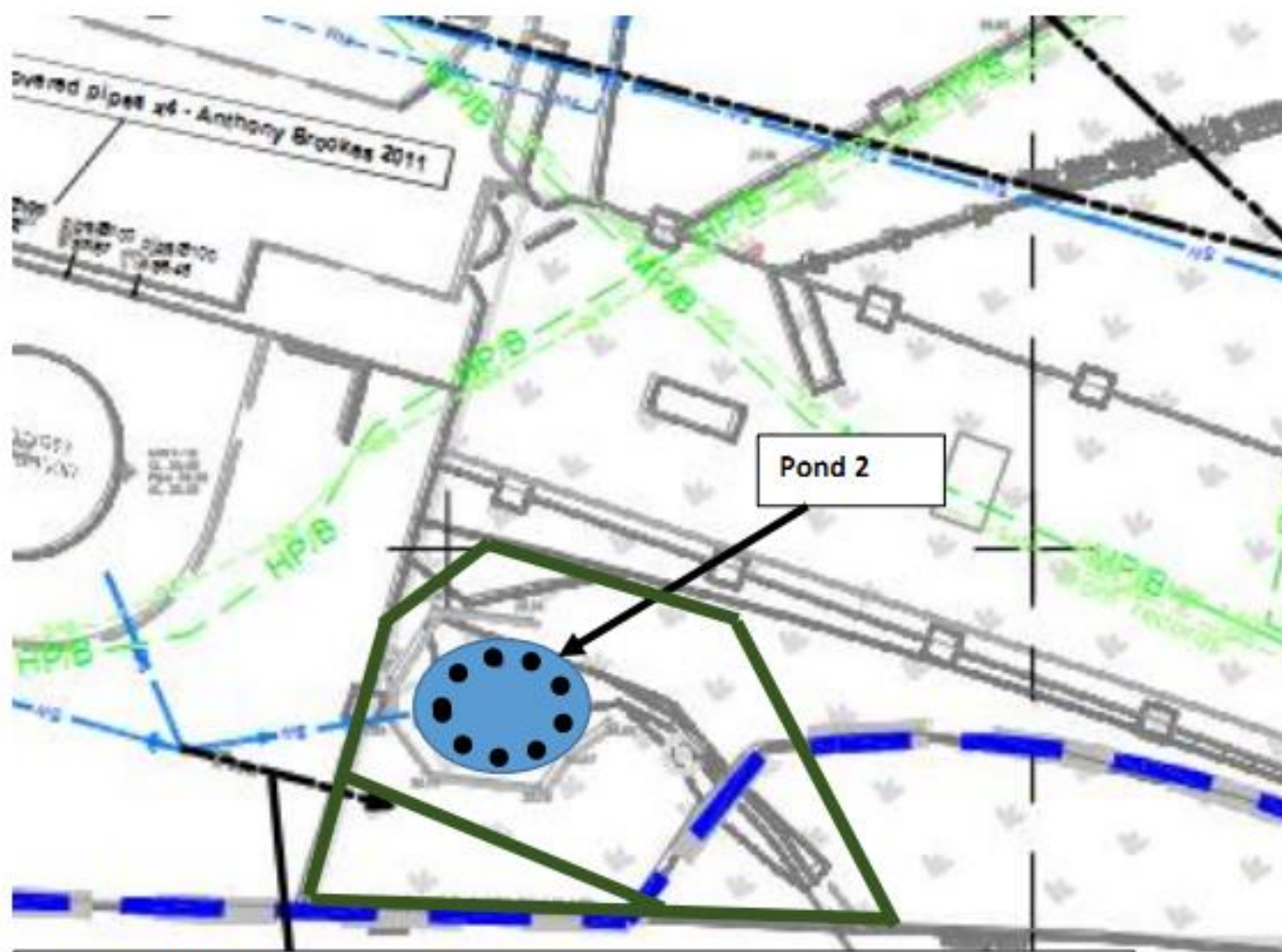
	CLIENT:		I&H Brown	
	PROJECT:		National Grid Wrexham Works	
	TITLE:		Overview of Mitigation Sites	
	DRAWING No:		Figure 4	
	JOB No:		13627	SCALE: N.T.S

Figure 5
Detailed Map Mitigation Site 1



CLIENT:	I&H Brown		
PROJECT:	National Grid Wrexham Works		
TITLE:	Mitigation Site 1		
DRAWING No:	Figure 5		
JOB No:	13627	SCALE:	N.T.S

Figure 6
Detailed Map Mitigation Site 2



Mitigation Site 2 Fencing Design,

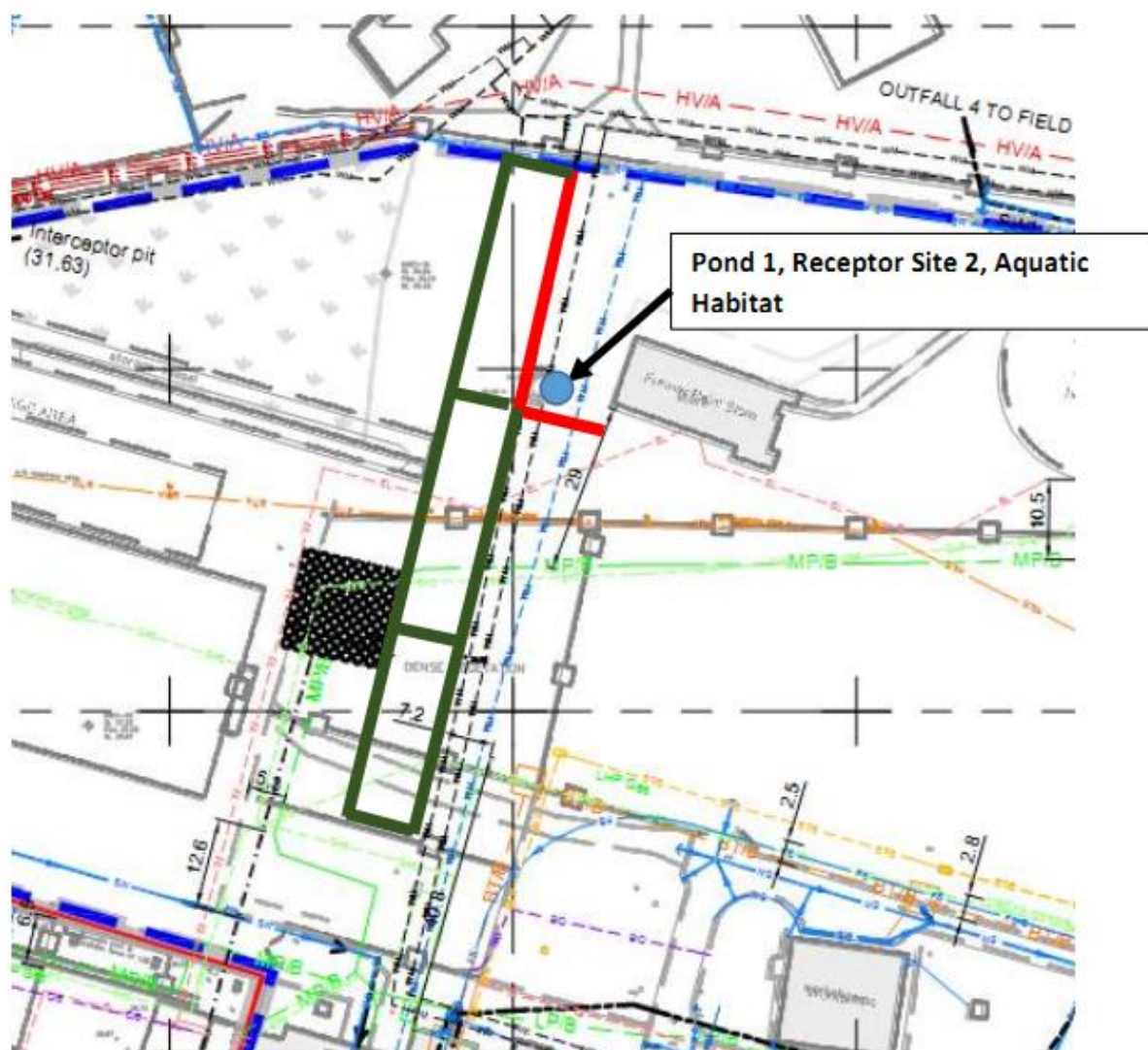
— : Newt fencing with combination of pitfall traps and refugia mats to be installed at 5m intervals along interior of exclusion fence.

• • • • : Bottle traps to be installed at 2m intervals around pond



CLIENT:	I&H Brown		
PROJECT:	National Grid Wrexham Works		
TITLE:	Mitigation Site 2		
DRAWING No:	Figure 6		
JOB No:	13627	SCALE:	N.T.S

Figure 7
Detailed Map Mitigation Site 3



Mitigation Site 3 Fencing Design

Green line : Newt fencing with combination of pitfall traps and refugia mats to be installed at 5m intervals (on both sides of drift fencing within exclusion, and on interior of perimeter fence).

Red line : One-way newt fencing to allow movement into Receptor Site 2



CLIENT:	I&H Brown		
PROJECT:	National Grid Wrexham Works		
TITLE:	Mitigation Site 3		
DRAWING No:	Figure 7		
JOB No:	13627	SCALE:	N.T.S

APPENDICES

Appendix A
Risk Assessment and Remediation Design Report
(IKM Consulting 2014)



Ref: 13627

I & H BROWN

MAELOR WORKS, WREXHAM (SITE CODE 138S)

RISK ASSESSMENT AND REMEDIATION DESIGN REPORT

13627-REP-005

September 2014

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Revision History

Revision History

[illegible]

I & H BROWN

MAELOR WORKS, WREXHAM (SITE CODE 138S)

RISK ASSESSMENT AND REMEDIATION DESIGN REPORT

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APPENDICES

Appendix A CLEA Input / Output Information

Appendix B Screened Compiled Site Data

Appendix C Aurora Radioactivity Survey and Monitoring Report

Appendix D Remedial Targets Modelling Output

Appendix E Remediation Volumes Breakdown

Appendix F HBR Limited Treatment Trials Report

Appendix G Geo2 Limited Pumping Trial Report

Appendix H Summary of Chemical Properties used in RTM

File name: 13627-REP-005

Version: v4

Prepared By:	David Cooke/ Jeremy Fox	Date:	2 September 2014	Initials:
Checked By:	Liz Copland	Date:	2 September 2014	Initials:

1. INTRODUCTION

IKM Consulting Limited has been commissioned by I&H Brown Limited (IHB) to act as their designers for the Maelor Works, Wrexham Gasworks Remediation Project. As part of their project brief, IKM has undertaken an initial site assessment and outline remediation design (as part of the original project tender submission), followed by supplementary site investigations and detailed remediation design work. In conjunction with these works, laboratory trials and specialist treatment design work has been conducted by HBR Limited and Geo2 Limited.

This report presents a continuation of the initial tender submission document, refined and expanded on the basis of the supplementary investigations and data assessment, which has been reported separately (IKM 2014 REP002 – Areas A and C Factual Report and IKM 2014 REP003 and REP004 – Areas B East and West Factual Reports – Ref 1, 2 and 3, respectively). The information contained in this report will be used to produce the detailed site remediation methodology and procedure documentation, and Stage 2 costings for the project.

This version of the report has been prepared in advance of the finalisation of the site treatment designs by the specialist solidification/stabilisation contractor, HBR Limited, and the groundwater recovery / treatment contractor, Geo2 Limited. Treatment details and specific permit applications are therefore subject to future detail revision and refinement prior to any site works commencement.

1.1 Objectives

The objectives of this Risk Assessment and Remediation Strategy Report are to:

- Provide a context and setting for the contamination issues affecting the site.
- Detail the site risk assessments from which remedial requirements have been derived.
- Set out the remediation requirements arising from the detailed assessment of risks associated with identified site contamination.

- Identify practical and effective remediation techniques to address identified remediation requirements and to provide a site with no significant residual pollutant linkages, based on the existing land uses in different parts of the site:
 - Area AC - ongoing commercial offices and gas storage / distribution and open storage use.
 - Area B East and West – non-arable agricultural land, including woodland and scrub, used for informal grazing (potentially including food animals).
- Describe the site works and associated management, monitoring and verification works necessary to meet the stated objectives.

1.1 Project Contact List

Client	National Grid Property Holdings Ltd National Grid House Warwick Technology Park Gallows Hill Warwick CV34 6DA	Contact Mobile No	Matt Pearce 07768 036925
		Embedded AOC Mobile No	Sarah Helby 0758 4496003
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		Design Co-ordinator Tel No Mobile No	James Wood 01738 637171 07917 410236
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		Lead Engineer Mobile No	Mark Sweeney 07934 396404
		Mobile No	David Cooke 07966 126240
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CDM Co-ordinator	Parsons Brinckerhoff Manchester Technology Centre Oxford Road Manchester M1 7ED United Kingdom	Contact Tel No Mobile No	TBC
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	<u>Sample Analysis (Soils and Groundwater)</u> Derwentside Environmental Testing Services Unit 2 Park Road Industrial Estate Consett Co Durham DH8 5PY	Contact Tel No	Adam Fenwick 01207 582333
	<u>Topographical Survey</u> Cheshire Surveys Ltd Unit 18 Barrowmore Enterprise Estate Barnhouse Lane Chester Cheshire CH3 7JS	Contact Tel No	Martin Crank 01829 741859
	<u>Drilling/Trial Pits</u> Rotary Test Drilling Marshes Farm Coach Road West Houghton Bolton BL5 2BT	Contact Tel No	R T Dainton 01942 810348
	<u>Radiological Survey</u> Aurora Health Physics Services Ltd 3 The Terrace Library Avenue Harwell Oxford Oxfordshire OX11 0SG	Contact Tel No	Allan May 01235 820049

	<u>Pump Test</u> Geo2 Remediation Ltd Units 7 Ferrybridge Workspace Pontefract Road Ferrybridge WF11 8PL	Contact Tel No	Adam Wilson 01977 674113
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	<u>Ecological Survey</u> Evolution Ecology Ltd Park Hall Farm Brookhouse Road (Trimpos) Cheadle Staffordshire ST10 2NJ	Contact Mobile No	Dr. Paul Keeling 07838377612
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1.2 Disclaimer

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Any site investigation provides an assessment of the site conditions in certain locations from which conditions of the site, as a whole, are interpreted. It is not, therefore, possible to preclude the existence of on-site conditions or contamination not encountered during the site works relied upon by this report.

2. SITE

2.1 General

The site is known as Maelor Works, Marchwiel, Wrexham LL13 0UW. The centre of the site has a National Grid Reference SJ38087 48086. The site area comprises the total NGPH landholding at the Maelor Works site, with the NGPH site reference number 138S. The site has been divided into three adjoining areas by NGPH, known as Areas A, B and C. Areas A and C form the majority of the main occupied area at Maelor Works (hereafter Area AC) and Area B is split into two by that site. Area B West lies to the west of Area AC, and Area B East lies to the southeast of Area AC. Land boundaries and surrounding features are shown on Drawing A1-13627-3051.

2.2 Site Description

The site is situated in a largely rural setting, albeit that the surrounding area was formerly part of the Royal Ordnance Factory (ROF) Wrexham facility, which consisted of widely scattered manufacturing and small storage facilities in the predominantly open land to the north. The main manufacturing area for the ROF is now occupied by Wrexham Industrial Estate, approximately one kilometre to the north. A few remnant brick built buildings from the ROF lie in the fields immediately to the north of the site.

The shallow River Clywedog river valley lies immediately to the north of the site, with the river some 120m away at its closest point. The river flows west to east past the site. A second smaller watercourse, Bedwell Brook, flows towards the site from the west and passes through a culvert under the former railway line embankment, on the southern boundary of the site, before entering and flowing in a steep sided valley through the south easternmost corner of the site area.

A number of long established farms are located around the site boundary to the west, south and northeast.

The site is accessed via a private access road that leads north from the B5130 public road through Area B East, entering Area AC through the main reception gate, shared with other site users. The operational site area is completely surrounded by a boundary fence, with a number of secured access points from the surrounding third party agricultural land, including a long established un-surfaced track way that passes the northwest corner of the site and continues along the northern boundary and away to the northeast.

The remainder of the site is bounded by agricultural fences and hedgelines of variable construction and condition.

2.3 History

The site was originally open farmland that was developed into a small part of the extensive former Royal Ordnance Factory (ROF) Wrexham, the majority of which lay to the north of the site. Following closure of the ROF, Area AC was redeveloped as a large coal and ultimately oil fuelled town gas manufacturing works. Following closure of the gasworks in the 1970s, Area AC has been used for a variety of gas distribution related activities, with some new office buildings constructed over the footprint of the former gasworks. Other parts of the Main Works site have subsequently been used for the storage of containerised gas (Flogas) and portions of the site have been sold to a separate gas utility company (Wales and West Utilities). Large parts of the northern and south-eastern sectors of the site have essentially been disused since the closure of the gasworks operations.

Rail connections passing through Area B East continued to be used to supply the gasworks site, before also being dismantled sometime after the gasworks closure.

The history of the individual site areas is discussed in more detail in the Factual Reports for Area AC, Area B West and Area B East (Ref: 1, 2 and 3 respectively). Drawing No. A1-13627-3049 shows the key historical gasworks structures and current site buildings for the Main Works site area (there being no historical or current buildings in either Area B West or East).

2.4 Geology

According to published mapping, the site is underlain by substantial thicknesses of glacial drift, with bedrock at depths in excess of fifty metres below ground. Bedrock is indicated as sandstone from the Triassic Sherwood Sandstone formation, although the boundary between this rock formation and Carboniferous Coal Measures is postulated as being close by.

Previous site investigations have revealed the site area to be underlain by a variable range of clayey, silty, sandy and gravelly alluvium and ultimately by stiff, cohesive, silty clay of glacial origin (Boulder Clay). The bedrock surface is anticipated to be covered by many metres of low permeability glacial boulder clay laid down under a former ice sheet, with the boulder clay in turn draped with variable thicknesses of clays, silts and sands and gravels laid down by flowing water following the retreat of the ice sheet. The elevation of the underlying Boulder Clay surface beneath the western part of Area AC, has been interpreted from historical investigations and contours for the surface plotted, as shown in Drawing No. A1-13627-3042.

Due to the artificial nature of the site foundations, there are no natural soils or strata exposed at the site surface, apart from the Bedwell Brook channel banks and the flanks of the former railway cutting in Area B West. Made Ground deposits across the rest of the site have either been laid directly over the alluvial strata, or laid on top of re-graded alluvial deposits.

Ground conditions across the site area are described in more detail in the Factual Reports prepared from the most recent site investigations for the component parts of the site (Ref. 1, 2 and 3 respectively).

2.5 Hydrogeology

No natural soils are exposed at the site surface, but a shallow groundwater table has been developed, perched on the low permeability Boulder Clay beneath the Made Ground and granular alluvium. Groundwater level contours for the identifiable water bearing strata (Made Ground and granular alluvium) across Area AC are provided in Drawing Nos. A1-13627-3033-3035.

Groundwater movement in the shallow alluvial soils is largely controlled by local variations in permeability and recharge and the topography of the underlying low permeability Boulder Clay. A shallow groundwater high is apparent in the western central part of Area AC, in the vicinity of the former tar tank (and in an area known to be affected by leaking water mains). Groundwater flow paths are generally to the northwest and north and to the southeast and south of this point. Most of the flow occurs within a layer of sand / sand and gravel that typically lies immediately above the Boulder Clay and varies in thickness from less than 1m to over 4m across the majority of the site area. Groundwater flowing northwest from the groundwater highpoint is likely to discharge directly into a French Drain that has been installed along the western perimeter of the site, cut into the original ground, below the level of the site and typical groundwater surface levels. The granular alluvium strata are largely absent in the far north of the site, which is likely to prevent significant groundwater movement beyond the northern boundary (groundwater is sometimes observed seeping onto the ground surface in this area during wet weather).

The sand stratum does extend across the majority of the south and eastern site area, but along the north bank of the Bedwell Brook valley feature, tipped Made Ground deposits have been placed directly on the Boulder Clay surface. Shallow groundwater is thought to flow through this Made Ground deposit along the Boulder Clay interface and to discharge to the brook below the foot of the tipped slope (groundwater spring discharges are not generally visible in this area).

A degree of interaction between surface water drainage and the shallow groundwater in the granular alluvium is suspected, but has not been quantified. Surface water discharges to the Bedwell Brook are observed to persist even during periods of no rainfall.

The bedrock strata at depth beneath the site are known to form designated aquifers (classified by National Resources Wales as a Principal Aquifer), but the groundwater is effectively isolated from surface impacts by the intervening cohesive drift deposits.

The site area lies within the outer zone (Zone 2) source protection zone of a bedrock water abstraction borehole in Wrexham Industrial Estate approximately 2km to the north of the site. Up to date details are provided on the online groundwater vulnerability mapping hosted on the UK Government website: <http://maps.environment-agency.gov.uk>.

2.6 Hydrology

The site sits on a watershed between the River Clywedog to the north and Bedwell Brook to the southeast (although Bedwell Brook itself flows into the River Clywedog approximately one kilometre to the east of the site). The Clywedog sits in a broad, shallow valley that is drained by a network of mostly artificial agricultural drainage ditches and field drains, some of which are associated with the former ROF facility. Bedwell Brook is similarly fed by ditches and drains in land to the south of the site, but is a much smaller watercourse than the Clywedog. Bedwell Brook enters the site area beneath the former railway embankment in the south-eastern corner of Area AC and flows in a valley through this part of the site. The northern flank of the valley has been steepened and constrained by tipping activities within the site, but the brook appears to continue to flow in its original bed up to the culvert beneath the access road on the eastern boundary of the site.

The majority of the site area is largely flat and level and does not contain any open, flowing water courses. An extensive surface water drainage system has been installed across Area AC, presumably at the time of the original construction of the gasworks site. The majority of Area AC (excluding the far west and northwestern corner) and the northeastern WWU area, drains into three main branches, all of which ultimately discharge to the Bedwell Brook in the southeast of the site. The integrity and status of this drainage system has not been confirmed and many of the manhole entry points are not accessible without powered mechanical aids (not available to the current investigation).

The western and northwestern part of Area AC is thought to be provided with informal drainage that leads to the external network of field drains and ditches to the north of the site. A French Drain interceptor installed along the western boundary of this part of the site is also connected into this drainage network at the northwestern corner of the site. Direct drain discharges to the French Drain have not been identified and it is thought that only perched groundwater from the adjacent raised Made Ground is intercepted by this feature.

3. CONCEPTUAL SITE MODEL

3.1 Background

Based on the site context described above and the results of the additional site investigation work conducted at the site, as reported in detail in the Factual Reports for Areas A, B and C (Refs: 1, 2 and 3), a refined conceptual site model (CSM) has been produced that describes the nature of contamination sources present at the site and the potential impacts that these contamination sources may have on identified receptors, by way of the various pathways that are known to be present, or are considered likely to be present under the proposed future use of the various parts of the site area (potential pollutant linkages).

Key potential pollutant linkages previously identified at the site include:

- On-site soil contamination – entering drinking water supplies – impacting site users;
- Soil and associated perched groundwater contamination – leaching/migrating – impacting local surface water receptors; and
- Soil contamination – exposed at, or near to, the surface - impacting site users.

These key linkages have been considered, along with the site data discussed above, to produce the revised conceptual site model (CSM) for the site that has been used as the basis for the development of the detailed risk assessment and proposed remediation work described in later sections of this report.

On the basis of information reviewed, individual source – pathway – receptor terms for each part of the site are described below. The CSM linkages arising from this assessment are shown on Drawing No. A1-13627-3050.

3.2 Refinement of Existing CSM

A number of data gaps and uncertainties associated with earlier site investigation and assessment were recognised and supplementary site investigations were carried out to allow detailed qualitative risk assessment and remediation design to be made. During the site investigation, an initial assessment of contamination was made based on visual examination of soil and groundwater and the presence of hydrocarbon odours. The locations where such observations were made are listed in Table 1 below and plotted on Drawing Nos. A1-13627-3038 to 3041. This information has been incorporated into the refined CSM source – pathway – term descriptions presented in Section 3.3 to 3.5 below.

In addition to the qualitative identification of sources, quantitative assessment of chemical concentrations detected in soil and groundwater has been carried out to further refine the remediation strategy. These assessments are presented in Section 4 and Section 5.

Table 1: Visual and Odour Contamination Indicators

Location	Contamination Description
Komex Clarke Bond Investigation 1995	
MW1	Black staining
MW2	Spent oxide, black staining
MW3	HC on groundwater, Visible tar
MW4	HC odour, spent oxide, Visible tar
MW5	No visible contamination
MW6	Black Staining, HC odour
TP1	HC odour
TP2	HC odour and HC on groundwater
TP3	HC odour
TP4	No visible contamination

Location	Contamination Description
TP5	HC odour, Spent oxide
TP6	No visible contamination
TP7	Spent oxide
TP8	Spent oxide
TP9	HC odour
TP10	No visible contamination
TP11	No visible contamination
TP12	HC odour
TP13	No visible contamination
TP14	No visible contamination
TP15	HC odour
TP16	No visible contamination
TP17	No visible contamination
TP18	HC odour, spent oxide
TP19	No visible contamination
TP20	HC odour, Visible tar, HC sheen
TP21	HC odour
TP22	No visible contamination
TP23	HC odour, HC on groundwater, visible tar
TP24	HC odour
TP25	No visible contamination
TP26	No visible contamination
TP27	HC odour, spent oxide

Location	Contamination Description
TP28	No visible contamination
TP29	Spent oxide, visible tar
Komex Clarke Bond Investigation 1999	
TP99-101	No visible contamination
TP99-102	No visible contamination
TP99-103	Spent oxide, visible tar
TP99-104	No visible contamination
TP99-105	HC odour, visible tar
TP99-106	No visible contamination
TP99-107	Visible tar
TP99-108	No visible contamination
TP99-109	HC odour
TP99-110	No visible contamination
TP99-111	No visible contamination
TP99-112	No visible contamination
TP99-113	No visible contamination
TP99-113A	HC odour
TP99-115	No visible contamination
TP99-116	No visible contamination
TP99-117	HC odour
TP99-118	Black staining, HC odour
TP99-119	No visible contamination
TP99-120	No visible contamination

Location	Contamination Description
TP99-121	No visible contamination
TP99-122	No visible contamination
TP99-123	Spent oxide
MW99-101	Spent oxide, Black staining
MW99 – 102	Spent oxide
MW99-103	No visible contamination
MW99-104	Black staining, HC odour
MW99-105	Spent oxide
MW99 – 106	HC odour
MW99-107	No visible contamination
MW99-108	No visible contamination
MW99 -109	HC odour, visible tar
MW99-110	No visible contamination
MW99-201	No visible contamination
MW99-202	No visible contamination
MW99-203	No visible contamination
MW99 – 204	Black staining
MW99 – 205	Visible tar
Worley Parsons Investigation 2011	
MW11-01	No visible contamination
MW11-02	No visible contamination
MW11-03	No visible contamination
MW11-04	No visible contamination

Location	Contamination Description
MW11-05	HC odour
MW11-06	No visible contamination
MW11-07	Black staining, HC odour
MW11-08A	HC odour
MW11- 08B	Black staining, HC odour, HC on groundwater
MW11-10	No visible contamination
MW11-12	No visible contamination
MW11-13	No visible contamination
MW11-14	No visible contamination
MW11-15	No visible contamination
MW11-16	No visible contamination
TP11-01	No visible contamination
TP11-02	No visible contamination
TP11-03	No visible contamination
TP11-04	No visible contamination
TP11-05	No visible contamination
TP11-06A	No visible contamination
TP11-06B	No visible contamination
TP11-07	HC Odour
TP11-08	HC Odour
IKM Investigation 2013	
HP13-48	No visible contamination
13-01	Visible tar, HC odour, HC sheen on water

Location	Contamination Description
13-02	HC sheen on water, HC odour
13-03	Blue spacers, HC sheen on water, HC odour
13-04	HC sheen on water
13-05	HC odour
13-06	HC sheen on water
13-07	Visible tar, HC odour, HC sheen on water
13-08	HC odour
13-08A	HC odour
13-09	HC odour
13-10	HC odour, HC sheen on water
13-11	No visible contamination
13-12	No visible contamination
13-13	No visible contamination
13-15	No visible contamination
13-16	No visible contamination
13-17	No visible contamination
13-18	No visible contamination
13-19	No visible contamination
13-20	No visible contamination
13-21	No visible contamination
13-22	No visible contamination
13-23	No visible contamination
13-24	No visible contamination

Location	Contamination Description
13-25	No visible contamination
13-26	No visible contamination
13-27	No visible contamination
13-28	No visible contamination
13-29	No visible contamination
13-30	Ground water red in colour
13-31	No visible contamination
13-32	Visible tar, HC odour
13-33	No visible contamination
13-34	No visible contamination
13-35	No visible contamination
13-36	No visible contamination
13-37	No visible contamination
13-38	No visible contamination
13-39	No visible contamination
13-40	No visible contamination
13-41	No visible contamination
13-49	No visible contamination
13-50	No visible contamination
13-51	No visible contamination
BH1	HC odour, HC sheen on groundwater
BH2	HC odour, HC sheen on groundwater
BH3	HC odour

Location	Contamination Description
BH3A	HC odour
BH4	No visible contamination
BH4A	No visible contamination
BH4B	No visible contamination
BH5	HC odour
BH6	HC odour
BH7	HC odour
BH8A	HC odour
BH22	No visible contamination
BH23	HC odour, HC sheen on groundwater
SD1	No visible contamination
SD2	Visible tar
SD3	HC sheen on groundwater
SD3A	No visible contamination
SD4	Visible tar
SS11-01-1	No visible contamination
SS11-08-1	No visible contamination
SS11-02-1	No visible contamination
SS11-02-2	No visible contamination
SS11-02-3	No visible contamination
SS11-03-1	HC sheen on groundwater
SS11-05-1	Red sediment
SS11-06-1	No visible contamination

Location	Contamination Description
SS11-07-1	No visible contamination
RB1	Red staining

<i>Visible Tar</i>	<i>Visible free tar in matrix or coating spoil surfaces</i>
<i>Spent oxide</i>	<i>Visible spent oxide materials</i>
<i>Black staining</i>	<i>Black hydrocarbon or tarry staining observed in excavation</i>
<i>HC odour</i>	<i>Hydrocarbon Odour noted during excavation</i>
<i>HC sheen</i>	<i>Hydrocarbon sheen observed on water during sampling</i>
<i>HC on groundwater</i>	<i>Free phase hydrocarbon layer floating on groundwater</i>
<i>Red sediment</i>	<i>Ferruginous orange / red sediment observed in groundwater</i>
<i>Red staining</i>	<i>Ferruginous orange / red staining observed in soil</i>
<i>Groundwater red in colour</i>	<i>Ferruginous colouration to trial pit groundwater ingress</i>

3.3 Area AC

Based on the combined information available for the site, the source – pathway – receptor terms of the CSM for Area AC are described in the following sections, with reference to separate site sub-areas defined by ground conditions and historical land-use details (Areas AC1, AC2 AC3 and AC4). Any significant pollutant linkages identified within the revised CSM are summarised in Table 2. Summary of Linkages in Section 3.6 and carried forward for detailed risk assessment in Sections 4 and 5.

3.3.1 Sources

S1 Surface deposited spent oxide waste and associated contaminated timber and other debris containing elevated levels of cyanide compounds, acid generating free sulphur and sulphate salts and water soluble iron compounds. Concentrations of these principal contaminants of potential concern (CoPC) may exceed typical screening criteria for potential risks to human health and surface water and groundwater quality. These materials are recorded in borehole and trial pit logs from locations across the northern sector of the site, primarily in Area AC 1 , but also present in small parts of Area AC2. The spent oxide material is commonly admixed with other waste material and general granular fill and has not been definitively delineated in terms of its areal extent. A small area of ground in the east of Area AC1, has previously been excavated and disposed of off-site as part of previous site remediation works.

- S2 Shallow granular made ground deposits and underlying in-situ soils contaminated with visible free phase tar and associated strong hydrocarbon / coal tar odours and visible black staining and oily sheens. Tar contaminated materials contain elevated concentrations of polycyclic aromatic hydrocarbons (PAHs), phenols and volatile organic compounds (VOC including benzene). Concentrations of these principal CoPC exceed typical screening criteria for potential risks to human health and surface water and groundwater quality. These materials are recorded in borehole and trial pit logs from locations in the western central part of Area AC2, in the vicinity of key gasworks production process structures, such as the effluent tar and liquor tank, tar separator and condenser tanks and the CWG plant. Tar contamination has been shown to be absent beyond the perimeter roadways to the east, west and south of the identified source area, although limited contamination has been encountered in granular alluvium beneath the Training Centre building (an historical gasworks structure) and immediately to the north of the garage building (a modern building built over the foundations of the former CWG plant structures). The tank immediately to the west of the current Training Centre building was located, emptied and backfilled with granular imported backfill as part of previous remediation works.
- S3 Shallow granular made ground deposits and underlying sand and gravel strata and groundwater impacted by assumed leaks and spills associated with the concentrated liquor plant and benzol plant, leading to elevated concentrations of ammoniacal nitrogen, phenols, PAH and VOC. Detectable concentrations of identified CoPC are present in groundwater from boreholes across the northwestern corner of Area AC1 (north of the source area) and in soils and groundwater within Area AC2 (immediately south of the source area). Concentrations of CoPC in made ground and underlying soils in the original source area are not available for review.

- S4 Surface deposited rubble, debris and gasworks process waste materials (including solidified tar and spent oxide), deposited as a large upfill wedge on the northern flank of the Bedwell Brook in the southeast corner of the site, in Area AC4. The material rests directly on in-situ glacial boulder clay strata, which formed the original valley profile and also forms the northern boundary of the source area. Very little perched groundwater is present within the made ground deposit, levels of which appear to be controlled by seepage from the toe of the slope and into surface water drainage pipework that passes through the area.
- S5 Shallow, perched groundwater within and flowing through the contaminated Made Ground and granular alluvium deposits in source areas S2 and S3, extending into granular alluvium deposit beneath area AC1. Groundwater is contaminated with typical soluble gasworks contaminants (ammoniacal nitrogen and phenols), along with dissolved and free phase elements of coal tar and other liquid hydrocarbon residues from the gasworks processes (PAHs and a wide range of aliphatic and aromatic hydrocarbons).
- S6 Leachate and perched shallow groundwater within the tipped Made Ground deposit in source area AC S4. Leachate and groundwater are of variable quality, reflecting the variability of the Made Ground, but contain elevated concentrations of iron, sulphate, PAHs and in one location other toxic metals released by the low pH local to monitoring well.
- S7 Surface water drains within the AC2 former operational area and AC4 tip area. Drains contain residual contaminated sediments (contaminants similar to the adjacent S2 source area) and tar adhering to pipework walls that can be flushed through the pipework during periods of high flow.
- S8 Surface water drains within the AC3 area, previously used for the bulk storage of liquid oil feedstocks for the oil-gas process. Drains contain hydrocarbon residues that can be flushed through the pipework during periods of high flow.

3.3.2 Pathways

Pathways that have the potential to form linkages between site source terms and identified receptors are:

- P1 Direct contact with contaminated made ground materials and soils exposed at the site surface in open parts of the site area (Areas AC1, AC2 and AC4).
- P2 Inhalation and ingestion of dust and inhalation of vapours (indoor and outdoor) containing contamination from site source areas, by site users (Areas AC1 and AC2)).
- P3 Leaching of contamination from made ground and soils in site source areas by infiltration and run-off. Direct infiltration of rainfall through unsealed surfaces within source areas and leaks from unsealed / damaged underground drainage pipework passing through these areas. Leachate will drain down through granular made ground deposits and enter underlying shallow groundwater, travel times are relatively short due to the permeability of made ground and presence of preferential flow paths. On the other hand, leaching is increased by the presence of shallow, perched groundwater rising and falling in response to infiltration, within or close to the base of the made ground deposits.
- P4 Migration of shallow groundwater through alluvial sand and gravel strata, driven by hydraulic gradients and the topography of the underlying low permeability Boulder Clay deposits. Flow is predominantly towards the northwest and north (for contamination source areas S1, S2, and S3) and towards the southeast and south (for contamination source area S4 and the remainder of the AC site area. Groundwater flowing north or northwest discharges to the western perimeter French Drain and into surface seeps on low lying land to the north of the site (Area AC1 during wet weather only). Groundwater flowing south and southeast will ultimately discharge to the Bedwell Brook, including some limited interaction with the site surface water drainage pipework en-route (Area AC2 and AC4).

Travel distances are relatively short to the northwest and north, reducing potential for attenuation, dispersion and dilution, while migration to the south and southeast will be subject to significant attenuation, dispersion and dilution due to the more substantial migration distances and infiltration entering from other parts of the site area.

- P5 Entry of leached contamination, run-off and contaminated groundwater into site drainage flowing off-site along the northern boundary (Area AC1) and discharging into the southern pond and Bedwell Brook in the southeast of the site area (Area AC3 and AC4).

Due to the presence of substantial thicknesses of clay rich glacial drift beneath the site area, no pathway has been identified between the site source areas and the underlying bedrock groundwater receptor.

3.3.3 Receptors

Key sensitive receptors identified on and within the vicinity of the site are:

- R1 Current and future users of the site, adult office workers routinely occupying the retained site buildings, with regular access to open areas of land on the site area as a whole.
- R2 Adult temporary workers carrying out construction or maintenance works within the site area.
- R3 Small scale open drainage ditches flowing into the River Clywedog approximately 120-200m to the west and north of the site. The ditches have not previously been formally classified in terms of water quality or quantity and may be subject to very low flow or loss of water in periods of dry weather.
- R4 The Bedwell Brook surface water body flowing through an incised valley in the southeast corner of the site. Bedwell Brook is considered to have good water quality and is capable of supporting typical freshwater fauna and flora. A small pond feature lies immediately to the east of Area AC3 and overflows into the Bedwell Brook channel. The pond is therefore considered part of this receptor system.

- R5 Retained structures and live site services, including gas mains, water supply pipework, surface water drains and foul sewerage buried in the made ground deposits and underlying soils within the site area.
- R6 Bedrock groundwater bodies in Sherwood Sandstone and Coal Measures aquifers lying at depth beneath the site area and surrounding land.
- R7 Local livestock. Grazing animals and poultry that has unrestricted and permanent access to open grassland directly adjacent to Area AC.

Shallow groundwater perched within made ground deposits and variable thickness, laterally non-persistent alluvial sand and gravel is not considered of sufficient quantity or character to constitute a groundwater receptor in its own right and is therefore incorporated into the CSM as a potential pathway for contamination migration only.

3.4 Area B East

Based on the information now available for the site, the source – pathway – receptor elements of the CSM for Area B East are described in the following sections. Any significant pollutant linkages identified within the revised CSM are summarised in Table 2. Summary of Linkages in Section 3.6 and carried forward for detailed risk assessment in Sections 4 and 5.

3.4.1 Sources

- S9 Made Ground deposits within the substantial embankment earthwork and more generally across the site surface, resulting from the distribution of imported fill used for the construction of the railway corridor through the western site sector. Made Ground deposits contained carbonaceous ashy material, as well as shale and brick fragments, with potentially elevated concentrations of PAHs and toxic metals.

3.4.2 Pathways

Pathways that have the potential to form linkages between site source terms and identified receptors are:

- P1 Direct contact with contaminated made ground materials and soils exposed at the site surface in open parts of the site area.
- P2 Inhalation and ingestion of dust and inhalation of vapours (outdoor) containing contamination from site source areas, by site users.
- P3 Leaching of contamination from made ground and soils in site source areas by infiltration and run-off. Direct infiltration of rainfall through unsealed, vegetated surfaces. Leachate will drain down through granular made ground deposits and enter underlying shallow groundwater, travel times are relatively short due to the restricted thickness and high permeability of made ground. On the other hand, leaching is increased by the presence of shallow, perched groundwater rising and falling in response to infiltration, within or close to the base of the made ground deposits.
- P4 Migration of shallow groundwater through alluvial sand and gravel strata, predominantly towards the west and north (towards Bedwell Brook). Travel distances are relatively short to the northwest and north, reducing potential for attenuation, dispersion and dilution.
- P5 Entry of leached contamination, run-off and contaminated groundwater into site drainage flowing off-site along the western boundary and discharging into Bedwell Brook to the north.

Due to the presence of substantial thicknesses of clay rich glacial drift beneath the site area, no pathway has been identified between the site source areas and the underlying bedrock groundwater receptor.

- P6 Uptake of contaminants by livestock through consumption of vegetation at the site surface and associated ingestion of soils developed / placed on the Made Ground surface.

3.4.3 Receptors

Key sensitive receptors identified on and within the vicinity of the site area are:

- R1 Current and future users of the site, adult agricultural workers or casual walkers / riders routinely accessing the open areas of land on the site area as a whole.
- R2 Adult temporary workers carrying out construction or maintenance works within the site area.
- R3 Small scale field drains and drainage ditches flowing into the Bedwell Brook, approximately 50m to the north of the site. The ditches have not previously been formally classified in terms of water quality or quantity and may be subject to very low flow or loss of water in periods of dry weather.
- R4 The Bedwell Brook surface water body flowing through an incised valley immediately to the north of the site. Bedwell Brook is considered to have good water quality and is capable of supporting typical freshwater fauna and flora.
- R5 Live site services buried in the made ground deposits and underlying soils within the site area.
- R6 Bedrock groundwater bodies in Sherwood Sandstone and Coal Measures aquifers lying at depth beneath the site area and surrounding land.
- R7 Local livestock. Grazing animals and poultry that have unrestricted and permanent access to open grassland within the site area.

Shallow groundwater perched within made ground deposits and variable thickness, laterally non-persistent alluvial sand and gravel is not considered of sufficient quantity or character to constitute a groundwater receptor in its own right and is therefore incorporated into the CSM as a potential pathway for contamination migration only.

3.5 Area B West

3.5.1 Sources

Based on the information now available for the site, the source – pathway – receptor elements of the CSM for Area B West are described in the following sections. Any significant pollutant linkages identified within the revised CSM are summarised in Table 2. Summary of Linkages in Section 3.6 and carried forward for detailed risk assessment in Sections 4 and 5.

S10 Made Ground deposits across the site surface, in the base of the former railway cutting, resulting from the distribution of imported fill used for the construction of the railway corridor through the centre of the site. Made Ground deposits contained carbonaceous ashy material, as well as shale and brick fragments, with potentially elevated concentrations of PAHs and toxic metals. One sample from this material also contained detectable asbestos fibres (<0.001% by mass).

3.5.2 Pathways

Pathways that have the potential to form linkages between site source terms and identified receptors are:

- P1 Direct contact with contaminated made ground materials and soils exposed at the site surface in open parts of the site area.
- P2 Inhalation and ingestion of dust and inhalation of vapours (outdoor) containing contamination from site source areas, by site users.
- P3 Leaching of contamination from made ground and soils in site source areas by infiltration and run-off. Direct infiltration of rainfall through unsealed, vegetated surfaces within the site area. Leachate will drain down through granular made ground deposits and enter underlying shallow groundwater, travel times are relatively short due to the restricted thickness and high permeability of made ground. On the other hand, leaching is increased by the presence of shallow, perched groundwater rising and falling in response to infiltration, within or close to the base of the made ground deposits.

- P4 Migration of shallow groundwater through alluvial sand and gravel strata, predominantly towards the northwest and north. Groundwater flowing north or northwest is likely to discharge to agricultural ditches and field drains in open land between the site and the River Clywedog approximately 200m to the north.
- P5 Entry of leached contamination, run-off and contaminated groundwater into site drainage flowing off-site to the west, destination and character not known.
- P6 Uptake of contaminants by livestock through consumption of vegetation at the site surface and associated ingestion of soils developed / placed on the Made Ground surface.

Due to the presence of substantial thicknesses of clay rich glacial drift beneath the site area, no pathway has been identified between the site source areas and the underlying bedrock groundwater receptor.

3.5.3 Receptors

Key sensitive receptors identified on and within the vicinity of the site are:

- R1 Current and future users of the site, adult agricultural workers or casual walker, with regular access to open areas of land on the site area as a whole.
- R2 Adult temporary workers carrying out construction or maintenance works within the site area.
- R3 Small scale old railway drains / open drainage ditches flowing into the River Clywedog approximately 200m to the north of the site. The ditches have not previously been formally classified in terms of water quality or quantity and may be subject to very low flow or loss of water in periods of dry weather.
- R5 Live site services buried in the made ground deposits and underlying soils within the site area.

R6 Bedrock groundwater bodies in Sherwood Sandstone and Coal Measures aquifers lying at depth beneath the site area and surrounding land.

R7 Local livestock. Grazing animals and poultry that have unrestricted and permanent access to open grassland within the site area.

Shallow groundwater perched within made ground deposits and variable thickness, laterally non-persistent alluvial sand and gravel is not considered of sufficient quantity or character to constitute a groundwater receptor in its own right and is therefore incorporated into the CSM as a potential pathway for contamination migration only.

3.6 Summary of Pollutant Linkages

The pollutant linkages considered viable for the source-pathway-receptor elements described in Sections 3.3 – 3.5 have been summarised in Table 2 below.

Table 2: Summary of Linkages

Site Area	Source	Pathway	Receptor	Current site conditions		
				Consequence	Likelihood	Risk
AC1 AC2	Variable made ground impacted by gasworks process residues and asbestos fibres, exposed at the site surface or present at shallow depth with no containment or controls in place. Source areas S1, S2, S3 and S4.	Direct contact and dust / vapour inhalation.	Site users and trespassers.	Moderate / severe - exceedance of preliminary CLEA derived assessment criteria, inhalation of excess asbestos fibres (above background) and presence of free phase tar, and spent oxide.	Unlikely – no capping layer or other containment, but limited contact under normal site use scenarios.	Unacceptable under current site conditions / use, due to uncontrolled nature and potential severity of consequence.
AC1 AC2	Free phase tar and contaminated made ground and granular alluvium extending into the saturated zone with no control over infiltration. Source areas S2 and S3.	Migration / leaching by infiltration and shallow groundwater, followed by groundwater migration and movement through site drainage.	Third party field drains / ditches (linked to River Clywedog. Bedwell Brook	Moderate / severe - visible entry of free phase hydrocarbons / exceedance of surface water quality criteria.	Likely – typical contaminants detected in water samples, and free phase contamination of sediment found in Bedwell Brook, no containment or pathway interruption in place.	Unacceptable under current site conditions / use

Site Area	Source	Pathway	Receptor	Current site conditions		
				Consequence	Likelihood	Risk
AC1 AC4	Contaminated shallow groundwater in made ground and granular alluvium. Source areas S5 and S6.	Migration along local hydraulic gradients / entry into surface water drainage.	Third party field drains / ditches (linked to River Clywedog. Bedwell Brook.	Moderate / severe – concentrations in Bedwell Brook and field drains exceed surface water quality criteria, but no detectable impact on River Clywedog.	Likely – but limited volumes suspected.	High, remedial actions necessary under current conditions / use.
AC1 AC2	Free phase tar and tar contaminated made ground exposed at the site surface or present at shallow depth with no containment or controls in place. Source areas S1, S2 and S3.	Inhalation of vapour.	Site users / trespassers.	Moderate –sporadic exceedance of site specific model derived assessment criteria.	Likely - no capping layer, contaminants present in shallow deposits.	Moderate, risks reduced through other remediation actions.
AC2 AC4	Contaminated sediments collected in surface water drainage pipework and around outfalls. Sources S7 and S8	Flushing by infiltration and shallow groundwater, followed by discharge to surface water bodies.	Area AC3 pond / Bedwell Brook.	Moderate / severe – visible hydrocarbons in surface water sediments and standing water adjacent to outfalls, but no detectable rise in water concentrations under typical conditions.	Likely - limited volumes and intermittent, depending on rainfall.	High, remedial actions required due to uncontrolled nature of discharges.

Site Area	Source	Pathway	Receptor	Current site conditions		
				Consequence	Likelihood	Risk
AC1 AC2	Shallow groundwater within granular alluvium impacted by dissolved gasworks process contaminants. Source S1.	Lateral migration along hydraulic gradient towards surface water.	River Clywedog.	Mild - no detectable rise in water concentrations under typical conditions.	Unlikely – due to limited volumes, absence of direct pathway.	Low. No remedial actions required under current conditions / use.
B EAST B WEST	Contaminated imported made ground (ash / clinker / coal mining spoil) in embankments and shallow surface layer. Source S9 and S10.	Direct contact and dust / vapour inhalation.	Site users / trespassers.	Moderate - exceedance of typical CLEA criteria, but bioavailability likely to be very low (due to nature of contaminated materials).	Unlikely – due to low usage of site / presence of soil / vegetation cover.	Low. No remediation action required under current site use.
B EAST B WEST	Contaminated imported made ground (ash / clinker / coal mining spoil) in embankments and shallow surface layer. Source S9 and S10.	Migration / leaching by infiltration and shallow groundwater, followed by groundwater migration and movement through site drainage.	Field drains / ditches (linked via third party drainage to River Clywedog. Bedwell Brook	Negligible – due to limited volumes. No detectable rise in water concentrations under typical conditions.	Likely – no controls in place.	Low. No remediation action required under current site use.

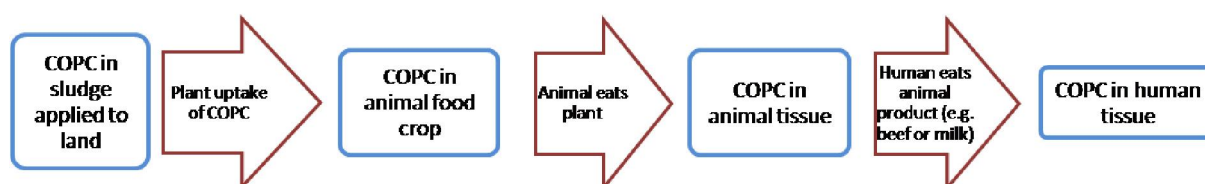
4. HUMAN HEALTH RISK ASSESSMENT

4.1 Background

Quantitative human health criteria for soils were generated using the CLEA model and based on the proposed use of the site for open storage (but with occupied office buildings on-site). CLEA inputs and outputs are included in Appendix A. These CLEA screening values were then compared against the combined chemical analysis dataset for each area of the site (A, B and C), so that the location of individual exceedances could be identified.

It has been assumed that Areas B East and West will remain in their current informal agricultural use (as grazing land / occasional stock-keeping only). Therefore, in addition to the CLEA based screening (the open storage use scenario characteristics being considered appropriate to Area B also), soil concentrations of certain metals in these areas have been compared with the screening criteria (Sludge Criteria) contained in the Sludge (Use in Agriculture) Regulations 1989, as amended 1990. These criteria are designed to be protective of human health effects due to ingestion of animal food products, from animals fed on food crops grown on agricultural land to which sewage sludge has been applied. The Sludge Criteria are considered to be more appropriate to the current site condition and future use scenario than the use of criteria derived using the CLEA model for allotment use. These criteria are not intended to be directly protective of animals or agricultural plants on-site, but are intended to protect subsequent consumers of such animals or crops. These criteria are therefore considered relevant to Area B (but not Area A or C). It is acknowledged that they refer to a limited range of toxic metal contaminants compared to the CLEA derived criteria.

The assessment using the sludge criteria does not consider crops as a receptor but as a pathway for human exposure through the food chain. The conceptual site model for the use of the sludge criteria is as follows:



4.2 Model Assumptions

The following receptors have been considered in this assessment:

- Current site occupants, users and trespassers with access to Areas AC1 and AC2.
- Current site users and trespassers with access to Areas B East and B west.

The following potential exposure pathways have been considered within the assessment:

- Direct dermal contact with soil.
- Ingestion of soil.
- Dust inhalation.
- Vapour inhalation.

The criteria have been derived using the following assumptions:

- Soil Organic Matter (SOM) value was assumed to be 1%.
- A default pH value of 7 was used.
- A soil type of sandy loam is considered to be representative of the made ground at the site.
- The fraction of the site with hard or vegetative cover is assumed to be approximately 80%.
- The receptor is assumed to be a female office worker in a pre 1970s office.

It is assumed that these exposure characteristics would be adequately protective of site users in Area B (tending stock / repairing fences) and potential trespassers in all areas of the site. These site users would typically have lower exposure times and contact opportunities than the user scenario used for the CLEA modelling.

Assessment criteria have only been derived for the contaminants detected above their laboratory method detection limits. Where contaminants have not been detected it has been assumed that there were no associated risks to human health for the purposes of this assessment.

4.3 Screening Criteria

The human health screening criteria derived for a commercial site use (an applied to all site areas) are summarised below:

Table 3: Soil Screening Criteria

Contaminant of Concern	Human Health Commercial Land Use (mg/kg)
TPH Aliphatic C5-C6	3.39E+03*
TPH Aliphatic C6-C8	8.25E+03*
TPH Aliphatic C8-C10	2.13E+03*
TPH Aliphatic C10-C12	1.03E+04*
TPH Aliphatic C12-C16	6.08E+04*
TPH Aliphatic C26-C21	1.91E+06
TPH Aliphatic C21-C35	1.91E+06
TPH Aliphatic C35-C44	3.81E+06
TPH Aromatic C5-C7**	2.77E+04*
TPH Aromatic C7-C8**	5.90E+04*
TPH Aromatic C8-C10	3.67E+03*
TPH Aromatic C10-C12	1.69E+04*
TPH Aromatic C12-C16	3.63E+04*
TPH Aromatic C16-C21	2.86E+04
TPH Aromatic C21-C35	2.86E+04
TPH Aromatic C35-C44	2.86E+04

Contaminant of Concern	Human Health Commercial Land Use (mg/kg)
TPH Aromatic and Aliphatic	2.86E+04
Acenaphthene	8.49E+04*
Acenaphthylene	8.43E+04*
Anthracene	5.25E+05
Benzo(a)anthracene	8.95E+01
Benzo (a) pyrene	1.41E+01
Benzo(b)fluoranthene	1.00E+02
Benzo(g,h,i)perylene	6.54E+02
Benzo(k)fluoranthene	1.41E+02
Chrysene	1.37E+02
Dibenzo(a,h)anthracene	3.29E+01
Fluoranthene	2.26E+04
Fluorene	6.35E+04*
Indeno(1,2,3 cd)pyrene	6.00E+01
Naphthalene	2.04E+02*
Phenanthrene	2.19E+04
Pyrene	5.42E+04
Arsenic	6.35E+02
Cadmium	2.30E+02
Mercury	3.64E+03
Chromium III	8.84E+03
Chromium VI	3.42E+01
Copper	7.17E+04

Contaminant of Concern	Human Health Commercial Land Use (mg/kg)
Nickel	1.79E+03
Selenium	1.30E+04
Lead	7.50E+02^
Zinc	6.65E+05
Cyanide, total	1.71E+04
Benzene	2.81E+01
Toluene**	5.90E+04*
Ethylbenzene**	1.68E+04*
Xylene, o-**	6.94E+03*
Xylene, m-**	6.46E+03*
Xylene, p-**	6.22E+03*
2-Methylphenol	1.62E+05*
3-Methylphenol	1.71E+05
4-Methylphenol	1.63E+05*
Phenol	3.10E+04

* The combined screening criteria for these chemicals exceeds the lower saturation limit as well as the vapour pathway being an important contributor to exposure. According to the CLEA software handbook (Science Report - SC050021/SR4). This means that:

- Free phase contamination may be present.
- Exposure from the vapour pathways will be over predicted.
- Where the vapour pathway dominates exposure (greater than 90%) then it is unlikely that the relevant HCV will be exceeded at soil concentrations at least a Factor of 10 higher than the relevant HCV.

** Screening criteria exceeds soil saturation limit and vapour inhalation pathway dominates exposure (greater than 90%).

^ Former SGV adopted in absence of CLEA value.

4.4 Summary – AC

Tables of screened soil sample results from the various investigations conducted at the site are provided in Appendix B. The key points arising from the screening are discussed in the following sections.

4.4.1 AC 1

There were exceedances of the screening criteria for chromium (BH8B 2.0m and TP23 1.5m), lead (TP3-1 0.4m), benzo (a) pyrene (TP99-103/1 0.6m and TP99-123/1 0.3m). These exceedances are shown in Drawing number A1-13627-3022.

The screening criteria for chromium is based on the chromium (VI) oxidation state, whereas the screening criteria for the chromium (III) oxidation state of 8,844mg/kg was not exceeded at any locations. The exceedances occurred in natural or re-worked natural materials and are considered likely to be representative of natural conditions. It is therefore considered that these do not represent a significant possibility of significant harm to human health.

The exceedance of the screening criteria for lead is considered to be an isolated occurrence (1 out of 26 samples analysed) and is therefore also not considered to represent a significant possibility of significant harm to human health.

The exceedances of the screening criteria for benzo (a) pyrene are related to tar and tar staining (TP99-103) and ash fragments (TP99-123) observed at these locations. The risk driving pathway for benzo (a) pyrene is direct soil ingestion. It is considered that due to the nature of the overlying made ground these sources are effectively isolated from the surface and as such site users are unlikely to come into contact with them. It is considered that there is not a significant possibility of significant harm to human health due to benzo (a) pyrene.

4.4.2 AC 2

There were exceedances of the screening criteria for chromium (TP4 0.4m, TP7 0.8m), benzo (a) pyrene (MW99-205 1.7m, TP2 0.5m, TP3 0.5m, TP4 1.0m), naphthalene (TP1 1.5m, TP4 1.0m).

The exceedances of the screening criteria for chromium are based on the chromium (VI) oxidation state and would not exceed screening criteria for the chromium (III) oxidation state (8,844mg/kg). It is considered that the chromium detected in these samples is unlikely to be in the chromium (VI)

oxidation state and as such the chromium (III) screening criteria is more appropriate. Therefore, chromium is not considered to represent a significant possibility of significant harm to human health.

The PAHs detected are considered to originate in the tar stained sands and gravels at these locations. It is considered unlikely that these concentrations represent a significant possibility of significant harm to human health by direct contact (that is soil ingestion or dermal contact) because the contamination is covered by a layer of gravel, soil or other relatively uncontaminated fill material. However, there remains a degree of uncertainty in relation to the extent of naphthalene contamination and whether this extends beneath the garage to the north of TP1 and TP2, where people could be exposed via indoor vapour inhalation. Recommendations have been made for further site investigation works to close out this potential issue (see Section 6.2).

4.4.3 AC3

There were no exceedances of the screening criteria for human health in Area AC3.

4.4.4 AC4

There were exceedances of the screening criteria for benzo (a) pyrene (TP99-107 0.9m, TP99-109 0.8m, TP99-110 1.9m), nickel (TP99-108 3.0m). The contamination detected at TP99-107 and TP99-109 is considered to be the result of observed isolated fragments of tar and pitch and the contamination at TP99-110 the result of coal and ash.

These exceedances are not considered to present a significant possibility of significant harm to human health due to the depth at which they were detected blocking the exposure pathway.

4.5 Summary – Area B East

There were exceedances of the screening criteria for chromium (VI) only in this area. The majority of exceedances were at depths >1.0m within natural alluvium and therefore were considered not to present a risk to human health. Exceedances of the chromium screening criteria at <1.0m were found at BH11 (0.3m), BH12 (0.5m). The exceedances at >1.0m are considered to be the result of the presence of reworked natural materials. The locations of the individual exceedances are shown on Drawing No. A1-13627-3024.

There were no exceedances of the soil assessment criteria for agricultural land (Sludge (Use in Agriculture) Regulations 1989 as amended 1990).

It is considered that there is not a significant possibility of significant harm to human health within this area.

4.6 Summary – Area B West

There were exceedances of screening criteria for chromium (TP44 1.0m, TP47 1.0m), and lead (HP48 0.3m, TP45 0.2m, TP47 0.2m). The exceedances of the screening criteria for chromium are based on the chromium (VI) oxidation state and do not exceed the screening criteria for the chromium (III) oxidation state (8,844mg/kg). These concentrations of chromium are considered to be representative of natural conditions and therefore likely to comprise chromium (III) or chromium (III) compounds. The exceedances are therefore considered not to present a significant possibility of significant harm to human health.

The exceedance of the screening criteria for lead occurred in black ashy topsoil observed at these locations (HP58 0.3m, TP45 0.2m, TP47 0.2m). These are not considered to present a significant possibility of significant harm to human health under the current use of the site, however, should the site use change significantly allowing more frequent and long term human exposure (e.g. allotments producing food for human consumption, a play park or residential use) this conclusion will need to be revisited. The locations of the individual exceedances are shown in Drawing No. A1-13627-3023.

There were exceedances of the criteria for agricultural land (Sludge (Use in Agriculture) Regulations 1989 as amended 1990) for cadmium (HP48 0.3m, TP45 0.2m, TP47 0.2m), copper (HP48 0.3m, TP45 0.2m, TP47 0.2m), lead (HP48 0.3m, TP45 0.2m, TP47 0.2m), zinc (BH17 0.5m, BH19 0.4m, BH20 0.3m, BH21 0.5m, HP 48 0.3m, TP45 0.2m, TP47 0.2m, TP45B 1.3m). The locations of these exceedances are shown on Drawing No. A1-13627-3031.

The sludge criteria are designed to protect human health and the environment from harmful effects due to the use of sewage sludge in agriculture. This means that concentrations in sewage sludge (and by inference, agricultural soil) above the criteria would make it unsuitable for spreading on agricultural land. In addition, exceedance of these screening criteria prevents the use of the soil for the growing of forage crops, fruit and vegetable crops. Quality and safety of commercially produced foods is regulated by Trading Standards, Environmental Health, etc and should the need for to grow crops on this land arise, it is advised that the Local Authority Environmental Health Officer should be consulted. Otherwise it is considered that this land is suitable for its current use and unlikely to present a risk to the health of grazing animals.

4.7 Radioactivity

4.7.1 Background

In response to the previous use of radioactive, depleted uranium catalyst materials on the site (as part of the oil gas production process) and uncertainties over the completeness of historical remediation work, a comprehensive programme of additional surveying and monitoring was conducted as part of the Stage 1 works. All the survey work was carried out to a level and specification recommended by the specialist radiological consultant, Aurora Health Physics Services Limited (Aurora).

4.7.2 Scope of Works

The scope of the survey and monitoring works conducted by Aurora included: a full site surface area survey for above background radioactivity, detected as counts per second by a gamma radiation detector; instrumental monitoring of all intrusive contamination investigation locations / sampling points for anomalous radioactivity (including monitoring of all personnel on completion); excavation of trial pits into the Bedwell Brook tipping area (Area AC4) and instrumental monitoring to confirm the absence of significant deposits of radioactive materials in this area; and sampling and laboratory analysis of representative materials from all monitoring areas for radioactive contaminants.

Aurora produced a detailed interpretive report on the works listed above, a copy of which is included as Appendix C to this report.

4.7.3 Conclusions

Due to the absence of any significant radiological concerns at the site, no further investigative or remedial work is required.

As a precautionary measure, it is proposed that Aurora are asked to attend site to undertake instrumental monitoring during the bulk excavation works in the vicinity of the former Fire Pit area, that being the only previously remediated area that will be subject to exposure and disturbance during the currently proposed site works."

5. CONTROLLED WATERS

5.1 Background

At the site, the controlled waters have the potential to be impacted from leaching of contaminants from identified soil sources and/or the lateral migration of contaminants in the groundwater towards offsite receptors.

In order to provide an indication of risks to controlled waters, concentrations of contaminants detected in groundwater and surface water samples from all of the referenced site investigation reports were compared with relevant Environmental Quality Standards (EQS) for freshwater bodies. The results are presented as highlighted data tables in Appendix B. The locations of exceedances are also shown on Drawing Nos. A1-13627-3026 to 3030.

In addition, the Environment Agency Remedial Targets Methodology spreadsheet was used to calculate soil assessment criteria for those contaminants detected in groundwater on more than one occasion at any given exploratory hole.

The Hydrogeological Conceptual Model is described in Section 3.6 and has been modelled within the RTM spreadsheet as a single groundwater body, with a combined flow (in made ground and alluvium) from source areas towards the nearest surface water receptor. Separate modelling of groundwater flow towards the more distant Bedwell Brook receptor was not considered justified, with output from the model being applicable (but conservative) to that linkage also. The relevant pollutant linkages, as they relate to the RTM spreadsheet, are described in Table 4 below.

It is considered that the groundwater lying within the Made Ground and underlying granular alluvium (sands and sand and gravel) is in hydraulic continuity, and is flowing in a predominantly north and northwesterly direction towards the local agricultural ditches and the River Clywedog. Although the River Clywedog is some distance from the site boundary, the western French Drain feature is connected via a series of informal ditches (variably open or culverted) to the river. Given that the drain and ditches are all under third party control and ownership, it is considered that the most appropriate approach is to consider the French Drain collection chamber as the compliance point for the assessment. Attenuation by dilution in the ditches between the site and the river is an unknown quantity.

For any separate identified impacts on Bedwell Brook, which flows directly through part of the Area AC site, it is considered that the compliance point for any assessment should be the downstream point at which the brook leaves the site.

The Boulder Clay below the Made Ground / granular alluvium is considered to be acting as an aquiclude, with no significant groundwater flow either vertically or laterally in this strata.

Compliance points used by the assessment are shown on Drawing No. A1-13627-3050.

It is considered that groundwater from areas AC1 and AC2 is not migrating towards Bedwell Brook. The source of any shallow groundwater entering Bedwell Brook is considered to be Area AC4. Additionally there may be a pathway for groundwater to reach Bedwell Brook from Area AC2 via surface water drains, however this has not been modelled.

The site specific input parameter values for the RTM model are presented in Tables 5, 6, 7 and 8 and the RTM model outputs are presented in Appendix D. A summary of chemical properties used in the RTM modelling is presented in Appendix H.

Table 4: RTM Linkages

Source	Adopted Receptor for RTM	Migration Pathways	Relevant RTM Tiers
Soil in made ground in Area AC2	French Drain collection chamber (proxy for River Clywedog)	Infiltration, leaching and advection in shallow groundwater with anaerobic biodegradation in the dissolved phase.	Soil 1, 2 and 3
Shallow groundwater in Area AC1	French Drain collection chamber (proxy for River Clywedog)	Advection in shallow groundwater with anaerobic biodegradation in dissolved phase.	Groundwater 3

Table 5: Level 1 Soil RTM Model Inputs

Parameter	Units	Value	Justification
Water filled porosity		0.24	Updated technical background to the CLEA model (Science report: SC050021/SR3) value for sand
Air filled porosity		0.3	
Bulk density of soil zone material	g/cm ³	1.18	
Fraction of organic carbon		0.04	Conservative assumption for Made Ground with no contamination observations.

Table 6: Level 2 Soil RTM Model Inputs

Parameter	Units	Value	Justification
Infiltration	m/day	4.97E-04	The annual average infiltration rate recorded by the Met Office is 726.2mm/year. It has conservatively been assumed that 25% of this value will be available to recharge the ground following redevelopment. This assumes a freely draining ground surface.
Area of contaminant source	m ²	3670	Approximate dimensions of treatment area in Area AC2..
Length of contaminant source in direction of groundwater flow	m	118	Approximate north-south dimension of Area AC2.
Saturated aquifer thickness	m	1.8	Assumed thickness of Made Ground in AC2
Hydraulic conductivity of aquifer	m/day	0.28	Calculated from upper value of 3.2 x 10 ⁻⁶ m/s from: Hydrological and Hydrogeological Investigation At Maelor Works, Wrexham (Mentor No: 00138), Komex (2000).
Hydraulic gradient of water table		0.026	Maximum of hydraulic gradient range from: Hydrological and Hydrogeological Investigation At Maelor Works, Wrexham (Mentor No: 00138), Komex (2000).

Parameter	Units	Value	Justification
Width of contaminant source perpendicular to groundwater flow.	m	33	Width of contaminant source of AC2.
Background concentration of contaminant in groundwater beneath the site	mg/l	0	Conservatively, assumes that no background contamination exists within the aquifer.
Mixing zone thickness	m	1.8	Mixing zone thickness calculated by the Remedial Targets Methodology based on the input saturated aquifer thickness.

Table 7: Level 3 Soil RTM Model Inputs

Parameter	Units	Value	Justification
Bulk density of aquifer materials	g/cm ³	1.18	Value for sand in SC050021/SR3.
Effective porosity of aquifer materials		0.25	The specific yield presented within Kruseman & De Ridder (2001) for sand.
Fraction of organic carbon		0.04	Site specific for made ground with no contamination observations.
Distance to compliance point	m	117	This is the distance from the northern edge of Area AC2 to MW11-01, which is the closest groundwater monitoring well to the site boundary. The location of the compliance point is shown on Drawing no. A1-13627-3050.
Time since pollutant entered groundwater	Years	9E+99	Timescale recommended by the Remedial Targets Methodology to simulate steady state conditions.
Longitudinal dispersivity	m	11.8	Assumed to be 10% of pathway length.
Transfer to dispersivity	m	1.18	Assumed to be 1% of pathway length.
Vertical dispersivity	m	0.118	Assumed to be 0.1% of pathway length.

Table 8: Level 3 Groundwater RTM Model Inputs

Parameter	Units	Value	Justification
Width of plume in aquifer at source (perpendicular to flow)	m	312	Approximate width of AC1 treatment area
Plume thickness at source	m	1.6	Estimated thickness of contaminated layer, based on the thickness of the sand and gravel layer in the area of MW99-106 and MW11-02.
Saturated aquifer thickness	m	1.8	Estimated thickness of sand and gravel layer at source. Taken from monitoring well logs for MW99-106 and MW11-02.
Bulk density of aquifer materials	g/cm ³	1.18	SR3 value for sand
Effective porosity of aquifer		0.25	Value for fine gravel or fine to medium sand from: Analysis and Evaluation of Pumping Test Data, (2000). Kruseman, G.P., and de Ridder, N.A.
Hydraulic gradient		0.026	Maximum of hydraulic gradient range from: Hydrological and Hydrogeological Investigation At Maelor Works, Wrexham (Mentor No: 00138), Komex (2000).
Hydraulic conductivity of aquifer	m/d	0.28	Calculated from upper value of 3.2×10^{-6} m/s from: Hydrological and Hydrogeological Investigation At Maelor Works, Wrexham (Mentor No: 00138), Komex (2000).
Distance to compliance point	m	189	Distance from MW99-106 to site boundary. The location of the compliance point is shown on Drawing no. A1-13627-3050.
Distance (lateral) to compliance point perpendicular to flow direction	m	0	Default value for calculating remedial target values
Distance (depth) to compliance point perpendicular to flow direction	m	0	Default value for calculating remedial target values

Parameter	Units	Value	Justification
Time since pollutant entered groundwater	Years	9.99E+99	Steady state conditions simulated
Longitudinal dispersivity	m	18.9	10% of pathway length
Transverse dispersivity	m	1.89	1% of pathway length
Vertical dispersivity	m	0.189	0.1% of pathway length

5.2 Remedial Targets Methodology Outputs

Table 9 below shows the Level 3 soil remedial targets calculated using the remedial targets methodology spreadsheet. These have been applied to concentrations of chemicals detected in the soil within Area AC 2.

Table 9: Level 3 Soil – AC2

Contaminant of Concern	Controlled Waters Level 3 Soil (mg/kg)
Anthracene	0.178
Benzo (a) pyrene	0.00679
Benzo(b)fluoranthene	0.0525
Benzo(g,h,i)perylene	0.00349
Benzo(k)fluoranthene	0.0525
Indeno(1,2,3 cd)pyrene	0.00349
Naphthalene	1.52
Arsenic	167
Cadmium	0.834
Mercury	0.164
Chromium III	11.3
Chromium VI	
Copper	93.4
Nickel	66.7
Zinc	41
Cyanide, total	3.74
Benzene	22.6

Contaminant of Concern	Controlled Waters Level 3 Soil (mg/kg)
Toluene	2.54
Ethylbenzene	3.89
Xylene, o-	15.2
Xylene, m-	
Xylene, p-	
Phenol	1.97

Table 10 below summarises the Level 3 groundwater remedial targets, which have been applied to groundwater concentrations detected in Area AC1.

Table 10: Level 3 Groundwater – AC1

Contaminant of Concern	Level 3 Groundwater (mg/l)
Arsenic	3.33E-01
Cadmium	1.67E-03
Chromium	2.26E-02
Copper	1.86E-01
Iron	6.66E+00
Lead	7.99E-03
Mercury	3.33E-04
Nickel	1.33E-01
Zinc	8.33E-01
Cyanide	1.70E-02
Ammoniacal Nitrogen as N	4.59E-01
Total Sulphate	2.84E+03
Benzene	1.93E+00
Toluene	4.42E+04
Ethylbenzene	3.86E+00
Xylene, o-	7.48E+02
Xylene, m-	7.48E+02
Xylene, p-	7.48E+02
Phenol	6.80E+03

Contaminant of Concern	Level 3 Groundwater (mg/l)
Naphthalene	4.99E+01
Anthracene	2.61E-03
Fluoranthene	1.68E-04
Benzo (a) pyrene	4.26E-06
Benzo(b)fluoranthene	6.77E-04
Benzo(k)fluoranthene	6.77E-04
Benzo(g,h,i)perylene	4.46E-05
Indeno(1,2,3-c,d)pyrene	4.46E-05

5.2.1 Sensitivity Analysis

Conservative values were chosen for hydraulic conductivity of the aquifer and the groundwater hydraulic gradient based on previous site investigation information (Hydrological and hydrogeological investigation at Maelor Works, Wrexham (Mentor No: 00138), Komex (2000). There is uncertainty as to the real values of these aquifer properties and as such it was considered valuable to conduct model sensitivity analysis for these input parameters.

The remedial targets for soil and groundwater were calculated using the maximum estimated values for both hydraulic conductivity and hydraulic gradient as presented in Table 6 and Table 8 above. Minimum values for these parameters were also presented in the referenced site investigation reports and a median value for both parameters has been calculated.

Pumping tests were carried out for IKM by Geo2 Remediation Ltd in December 2013. Draw down was measured at MW99-104, BH7, BH8, BH3 and BH4. Hydraulic behaviour of the boreholes was highly variable and significant draw down was observed only at BH4, giving a calculated hydraulic conductivity of 8.47m/day. This is in marked contrast to the hydraulic conductivity measured by Komex using slug tests. It is considered that the Geo2 pumping test results are not representative of steady state aquifer conditions across the site and as such the results have not been used in the derivation of remedial targets.

In addition, the effective porosity of the aquifer is unknown and likely to be variable across the site, so the selected value was also varied by + and – 25% around the chosen literature value.

Each input parameter value was varied in isolation in order to limit the number of model iterations that were required, as well as providing a clearer picture of the sensitivity of the model.

The sensitivity analysis was carried out for benzo(a)pyrene, ammoniacal nitrogen and phenol. Metals were not included in the sensitivity analysis as the screening criteria for metals are not affected by these input parameters.

The results of the sensitivity analysis are presented below.

Table 11: Sensitivity analysis for Benzo(a)pyrene

Parameter	Change in value	Value used	Level 3 soil AC (mg/kg)	Level 3 GW AC (mg/l)
Hydraulic conductivity (m/d)	Max	0.28	6.79E-03	4.26E-06
	Median	0.15	6.42E-03	1.11E-05
	Min	0.02	5.93E-03	3.46E-02
Hydraulic gradient	Max	0.026	6.79E-03	4.26E-06
	Median	0.022	6.65E-03	5.26E-06
	Min	0.017	6.47E-03	7.75E-06
Effective porosity (fraction)	+0.25%	0.31	7.07E-03	5.62E-06
	0	0.25	6.79E-03	4.26E-06
	-25%	0.19	6.52E-03	3.18E-06

Table 12: Sensitivity Analysis for Ammoniacal Nitrogen

Parameter	Change in value	Value used	Level 3 GW AC (mg/l)
Hydraulic conductivity (m/d)	Max	0.28	4.59E-01
	Median	0.15	1.54E+00
	Min	0.02	2.57E+04
Hydraulic gradient	Max	0.026	4.59E-01
	Median	0.022	6.02E-01
	Min	0.017	9.85E-01
Effective porosity (fraction)	+0.25%	0.31	6.56E-01
	0	0.25	4.59E-01
	-25%	0.19	3.15E-01

Table 13: Sensitivity Analysis for Phenol

Parameter	Change in value	Value used	Level 3 soil AC (mg/kg)
Hydraulic conductivity (m/d)	Max	0.28	1.97E+00
	Median	0.15	2.16E+00
	Min	0.02	2.43E+00
Hydraulic gradient	Max	0.026	1.97E+00
	Median	0.022	2.03E+00
	Min	0.017	2.11E+00
Effective porosity (fraction)	+0.25%	0.31	3.13E+00
	0	0.25	1.97E+00
	-25%	0.19	1.20E+00

5.3 AC Findings

Output soil and water contaminant concentrations from the above modelling were compared against actual contaminant concentrations detected in samples from the individual source areas across the site. Any exceedences were assessed against the current CSM / active pollutant linkages for the site, to identify soil leaching or contaminated groundwater movement that posed a significant risk to nominated water receptors.

5.3.1 Area AC2 Soil Screening Criteria

The RTM Level 3 soil screening criteria (Table 9) were applied to Area AC2 and were exceeded for the following chemicals:

- Ethylbenzene (TP1 1.5m, TP3 0.5m, TP4 1.0m)
- Toulene (TP4 1.0m)
- Xylene (TP1 1.5m, TP4 1.0m)
- PAHs (BH23 2.6m, TP1 1.5m, TP2 0.5m and 1.0m, TP3 0.5m, TP4 1.0m, TP5 0.3m, TP6 0.4m, TP6 0.9m, TP7 0.8m, TP8 0.8m, TP10 1.8m and 2.0m)
- Phenol (BH23 2.6m, TP8 0.8m, TP9 1.0m and 2.7m)
- Cadmium (TP2 0.5m, TP5 0.3m, TP6 0.4m)
- Chromium exceedances were wide spread across this part of the site
- Lead exceedances were wide spread across this part of the site
- Zinc exceedances were wide spread across this part of the site

This indicates that there is a potential for pollution of controlled waters due to leaching of these chemicals from soil in Area AC2 and migration with groundwater to the River Clywedog (French Drain / Field Ditch compliance point).

5.3.2 Area AC1 Groundwater Screening Criteria

The level 3 groundwater screening criteria (Table 10) were applied to Area AC1 and were exceeded at the following locations:

- Cadmium (MW99-106)
- Lead (BH5, MW11-02, MW99-101, MW99-103, MW99-104, MW99-105)
- Ammoniacal nitrogen at a wide spread range of locations across the site.
- Benzo (a) pyrene (MW11-2, MW99-106)
- Fluoranthene (MW11-2, MW99-106)

This indicates that there is a potential for pollution of controlled waters due to migration of contaminated groundwater from Area AC1 to the River Clywedog (French Drain / Field Ditch compliance point).

5.4 Area B East Findings

There were exceedances of the Level 1 groundwater screening criteria for cadmium (BH9, BH12), copper (BH12), iron (BH12), and zinc (BH9, BH12). These are illustrated on Drawing No. A1-13627-3030. Both boreholes were installed to intercept groundwater either within the made ground (BH9) or the underlying silty lay deposits (BH12).

Neither of these groundwater units is considered to be an aquifer and there is very unlikely to be a direct pathway to, or significant impact on the underlying bedrock aquifer. The nearest surface water receptor would be the Bedwell Brook lying approximately 68m to the northwest of BH9.

In addition the groundwater bearing unit that was sampled is underlain by at least 2m of alluvial clay which will provide an effective barrier to vertical migration of contaminants into the underlying bedrock aquifer.

It is not considered that pollution of controlled waters is being, or is likely to be caused by the groundwater contamination in this area.

5.5 Area B West Findings

There were exceedances of the groundwater screening criteria for cadmium (BH21), copper (BH17, BH21), and zinc (BH17, BH21). These exceedances are illustrated on Drawing No. A1-13627-3029. Both of these boreholes were installed to intercept groundwater either in the shallow made ground (BH17) or within the underlying silty clay alluvium (BH21). This water bearing unit is considered to be a non-aquifer and is underlain by at least 2m of alluvial clay which provides an effective barrier to further vertical migration of contamination to the underlying bedrock aquifer. The nearest surface water receptor would be the River Clywedog located approximately 600m to the north and it is considered that there is no pathway for shallow groundwater to migrate to the River Clywedog.

It is not considered that pollution of controlled waters is being, or is likely to be caused by the concentrations of metals in this area.

5.6 Bedwell Brook

Concentrations of chemicals detected in surface water samples from Bedwell Brook were compared with Environmental Quality Standards (EQS) and were found to exceed the EQS for metals and PAHs, particularly at the upstream locations (SS11-03-1). Sediment samples from further downstream (SD2, SD4) showed indications of free phase tar contamination.

The source for this contamination is uncertain; however, it is considered likely to come from the area of BH24 via the surface water drainage system. There may also be a component of contamination due to leaching from deposited materials within Area AC4.

5.7 Summary

There is a possibility of pollution of controlled waters due to leaching of contaminants detected in shallow Made Ground soils within Area AC2 and the associated groundwater contamination.

It is considered that leaching of contaminants from Area AC2 is contributing to the groundwater contamination of Area AC1 to the north and consequently, also contributing to concentrations of contaminants in groundwater that are discharging to the French Drain feature at the western site boundary. Ultimately this is considered as presenting the possibility of significant impacts on third party water courses and eventually, the River Clywedog.

It is considered that the concentrations of chemicals detected in groundwater in Area B East and B West are not causing and are not likely to cause pollution of controlled waters due to the lack of a source pathway receptor linkage.

6. ENVIRONMENTAL RISKS

6.1 Unacceptable Risks

It is considered that there are potentially unacceptable risks to human health due to inhalation of vapours from naphthalene contamination of Made Ground beneath the garage (TP1 and TP4) and that limited further site investigation is required to close out this potential issue.

It is considered that there are potentially unacceptable risks of pollution of controlled waters due to soil and groundwater contamination detected in Area AC1 and Area AC2. The risk driving pathways are considered to be leaching of contaminants from soil in Area AC2; made ground and tar impacted alluvium, including some tar impacts at the Boulder Clay interface, well beneath the groundwater surface level; and migration with groundwater towards the north and west, entering the French Drain feature beyond the site boundary, and ultimately the River Clywedog. Groundwater contamination already present within Area AC1 is also considered likely to migrate towards the French Drain and River Clywedog in a similar manner (assumed to be currently in equilibrium with leachate and infiltration inputs).

In addition, free phase oil and dissolved phase contamination of the Bedwell Brook (AC4) was also detected in sediment samples. It is considered likely that this originates in contaminated sand and gravel in the area of BH24 and the source pathway receptor linkage is via the surface water drain which runs between the western part of Area AC2 and Bedwell Brook.

6.2 Further Investigation

It is recommended that an additional borehole and groundwater monitoring well is installed within the footprint of the garage to determine whether significant contamination of the groundwater or granular made ground soils has occurred and to assess whether this is significant.

Additional site investigation within Area AC4 is recommended to assess the possibility of shallow groundwater carrying dissolved phase contaminants from this area directly into Bedwell Brook.

7. REMEDIATION STRATEGY

7.1 Strategy

The remediation strategy for the site has been prepared in order to systematically address identified unacceptable risks in such a way as to allow the continued use of the site, as a mixed commercial and open storage facility (Area A and C), with two small additional areas of agricultural grazing land and woodland to the east and west of the main site area (Area B).

The remediation is designed to be compliant with the requirements of current legislation and the NGPH Brief, which goes beyond the legislative requirements alone. Key requirements of the brief include: site suitability for existing use(s); no significant volumes of free phase, liquid tar; no visible significant accumulations of spent oxide waste; no ongoing significant pollution of controlled waters. NGPH requirements are set out in detail in the Core Specification documentation (Ref: 4).

A range of established remedial techniques will be applied, tailored to site specific conditions, to permanently address soil, groundwater and surface water and sediment contamination issues. Remediation works will avoid significant changes to the site surface levels and existing infrastructure / underground services.

Ancillary works alongside the remediation will address the demolition of a surplus building and identified problems associated with leaking potable water supplies and surface water drainage maintenance and integrity.

The remediation work has been designed to be safe, practical and robust, with inherent risks well characterised and capable of minimisation and management through normal site construction and demolition procedures.

Remediation works will be undertaken in a cost effective and co-ordinated manner, within as short a time frame as possible, with minimal disruption to third party tenants, neighbouring site occupiers and the general public.

7.2 Objectives

Principal objectives for the remediation are:

- i. Verified treatment or removal of significant free phase tar and other hydrocarbon contamination present within Made ground deposits and residual structures / pipework beneath the site surface.
- ii. Removal and treatment or disposal, of contaminated Made Ground from site surface deposits posing unacceptable risk to site occupants and users and replacement with verified suitable materials.
- iii. Removal and treatment or disposal of significantly contaminated, perched groundwater from beneath the site and overall improvement in water quality discharging from the site to surface water drains adjacent to the site boundary.
- iv. Treatment or disposal of grossly contaminated Made Ground deposits to prevent ongoing leaching of contamination to perched groundwater and site surface water drainage. Treated material to be rendered suitable for re-use as sub-surface fill across the site area.
- v. Removal and treatment or disposal of sediments from delineated sections of the site surface water drainage pipework and impacted receiving surface water course / pond. Prevention of future release of free phase hydrocarbons to same.
- vi. Safe demolition of the redundant and derelict former North East Wales District Office building. Demolition materials to be made available for on-site reuse or off-site recycling, with separate disposal of asbestos containing materials to a suitable off-site facility.
- vii. Provision of a new potable water supply connection for the occupied site buildings, including the isolation and disconnection / replacement of existing pipework that is leaking. Provision of suitable protection to the newly installed pipework to prevent any potential ingress of contamination from surrounding ground.

- viii. Provide a comprehensive record of all site investigation and remediation work and associated data for use in the future management or redevelopment of the site.

7.3 Remediation Requirements

Based on the refined CSM and detailed quantitative risk assessment discussed in earlier sections, a number of pollutant linkages have been identified that require remediation actions to reduce risk to an acceptable level under the current site use scenarios. These are summarised in the following sections. These requirements are subject to change in the event that there are changes to the proposed use or redevelopment of the site and if significantly different (from those described in the current CSM) site conditions are revealed by the proposed remediation works.

7.3.1 Tars and Hydrocarbon Impacted Soils (Area AC2)

The full depth (0.5-1.5m) of Made Ground in Area AC2, to the west and south of the Training Centre and Garage buildings is variably impacted by visible free tar, other liquid hydrocarbons (oils) and elevated concentrations of typical gasworks contaminants (including cyanide, petroleum hydrocarbons, PAHs and asbestos). Contamination typically persists (as denser non-aqueous phase liquids – DNAPL, black staining and strong coal tar odours) into underlying granular alluvial strata (sand and gravel) and has spread beyond the immediate vicinity of the likely original sources (tar tanks, tar separators / condensers, liquor tanks and the CWG and Benzol plants). In isolated areas, a layer of uncontaminated clay separates contaminated Made Ground and near surface structures from the deeper contaminated granular alluvium. Delineation of specific parts of the Area AC2 source zone as being more contaminated than others is not feasible and therefore, all visibly impacted material within the source zone requires remediation or removal from site.

7.3.2 Asbestos Contamination (Area AC2)

The contaminated Made Ground deposits within Area AC2 also sporadically contains significant concentrations of disseminated free fibres of asbestos, unmanaged exposure of these Made Ground materials at the surface of the site therefore needs to be prevented regardless of other chemical contaminant concentrations.

7.3.3 Contaminated Groundwater (Areas AC1 and AC2)

Contaminated perched groundwater, in the granular alluvium underlying the northwestern corner of the site (and effectively confined to that area by groundwater flow paths / gradients), is discharging to surface water drains and agricultural ditches on third party land. These discharges need to be improved to avoid significant impacts on receiving surface waters. It is recognised that ongoing protection of the surface water receptor relies on the parallel remediation of the original source of the contamination (Area AC2), this being the contaminated Made Ground and granular alluvium source areas described above. Key contaminants of concern include ammonia, cyanide, petroleum hydrocarbons, PAHs, sulphate and phenols.

7.3.4 Contaminated Drainage & Surface Water Sediments (Areas AC3&AC4)

Bedwell Brook sediments in the channel between the two on-site culvert entrances (Area AC4) contains visible black, free phase tar contamination and high concentrations of lead. These sediments need to be removed from the water course to prevent ongoing transport of contamination downstream (off-site) and the potential exposure of site users / trespasser and flora and fauna to the contamination.

Free phase hydrocarbon contamination has also been observed in the southern pond outfall area (Area AC3), although this does not appear to be linked to the Bedwell Brook contamination.

Sediments around a number of individual surface water drainage outfalls (Areas AC3 and AC4) are similarly contaminated by free phase hydrocarbons, these sediments also need removal from the site surface / receiving water body.

Sediments collecting within surface water drainlines (Areas AC3 and AC4), connecting the identified sediment contamination locations and contaminated Made Ground source areas, are also contaminated by free phase product. These sediments need to be removed from the drains in order to prevent future recontamination of the surface water receptors.

7.4 Potential Remediation Options

Potential remediation options for the site have been considered in detail as part of the outline remediation design undertaken for the initial project tender. These initial options have been re-examined in the light of recent Stage 1 investigations and detailed quantitative risk assessments described above.

7.4.1 Contaminated Made Ground and Granular Alluvium – Area AC2

The large site surface area, the presence of numerous below-ground structures, and the highly variable shallow groundwater regime effectively prevents the widespread use of any in-situ treatment (either sub-surface treatment applications or surface and sub-surface containment engineering). As such, recovery of impacted materials (by full depth excavation (soils) or pumping (water) and ex-situ remediation, or disposal of the impacted soils was considered necessary for the main contamination source areas.

Excavation works will need to include all grossly contaminated soil within the Made Ground and the underlying impacted granular alluvial soils. Excavation extents are constrained on all sides by retained structures or services, or property ownership boundaries.

Ex-situ remedial solutions that have previously been successfully applied at a number of UK gasworks sites in the past include:

- Thermal desorption dismissed due to the relatively small volume of material requiring treatment. For such small volumes thermal desorption is not considered cost effective due to the high mobilisation costs. In addition, given the proximity of residential areas, a chimney stack and stockpiles of high temperature treatment residues may be negatively perceived by the community.

- Bioremediation. Dismissed on the basis of incompatibility with the observed extensive free phase heavy tars, oils and complex cyanide contaminated residues. Achieving significant reductions in recalcitrant PAHs and longer chain hydrocarbons concentrations would be unlikely without excessive treatment times and pre-treatment/augmentation.
- Soil washing. Originally selected as the preferred treatment option (combined with solidification / stabilisation of the fines residue), this technique has been rejected due to incompatibility with the heterogenic nature of the Made Ground and underlying granular alluvium that contains significant silt/clay content. The relatively small treatment volumes arising from the physically restricted treatment area makes mobilisation of an onsite soil washing kit economically unfeasible. Soil washing would also be unsuitable for use with the small volumes of clay rich / fine grained surface water sediments that will arise from impacted receptor remediation.
- Offsite disposal. Considered non-sustainable compared to on-site solutions, despite the proximity of the hazardous waste treatment and landfill disposal sites in the region (as has been used for previous remediation work at the site). It was not considered appropriate to haul multiple loads of hazardous material through local residential areas, with an additional requirement to import a corresponding quantity of material back onto the site to maintain existing site levels. It is recognised that in some cases, site constraints and contaminant characteristics / on-site treatment failures, means that off-site treatment or disposal is the only viable option. Off-site treatment / disposal will therefore be considered as an option of last resort or as an emergency response to problems arising on-site.
- Solidification/stabilisation – this is discussed in more detail below.

7.4.2 Groundwater Treatment – Areas AC1 and AC2

Although modular and flexible on-site treatment of contaminated water is technically feasible, cost considerations mean that off-site treatment will likely always be favoured if direct transfer of the contaminated water can be achieved (pipeline / sewer as opposed to vehicle tankering), even if volumes and timeframes are relatively small.

Given that the site is reported to have an existing high capacity sewer connection, the disposal of contaminated groundwater to an existing off-site treatment facility (existing waste water treatment works (WWTW)) is possible. Simple pre-treatment (removal of suspended solids / free phase hydrocarbon layers) would be undertaken on-site to meet the requirements of the WWTW plant operators (Dwr Cymru in this case).

Residues from pre-treatment would be similar in character to other fine grained sediments / impacted soils that are requiring treatment on-site during the remediation works, although volumes would likely be small enough to make off-site disposal a feasible alternative if need be.

7.4.3 Impacted Receptor Sediments – Areas AC3 and AC4

In-situ treatment of impacted receptors was considered unacceptable / impractical due to the absence of control over long term movement of the stream sediments and the risks of off-site pollution incidents during treatment (full containment of the water course can only be maintained for a relatively short period of time). Remediation options were also influenced by the identified requirement to undertake large scale soil treatment works on the site, with these facilities potentially being available to also treat any contaminated surface water sediments.

Arising of these materials are relatively small and off-site disposal would be a feasible alternative if need be.

7.4.4 Asbestos Containing Materials (ACM)

Separately identifiable ACM are known to be present within the building scheduled for demolition and will be removed and disposed of by licensed contractors. Made Ground materials in Area AC2 are known to contain disseminated fibres of asbestos (which will be treated in parallel to the chemical contamination as described in Section 7.4.1), but may also contain isolated fragments of visibly identifiable ACM. Any visible and identifiable ACM exposed during Area AC2 excavations (or during any other remediation activities) will be physically separated and disposed off-site as Hazardous Waste.

The potential presence of asbestos fibres in excavated / treated materials will be taken into account and managed as part of each of the other remediation actions at the site.

7.5 Preferred Remediation Techniques

7.5.1 Soils Treatment – Area AC2

Due to the nature of the materials (variable coarse granular fill, sands, gravel, silts and clays), and the overall volume of material to be treated, and following discussions with specialist contractors, solidification / stabilisation was considered the most cost-effective solution.

Allowing for selective excavation and pre-treatment through screening, it is anticipated that all of the excavated soils material requiring treatment will be suitable for the solidification/stabilisation process. As such it is not anticipated that any bulk soil material will require offsite disposal, avoiding wagon movements through local residential areas. In addition, given that no material will be disposed of offsite, no import material will be required to be brought on site.

With careful excavation and materials management, a significant amount of reusable material will be generated through crushing and screening and this will be used to immediately backfill the excavation void.

The stabilisation process ultimately generates a volume of material where any residual contaminants are bound up in a matrix and rendered effectively hazard-free (including asbestos fibres). The nature of the resultant material can be tailored to suit the engineering and environmental requirements of the project. Given the low sensitivity site end-use and the low level of current impacts on identified receptors, remedial targets should be readily achievable by standard techniques. Stabilised materials can be designed to achieve long-term durability in excess of 120 years, as predicted by Arrhenius-based modelling, using laboratory-based environmental stress testing data. Treatment reagents are selected on the basis of extensive previous experience and up-front bench-scale trials discussed in more detail in Section 8.2.

Excavation and treatment processes are essentially “wet” processes, which will minimise the potential for generation of airborne asbestos fibres at each stage of the proposed works. Any signs of dust generation during the works will be proactively managed through the use of sprays and damping down of surfaces.

Treatment of gasworks wastes via solidification/stabilisation has a relatively long and successful history of application in the UK. It is considered a robust treatment technology, attractive in terms of providing positive validation of remediated materials (as opposed to in-situ treatment applications), and regulation of the treatment process itself (via an Environmental Permit).

7.5.2 Groundwater Treatment – Areas AC1 and AC2

The preferred option for groundwater treatment is off-site treatment at an existing municipal WWTW facility (i.e. discharge to the existing sewer). Extracted contaminated groundwater from Area AC1 will undergo initial pre-treatment on-site, prior to being discharged to existing foul sewer pipes for transfer off-site.

In addition to soils treatment (which will address possible future groundwater contamination through leaching), for the duration of the ex-situ treatment excavations, groundwater will be removed from the excavation areas in AC2 and passed to the on-site above-ground water treatment system prior to discharge to foul sewer.

It is anticipated that the on-site pre-treatment system will comprise settlement and oil water separators, augmented if necessary by sand & GAC filters. Based on available data this system is considered sufficiently robust to achieve anticipated discharge criteria.

7.5.3 Impacted Receptor Sediments – Areas AC3 and -AC4

Given the availability of on-site treatment, the preferred approach for surface water and drain sediments, will be to excavate / remove the sediments and transfer them to the on-site treatment area for de-watering and incorporation into the solidification / stabilisation process. Water draining from the sediments can be combined with the raw groundwater entering the sewer discharge pre-treatment process.

8. REMEDIATION DESIGN

8.1 Summary of Proposed Remediation Strategy

A summary of the proposed remediation approach for each significant pollutant linkage encountered at the site is provided in Table 14 below:

Table 14: Remediation Summary

CSM Source Area	Details of Target Contamination/Linkage	Proposed Remediation Strategy*
S2 and S5	Free phase tar and other gasworks residues impacted soils (& associated grossly contaminated groundwater) within Made Ground and granular alluvium beneath the former gas and tar chemical processing area. Current direct contact/ ingestion risks to site users, exacerbated by future disturbance or surface erosion/run-off). Ongoing risk of further release of free phase and leachable contamination into the surrounding soils and groundwater.	Dewatering and selective excavation and sorting of grossly contaminated materials from Area AC2; followed by treatment by solidification/stabilisation to render contaminated materials safe under foreseeable site use conditions, subject to replacement below the site surface and beneath cover materials (recovered from excavated Made Ground); pre-treatment of recovered groundwater and discharge for offsite treatment / disposal (at local WWTW).
S2	Asbestos Containing Materials and contaminated Made Ground. Discrete fragments and disseminated fibres. Current risk to site users due to inhalation of fibres, exacerbated by future disturbance or erosion/ run-off.	Segregation and removal of visible individual fragments of asbestos containing materials during excavation and demolition. Treatment of materials potentially contaminated by disseminated fibres by stabilisation/ solidification preventing future release of fibres under foreseeable site use conditions. Provision of durable cover (with no quantifiable asbestos fibres) in all areas where contaminated Made Ground has been excavated/replaced, protecting stabilised materials and preventing generation of dust through weathering.

CSM Source Area	Details of Target Contamination/Linkage	Proposed Remediation Strategy*
S5	Contaminated groundwater within the Made Ground and perched in granular alluvium (Area AC1). Presents a risk to adjacent surface water receptors (private agricultural field drains and ditches) due to sub-surface migration and site drainage discharge.	Ex-situ treatment of recovered groundwater, combined with site run-off and discharged to local foul sewer for off-site treatment / disposal (at local WWTW).
S7 and 8	Tar and free phase hydrocarbon impacted surface water and drain sediments. Current and ongoing risk of further release of free phase contamination into the receiving watercourse. Current direct contact, ingestion and vapour inhalation risks to site users.	Dewatering and incorporation into ex-situ treatment by stabilisation / solidification. Offsite treatment / disposal of recovered water along with other contaminated water arisings.

**Details of remediation areas are shown in Drawing Nos A1-13627-3052 to 3055 and volumes are detailed in Appendix E.*

8.2 Treatment Trials

8.2.1 Solidification / Stabilisation Techniques

A central aspect of the preferred remediation option is the selection of solidification/ stabilisation treatment as the core technology to be utilised for all contaminated soils arising at the site. Stage 1 works reported in Ref 1 included the collection of representative samples from the site as the basis for bench scale treatment trials by an experienced solidification/stabilisation specialist contractor (HBR Limited).

The trials were conducted on selected sample material representing a mixture of different contamination characteristics from Area AC2.

Trials consisted of the mixing of site materials with a range of selected binders and treatment agents to produce solidified/stabilized blocks that were subsequently tested for physical strength and chemical leachability. The results of the mixing trials and test results were assessed against baseline data and site specific considerations to produce recommendations for the final treatment options and methodology.

For expediency during the timeframes available, leachate testing was conducted on agitated, crushed treated material at a 10:1 liquid to solid ratio, intended to represent standardised, but extreme worst case leaching scenarios (given that actual site treated materials that will be placed as bulk fill within the original excavation voids and provided with surface cover).

The results were screened against the following targets in Table 15 produced using the EA RTM based on a Level 3 soil assessment, as per the input parameters in Table 16.

Table 15: Leachate Targets – AC2

Contaminant of Concern	Amended Level 3 Leachate (mg/l)	ug/l
Arsenic	1.40E+00	1.40E+03
Copper	7.85E-01	7.85E+02
Iron	2.81E+01	2.81E+04
Mercury	1.34E-03	1.34E+00
Zinc	3.35E+00	3.35E+03
Cyanide	3.65E-02	3.65E+01
Phenol	2.34E+01	2.34E+04
Naphthalene	1.17E+00	1.17E+03
Anthracene	4.16E-03	4.16E+00
Fluoranthene	2.57E-04	2.57E-01
Benzo (a) pyrene	6.99E-06	6.99E-03
Benzo(b)fluoranthene + Benzo(k)fluoranthene	1.19E-03	1.19E+00
Benzo(g,h,i)perylene + Indeno(1,2,3-c,d)pyrene	7.93E-05	7.93E-02

Table 16: Input Parameter

Parameter	Units	Value	Justification
Infiltration	m/day	4.97E-05	The annual average infiltration rate recorded by the Met Office is 726.2mm/year. It has conservatively been assumed that 25% of this value will be available to recharge the ground following redevelopment. This accounts for the very low permeability of the solidified/stabilised material, placement of a reworked layer of excavated natural till and additional compaction of site surface material.
Area of contaminant source	m ²	3670	Approximate dimensions of treatment area in AC2.
Length of contaminant source in direction of groundwater flow	M	118	Approximate north-south dimension of Area AC2.
Saturated aquifer thickness	M	0.6	Assumed thickness of Made Ground in AC2
Hydraulic conductivity of aquifer	m/day	0.28	Calculated from upper value of 3.2×10^{-6} m/s from: Hydrological and Hydrogeological Investigation At Maelor Works, Wrexham (Mentor No: 00138), Komex (2000).
Hydraulic gradient of water table	Fr	0.026	Maximum of hydraulic gradient range from: Hydrological and Hydrogeological Investigation At Maelor Works, Wrexham (Mentor No: 00138), Komex (2000).
Width of contaminant source perpendicular to groundwater flow.	M	33	Width of contaminant source of AC2.
Background concentration of contaminant in groundwater beneath the site	mg/l	0	Conservatively, assumes that no background contamination exists within the aquifer.
Mixing zone thickness	M	0.6	Mixing zone thickness calculated by the Remedial Targets Methodology based on the input saturated aquifer thickness.

The trial results illustrate that substantial leachability reductions can be achieved for all of the main contaminants of concern found in the grossly contaminated Made Ground and granular alluvium materials present onsite. The precise mixture of solidification/stabilisation additives can be varied on-site in response to visual assessment of material type, and the results of process/validation testing.

On the basis of the treatment trial results and extensive experience treating typical gasworks contaminated materials elsewhere, HBR is confident that the Maelor Works site materials are all amenable to treatment by a refined quicklime and pulverised fuel ash (PFA) reagent mix. Treated materials would be free from visible tar accumulations and would meet required leachability remediation targets (see previous Table 15). HBR's treatment trial report is included as Appendix F to this report. The use of crushed material leaching tests has been factored into consideration of the achievability of leaching targets from treated materials. Full details of the proposed validation strategy are provided in Section 10.2.2 of this report.

8.2.2 Groundwater Removal

The practicality of recovering the contaminated groundwater plume extending beneath Area AC1 was investigated through the sinking of a series of boreholes along the western and northern area boundaries and the sampling of these installed wells for existing groundwater quality. Pumping trials were then conducted to assess the response of the individual wells to sustained groundwater abstraction and to allow an estimate to be made of the likely volumes of recoverable groundwater present within the area.

Analysis of the pump test data suggested that recovery of shallow groundwater (all strata above the Boulder Clay) was feasible within the AC1 area, although variable strata type, thickness and permeability would affect the relative volumes recovered at any particular pumping rate.

Pumping for the estimated duration of other treatment works on the site would result in a volume of recovered water in excess of the likely total porewater volume within Area AC1 (pumping could achieve complete plume interception and capture for the duration of the works).

Additional boreholes would be required to maximise water recovery and avoid identified areas of sub-surface obstruction and low permeability.

Details of the pump test trials are contained in the Geo2 Limited letter report, attached as Appendix G. Chemical testing data is included in the screened water quality data presented in Appendix B. Volumes of water requiring treatment and disposal have been estimated on the basis of the pump test results and other site specific information arising from previous site investigations (see below).

8.3 Treatment Volumes

8.3.1 Ex-situ Soils Treatment

Volumes of material requiring remediation have been revised from the initial outline remediation design, on the basis of the discussion in the above sections. Given the intention to excavate full depth of Made Ground and thereby access all grossly contaminated materials, volumes have been calculated from the average thickness of Made Ground horizons and the areal extent of the individual contamination source areas as indicated on Drawing No. A1-13627-3053. Volume calculations take into account the recovery of discernible layers of suitable materials and oversize fragments recovered from screening of any excavated materials. Volume calculations are detailed in Appendix E.

8.3.2 Groundwater Removal and Treatment

Initial pumping test trials conducted during the Stage 1 works suggested that a total volume in the order of 50m³ per day on average, could be feasibly extracted from selected extraction wells. Installation of additional wells in the thick granular alluvium strata immediately to the north of the WWU land should increase this volume up to approximately 150m³ per day from the treatment area in total.

The total amount of contaminated groundwater present beneath the northwestern sector of the site (the main plume area) is estimated to be in the order of 5,600m³. The basis of this estimate is shown in Table 17.

Groundwater recovery will continue beyond the estimated overall pore-space volume, with additional groundwater being pumped to encourage flushing of residual contamination. Monitoring of groundwater quality will allow the extent of contaminant reduction to be evaluated on an ongoing basis.

Additional volumes of contaminated groundwater will be generated by the dewatering of Area AC2 during excavation of the soil contamination, and a small amount of groundwater drawn from under the adjacent WWU land holding. Dewatering will begin in advance of the main excavations and will be maintained during the works, with dewatering points being reduced as backfill progresses. Placement of treated materials into excavated areas will reduce future groundwater volumes generated in this area due to the low permeability / porosity of the treated material.

The sand and gravel beneath the WWU land is a very small proportion of the total groundwater bearing strata being treated and separate treatment or monitoring is not considered necessary.

8.4 Remediation Actions

The key remediation actions proposed for the site are illustrated for each site sub-area, AC1, AC2, AC3 and AC4, on Drawing Nos. A1-13627-3052 to 3055.

8.4.1 Source Remediation - Hydrocarbon & Tar Contaminated MG

Excavation works will include all grossly contaminated soil within the Made Ground and underlying DNAPL impacted alluvial soils down to the Boulder Clay interface (Area AC2, between 1.5m and 5m bgl). Excavation extents are constrained, on all sides by retained services or structures and some residual contamination may require to be left in-situ to avoid damage to retained features / services. Excavation areas will be extended as close to these boundaries as possible without producing a risk of ground movement/collapse into the excavated area prior to backfill with treated materials. Volumes of retained contamination at the excavation boundaries are considered insignificant with regards to recontamination potential. The use of low permeability recovered materials and very low permeability treated material will be considered to further reduce this risk (see also Section 8.4.2).

As shown on Drawing A1-13627-3053, it is anticipated remediation of the contaminated soils will require the excavation of approximately 9,000m³ of Made Ground; approximately 475m³ of this is made up of below ground structures/foundation slabs to be broken out. Following screening, recovered overburden material will be stockpiled for reuse without treatment (subject to validation testing). A total of 4,380m³ of material will require further treatment by homogenisation and mixing with site specific, selected solidification/stabilisation agents

It is anticipated that all of the residue requiring treatment (following excavation, segregation and screening), will be suitable for processing through the on-site solidification/stabilisation treatment plant. As such, it is not anticipated that any material will require offsite disposal and consequently, no import material will be required to be brought on site. All treated material will be replaced into documented excavation void areas and allowed to cure.

Following validation of the success of the treatment through testing, cover material (recovered granular / crushed material not likely to be subject to significant erosion or disturbance) will be placed over the backfilled areas to a minimum depth of 0.2m to protect treated materials from weathering and run-off erosion and prevent direct contact between treated materials and site users.

Due to the presence of asbestos fibres and encapsulated tar contamination in the placed treated materials, a high visibility marker mesh material will be placed over the surface of the backfill areas prior to the placement of a cover layer.

A significant amount of reusable material will be generated through crushing and screening (estimated at 2,500m³). This material will be combined with suitable natural materials segregated from the excavation (almost 2,000m³) and used to backfill the excavation void along with treated material. Enough recovered excavation arisings / crusher output will be retained to provide a persistent cover surface layer over these backfilled treated materials (0.2m minimum cover).

Following curing of the treated backfilled material, validation testing will be carried out to demonstrate achievement of the specified treatment targets (strength and leachability). Validation is discussed further in Section 10.

8.4.2 Contamination under Garage Building

Depending on the outcome of the additional investigations within the garage building footprint, the contamination within the Made Ground and alluvium strata beneath the existing garage building will either be designated as “insignificant” and left in place, or will be allocated for excavation and treatment as part of the wider Area AC2 works (following demolition and clearance of the building).

Plans will be confirmed following completion of the additional site investigation namely: two boreholes within the garage work space, penetrating to the Boulder Clay and allowing the sampling of soils and groundwater, along with the visual and olfactory inspection of recovered materials. Data arising from this work will be incorporated into the verification report for the site as a whole.

8.4.3 Source Remediation - Contaminated Groundwater

Perched contaminated groundwater in the granular alluvium beneath Area AC1, in the northwest corner of the site, within the catchment of the existing off-site French Drain feature, will be recovered by pumping from a selection of existing and newly installed boreholes. The location of the proposed pumping wells are shown on Drawing No. A1-13627-3052.

The selected extraction wells have overlapping zones of influence and will be maintained at minimal water levels through the use of electric submersible pumps. All the recovered groundwater will be pumped to the on-site pre-treatment lagoon for settlement and removal of any floating, free phase contamination (no DNAPL has been identified in this area).

Pumping will continue for the duration of the on-site works or until recovered groundwater consistently meets the groundwater treatment targets previously shown in Table 10, whichever is the shorter. Total groundwater arisings for treatment and discharge are estimated from pumping capacity and treatment times, as shown in Table 17 below. Groundwater treatment verification is discussed further in Section 10.

Perched groundwater present within the Made Ground and underlying granular alluvium within Area AC2 (the ex-situ treatment area) will be removed in advance of the excavations through pumping from large installed sumps, excavated to the Boulder Clay interface and supported by concrete rings. It is estimated that the groundwater removed by the dewatering operations will represent at least 50% of the total intergranular water present within the saturated Made Ground horizon beneath the remediation areas. This volume is estimated to be 878m³, as per estimates in Table 17.

Table 17: Groundwater Volumes Estimates

ZONE	Excavation / pumping Area (m ²)	Depth Range (m)	Rest Water Level (mbgl)	Sat Zone Thickness (m)	Assumed Effective Porosity (unitless)	Recoverable GW Vol (m ³)
Area AC1	8,860	4.0 - 5.6	1.5 – 2.5	0.8 – 3.9	0.3	5,640
Area AC2	2,881	1.2 – 4.0	0.5 - 1	0.6 – 2.7	0.3	878
Total						6,518

For the duration of the excavation and backfilling operations, groundwater will be removed via pumping and passed through the water treatment system prior to discharge to foul sewer.

On cessation of pumping and backfilling of excavations, the removed groundwater will gradually be replaced by shallow groundwater flowing naturally from less contaminated areas of the site; the existing hydraulic gradient and flow patterns are likely to be generally re-established, with the exception of very low permeability treated materials backfill (Area AC2).

Backfill will comprise both recovered granular/clay materials and treated solidified/stabilised contaminated Made Ground residue; this will have greatly reduced permeability and leaching potential compared to other backfill. Surface infiltration and groundwater flow through backfilled treated material is expected to be minimal, but given the relatively high permeability and thickness of surrounding granular alluvium strata, this is not anticipated to have a significant impact on overall groundwater flow beneath the site.

During the works, water quality monitoring of recovered groundwater and the French Drain discharge chamber will provide data to compare against the historical baseline and treatment targets. It will also allow the assessment of any significant trends resulting from the site disturbance and remediation actions.

8.4.4 Source Remediation –ACM

All demolition work will be subject to the separate removal and disposal of ACM by licensed asbestos contractors. Only materials confirmed to contain no quantifiable asbestos will be released for use in other site works.

In Area AC2, Made Ground deposits contaminated by asbestos at concentrations likely to be in excess of 0.1% by weight require to be removed from the site surface. All affected Made Ground lies within the main remediation area excavations and will be subject to treatment, thereby producing a solidified / stabilised material suitable for use as general backfill at depth (no surface exposure).

Visible fragments of asbestos contaminated material exposed at the site surface or revealed by excavation and material processing will be individually removed and placed in secure containers awaiting off-site disposal at a licensed disposal facility.

8.4.5 Impacted Receptor Remediation

The Bedwell Brook channel (Area AC4), between the two culvert entrances (a total distance of approximately 120m) will be excavated by machine to a maximum depth of 0.5m below existing bed levels. Excavations will be to a shallow “V” profile and subject to visual inspection to ensure that all visibly impacted sediment is removed.

During the course of excavation, the watercourse will be temporarily dammed at both culvert entrances, with flow being managed by over-pumping.

The southern pond feature (Area AC3) also has a small amount of contaminated sediment around the existing outfall that will be excavated by machine in parallel to the Bedwell Brook works.

Both works areas will be surveyed for the presence of protected species (notably great-crested newts, water voles, otters and – dependant upon the time of year – nesting birds) by an appointed ecologist prior to commencement of any works. Any mitigation measure required in this context will be determined by the findings of the ecology survey. Note that these areas are outwith previously anticipated remediation areas, hence they were not included within the Phase 1 Habitat survey carried out during Stage 1 works (contained within Area AC Factual Report)

Total volume of impacted sediments is estimated as 152m³. This will be treated as per contaminated materials from AC2.

8.4.6 Pathway Modification – Clearance of Contaminated Drainage Sediments

Identified stretches of site drainage in Areas AC2, AC3 and AC4 contain contaminated sediments and other tarry / oily residues from historical site emissions. To prevent this pathway from operating in the future and recontaminating the remediated pond and brook receptors, the drains will be isolated and inspected to assess the extent of contaminated sediment build-up and current integrity. Where possible, drains will be cleared using water jetting techniques, with the dislodged sediment being transferred to site soil treatment area. The effectiveness of jetting will be confirmed by re-inspection of the treated drain lines.

Approximately 510 linear metres of drains need to be inspected and cleared. This is anticipated to generate a total of 76m³ of contaminated sediments and water slurry for treatment.

8.4.7 Pathway Modification - Leaching from Replaced Treated Materials

Leachability targets for key contaminants of concern (CoC) have been derived using the EA Remedial Targets Methodology assuming excavated materials is replaced into the excavation areas in Area AC2. The leachate treatability targets are included in Appendix D, and have been shown previously in Table 15. Treated materials will form a consolidated low permeability mass above and within the shallow, water saturated Made Ground, with a low hydraulic gradient towards the French Drain on the western site boundary. Achievement of the stated leachability targets for these materials is designed such that, allowing for attenuation and dilution, leachate from the placed material would not lead to exceedances of surface water quality standards upon entry into the French Drain (or field ditches beyond). Additional safety factors for water environment risks include:

- Leachate targets applied to disaggregated, small grain size samples of treated materials (in practice, placed materials will form a stable, monolithic mass with a bulk permeability estimated in the range of 10⁻⁹ to 10⁻¹⁰ ms⁻¹).
- Modelled scenario assumes uniform groundwater flow through the treated materials and Made Ground layer. In reality the significant permeability difference between the two materials will effectively prevent significant flow through the treated mass, further reducing leaching potential.

8.4.8 Pathway Modification - Burial of Contaminated Materials

Solidified/stabilised materials arising from Area AC2 works will contain elevated concentrations of a range of gasworks contaminants (including asbestos). Therefore, in order to prevent direct contact/surface inhalation pathways between these materials and future site users, all treated materials and asbestos contaminated Made Ground from within the main excavation areas, will be replaced at depth and covered by a persistent layer of recovered materials to a depth of not less than 200mm. Cover material suitability targets are the same as the initial soil screening criteria shown in Table 3.

The location and character of all retained contaminated materials will be recorded within the site verification report. This report will be produced in accordance with Appendix C11, Annex C, of the Core Specification (Ref. 4).

8.5 Post Remediation CSM and Pollutant Linkages

The remediation strategy for the works is based on a series of targeted, robust interventions aimed at permanently breaking identified pollutant linkages within the constraints of the site boundaries, retained services and the project timescale.

Adoption of this strategy will effectively reduce the hazards associated with identified source areas for both human health and water quality sensitive receptors, without reliance on any unquantified attenuation and pathway restrictions currently thought to be protecting the French Drain and agricultural ditches beyond.

Treatment of the worst affected source areas will also reduce the impact of future infiltration of rainwater into Made Ground deposits, and the subsequent leaching of gasworks contaminants into shallow groundwater, further reducing the potential impact of ongoing slow groundwater movement towards and seepage into the French Drain.

The strategy will allow the reinstatement of the site to its current form and use, without major constraints on future management or redevelopment.

8.5.1 Post Remediation Risk Assessment

The site qualitative risk assessment was revisited following the development of the remediation strategy to ensure that the strategy was robust and would adequately address identified significant pollutant linkages. The outcome of the post remediation risk assessment is summarised in Table 18 below.

Table 18: Post Remediation CSM

Site Area	Source	Pathway	Receptor	Post remediation site conditions		
				Consequence	Likelihood	Risk
AC2	Variable made ground impacted by gasworks process residues and asbestos fibres, treated by solidification / stabilisation techniques and placed beneath cover layer. Source area S2.	Direct contact and dust / vapour inhalation.	Site users and trespassers.	Negligible due to immobilisation of contaminants and absence of direct contact linkage.	Unlikely –capping layer provided over all treated materials.	Very low. Presence of treated materials recorded and future disturbance avoided or controlled.
AC1 AC2 AC4	Variable made ground impacted by gasworks process residues and asbestos fibres, present beneath building footprints and within buried service corridors. Source area S1, S2, S3 and S4.	Direct contact and dust / vapour inhalation.	Site users and trespassers.	Negligible due to limited areas affected and absence of direct contact linkages.	Unlikely – no unauthorised / managed access to contaminated materials.	Very low. Presence of contaminated materials recorded and future disturbance avoided or controlled.

Site Area	Source	Pathway	Receptor	Post remediation site conditions		
				Consequence	Likelihood	Risk
AC2	Free phase tar and contaminated made ground and granular alluvium extending into the saturated zone, treated by solidification / stabilisation techniques to form very low permeability mass. Source areas S2.	Leaching by infiltration and shallow groundwater, followed by groundwater migration and movement through site drainage.	Third party field drains / ditches (linked to River Clywedog. Bedwell Brook	Negligible due to low leachability / permeability and dilution by groundwater from adjacent areas.	Likely – hydrogeological regime re-established after placement of treated materials.	Very low. Presence of contaminated materials recorded and future disturbance avoided or controlled.
AC1 AC2	Free phase tar and contaminated made ground and granular alluvium extending into the saturated zone, present beneath building footprints and within buried service corridors. Source areas S2 and S3.	Leaching by infiltration and shallow groundwater, followed by groundwater migration and movement through site drainage.	Third party field drains / ditches (linked to River Clywedog. Bedwell Brook	Negligible due to small areas affected, length of attenuating pathways and dilution by groundwater from adjacent areas.	Likely – hydrogeological regime re-established after placement of treated materials.	Very low. Presence of contaminated materials recorded and future disturbance avoided or controlled.

Site Area	Source	Pathway	Receptor	Post remediation site conditions		
				Consequence	Likelihood	Risk
AC1 AC4	Residual historically contaminated shallow groundwater in made ground and granular alluvium. Source areas S5 and S6.	Migration along local hydraulic gradients / entry into surface water drainage.	Third party field drains / ditches (linked to River Clywedog. Bedwell Brook.	Mild due to limited volumes. Diminishing source, with ongoing degradation and dilution by groundwater from adjacent areas.	Likely – hydrogeological regime re-established after placement of treated materials.	Low. Any ongoing impacts monitored to demonstrate diminishing source.
AC1 AC2	Free phase tar and tar contaminated made ground present beneath building footprints and within buried service corridors. Source areas S2 and S3.	Inhalation of vapour.	Site users / trespassers.	Negligible due to small areas affected and presence of building structures / floor slabs.	Likely - no engineered containment.	Low. Presence of contaminated materials recorded and future disturbance avoided or controlled.
AC2 AC4	Contaminated sediments collected in surface water drainage pipework and around outfalls. Sources S7 and S8	Flushing by infiltration and shallow groundwater, followed by discharge to surface water bodies.	Bedwell Brook.	Negligible due to removal of historical contaminated deposits and treatment of original source.	Likely - limited volumes and intermittent, depending on rainfall.	Low. Future impacts subject to monitoring.

Site Area	Source	Pathway	Receptor	Post remediation site conditions		
				Consequence	Likelihood	Risk
AC1 AC2	Shallow groundwater within granular alluvium impacted by dissolved gasworks process contaminants. Source S1.	Lateral migration along hydraulic gradient towards surface water.	River Clywedog.	Mild - no detectable rise in water concentrations under typical conditions.	Unlikely – due to limited volumes, absence of direct pathway.	Low. No remedial actions required under current conditions / use.
B EAST B WEST	Contaminated imported made ground (ash / clinker / coal mining spoil) in embankments and shallow surface layer. Source S9 and S10.	Direct contact and dust / vapour inhalation.	Site users / trespassers.	Moderate - exceedance of typical CLEA criteria, but bioavailability likely to be very low (due to nature of contaminated materials).	Unlikely – due to low usage of site / presence of soil / vegetation cover.	Low. No remediation action required under current site use.
B EAST B WEST	Contaminated imported made ground (ash / clinker / coal mining spoil) in embankments and shallow surface layer. Source S9 and S10.	Migration / leaching by infiltration and shallow groundwater, followed by groundwater migration and movement through site drainage.	Field drains / ditches (linked via third party drainage to River Clywedog / Bedwell Brook	Negligible – due to limited volumes. No detectable rise in water concentrations under typical conditions.	Likely – no controls in place.	Low. No remediation action required under current site use.

All significant risks have been addressed through the proposed remediation strategy described in detail in the preceding sections. The site works required to achieve the remediation targets / objectives are detailed in the following section.

9. SITE WORKS

9.1 Introduction

On the basis of the preceding assessment and design, it is proposed to undertake a series of interrelated site works that will effectively implement all of the preferred remediation actions. These works are illustrated in Drawing Nos. A1-13627-3052 to 3055 and described in more detail in the following sections.

It is noted that the water main replacement and office building demolition work that are part of the overall contract for the project are essentially unrelated to the contamination remediation work and are dealt with under separate a documentation and permitting process. They are therefore not included in any detail in this report,

9.2 Scope of Works

All site works will be undertaken within defined remediation areas on site, under the control of the main contractor, and supplied with all necessary resources to complete the remediation and managed in line with agreed site procedures and working plans. The scope of the proposed remediation works within each designated site area is described in the following sections.

Required works will be undertaken within predefined, safe and secure working areas, in accordance with agreed method statement / risk assessments and including the protection of known site services / utilities as necessary.

9.2.1 Area AC1

- Four additional groundwater borehole recovery boreholes will be installed at the specified locations across the southern sector of Area AC1. Each groundwater borehole, including six existing boreholes, will be installed with a submersible pump and level switch to allow automatic continuous pumping of groundwater from each well (see Drawing No. A1-13627-3052). The rate of pumping will be adjustable and each pump will be supplied with sufficient temporary pipework to permit transfer of pumped water to the central collection / treatment facility.

- A settlement tank and optional additional pre-treatment facility will be established in a secure location within the vicinity of the groundwater recovery boreholes. The settlement tank will be monitored visually for the presence of free phase hydrocarbon liquids, which will be removed using absorbent booms or pads for off-site disposal
- Outflow from the settlement tank / pre-treatment modules will be discharged directly to sewer, with regular (weekly) sampling (in addition to daily visual inspection) to confirm compliance with the sewer discharge consent. Any visible contamination, complaints from the receiving WWTW, or testing failures will result in a review of pre-treatment requirements and modification of on-site facilities / practice as necessary.
- Groundwater levels (at established and new wells), recovered volumes and chemical quality will be monitored on a daily basis to allow prompt responses to changes and the continuous refinement of recovery / treatment operations. Monitoring to continue after cessation of pumping to enable assessment of any rebound / renewed flushing of contaminants.

9.2.2 Area AC2

- Breaking out of concrete foundation slabs / residues within the former operations area of the gasworks site (Area AC2) to allow excavation of contaminated materials for screening and treatment. Concrete to be crushed for reuse.
- Installation of temporary works system to support deep excavations in close proximity to existing services / buildings as required.
- Excavation of dewatering sump holes and installation of perforated concrete ring supports to keep sumps open during dewatering.
- Excavation in layers of designated contaminated Made Ground and granular alluvium on Area AC2 (see Drawing No. A1-13627-3053), with visual separation of contaminated and non-contaminated materials.

Excavated materials scheduled directly for screening or crushing depending on size and contamination status. Following screening, materials sentenced to treatment, or reuse stockpiles and subject to validation sampling/ testing. Oversize materials from screening and from breakout of hard structures crushed to nominal 100mm size and stockpiled separately for reuse on site.

- Contaminated fines in screening stockpiles moved to treatment area for the addition of treatment reagents and mixing using specialist mixing plant (deep rotorvator type). Treated materials placed in designated stockpiles or replaced directly into excavation voids (depending on availability).
- Dewatering of excavation voids using portable submersible pumps, with water pumped to on-site treatment facilities for settlement and oil separation prior to reuse within the soil treatment process or discharge to local sewer (subject to testing and possible further treatment if necessary). Additional, direct dewatering of excavation voids to be maintained until final backfill is completed.
- Retained crusher residue and recovered soils used to provide minimum of 200mm cover layers to replaced treated materials. Any surplus recovered material used to re-instate other working areas within the site on completion of works.
- Perimeter air and adjacent watercourse to be monitored throughout to confirm absence of significant contamination (including asbestos fibres), dust or odour emissions, as per the Site Safety, Health and Environmental Quality Plan.
- Visual inspection and instrumental monitoring of bulk excavation materials for radioactivity.

9.2.3 Area AC3

- Upstream manhole access points for surface water drainage will be nominated and confirmed free of visible contamination. Sections of drain downstream of access points will be visually surveyed by specialist inspection tools / cameras, with any physical obstructions cleared (including securing additional access points / resort to high pressure jetting where necessary).
- Securing of outfall to contain any drain sediments / contaminated water issued during inspection and cleaning. Transfer of collected sediments and liquids to the water treatment / soils treatment areas as appropriate.
- Re-inspection of cleaned pipework to confirm adequate clearance of sediments etc and record condition on completion.
- Excavation of the existing outfall pipe and surrounding sediments, including pond sediments contained within the temporary collection structure placed during the drain clearing operations. Regrading of existing bank materials as necessary and the installation of a new outfall pipe and gully pot type interceptor at the drainage entry point.
- Monitoring of the water quality within the receiving pond feature throughout the works and the preparation of / provision for pre-agreed actions in response to any contamination arising during the works.
- It is noted that the whole pond area will need to be confirmed as being free of great crested newts and secured against access by this species for the duration of the works.

9.2.4 Area AC4

The section of Bedwell Brook between the two culvert entrances will be isolated and flow transferred across the isolated section, initially by pumping equipment until temporary pipework can be placed to allow passive flow transfer during channel works. Pumping equipment and separate temporary pipework will be maintained on stand-by, in case additional flow management becomes necessary during periods of heavy rainfall / while passive flow pipes are being moved due to channel works.

Following the isolation of the main channel section of Bedwell Brook, upstream manhole access points for each branch of surface water drainage discharging to Bedwell Brook will be nominated and inspected for visible contamination. Sections of drain downstream of access points will be visually surveyed by specialist inspection tools / cameras, with any physical obstructions cleared (including securing additional access points / resort to high pressure jetting where necessary).

Once drains have been inspected and cleared, each outfall location will be excavated out (excavations supported by temporary support sheet piles or trench boxes) to permit the installation of new pipework and the placement of impermeable stank structures, a minimum of five metres back into the existing tipped material face. Stanks will provide an impermeable seal around drainage outfall pipes and will extend at least two metres on all sides of the pipe. Newly installed outfall pipes to be provided with reinforced (aggregate filled gabions or similar) spillway areas leading from the discharge point to the brook channel. Trenches will be backfilled using spoil from the original excavation (excluding any grossly contaminated or oversize material which will be transferred to the site soil treatment area for appropriate processing). Finally, a re-inspection of cleaned pipework will be conducted in order to confirm adequate clearance of sediments etc and record condition on completion.

Working upstream from the road culvert entrance, sections of isolated channel will be excavated out to remove loose sediment and any associated free phase contamination. The excavated channel will then be re-graded to a stable profile, utilising existing bank materials. On completion of each section, flow will be re-established to that section by adjusting the passive flow transfer pipework. All excavated sediments and entrained soils / debris will be transferred to the site soil treatment area in Area AC2 for incorporation into the solidification / stabilisation treatment process and re-use as backfill within the Area AC2 excavations.

Following excavation of the all channel sediments, the upstream isolation barrier will be maintained for use in the collection of sediment dislodged by the clearing of the railway embankment culvert pipes. Flow transfer during culvert clearing will need to be by pumping due to the presence of the railway embankment structure itself. Sediments collected from the culvert clearance will be transferred to the site soil treatment area for screening and re-use, subject to visual inspection and chemical testing to demonstrate compliance with site soil quality targets. Any materials rejected for direct re-use will be consigned for treatment by solidification / stabilisation in the site treatment facility.

It is noted that pre-works surveys of the Bedwell Brook valley between the culvert entrances will be required to confirm the absence of protected species (great crested newts, water voles, otters and badgers. An ecologist will be retained on a watching brief to ensure that these species remain excluded from the working area during flow transfer and channel clearing operations.

Limited tree / scrub clearance will be required to permit plant access along the northern bank of the brook and around the identified outfall locations. Visible surface refuse / oversize waste materials will also be recovered from the exposed tip face / brook bank-side at this time.

Downstream sediment trapping / flow polishing will be required throughout the works (straw bales or similar).

9.3 Site Set-up/Layout

It is recognised that the Maelor Works is an active site and that site tenants and visitors will require consideration and protection at all times during the works. The site has sufficient space to allow strict segregation of remediation areas and the re-location of existing operations from within the main excavations in Area AC2.

Regular liaison with site tenants will seek to ensure that remediation works are planned so as to have minimal impact on normal site operations / use.

The site set-up for carrying out the proposed scope of works described above is shown on Drawing No. A1-13627-3004 (subject to ongoing refinement / development in discussion with the site and regulators). The main treatment areas will be effectively separated from the adjacent WWU / Flogas working areas and already has a fully secured boundary on all other sides.

Working areas beyond the decontamination unit placed at the entrance to designated working areas will be designated as “dirty” with all workers required to pass through the decontamination unit on entry and exit from these areas.

Additional stockpiling areas will be designated and documented as required during the works, all maintained within the main working area, but separate from active excavation/open voids.

Entry into the operational Flogas area (Area AC3) will be required for the drain clearing / outfall works in this area. All works will be co-ordinated with Flogas to ensure health and safety and minimise disruption to their operations.

9.4 Service Location Strategy

All active services will be positively identified on site and service location and protection will be a prime focus of all excavation and materials placement work procedures. Known services for each remediation area are indicated on the current Site Constraints Plan (Drawing Nos. A1-13627-3003).

No significant service relocation or diversion is anticipated as part of the remediation works. A number of redundant / stub underground gas pipes and electrical cables are known to be present within the main Area AC2 excavation areas. These services will be positively located, disconnected and made safe prior to the commencement of any excavations in that area. Cables and gas pipework excavated from within Area AC2 will be manually separated / screened out of materials scheduled for treatment or reuse.

9.5 Excavation and Materials Processing

Excavation of Made Ground and underlying alluvial strata within the designated remediation areas will be carried out by standard excavation plant, with direct transfer to dump trucks for transport to stockpiles or treatment areas as appropriate. Excavators will have access to hydraulic breaker attachments for the breaking out of hard structures when encountered within excavation areas.

Additional excavators and dumpers will be utilised to move materials to and from stockpiles and the soils treatment area/backfill locations.

The soils treatment area will be provided with a solid, level surface as a base for the surface mixing of processed contaminated Made Ground and granular alluvium. This base area to be formed from existing concrete hardstanding and bitumen road surfaces.

Mixing will be carried out using specialist rotovation equipment with mixing to pre-set depths and the controlled addition of treatment reagents and water. Any surface run-off from the treatment area will be collected and pumped to the on-site water treatment plant.

All on-site materials movement will be either direct to treatment plant (screening or crushing), or from designated stockpiles, managed through close verbal communication between the plant operatives and the site manager/supervisor. All materials will be quantified and subject to tracking procedures from the point of excavation to final backfill (or off-site disposal if that proves necessary).

9.6 Soils Treatment

All excavated materials will be subject to designation as contaminated or reusable and treatment via mechanical screening or crushing (all as specified at the point of excavation). Screened and crushed material will be placed in segregated stockpiles awaiting reuse or treatment.

Contaminated screenings will be subject to treatment by solidification/stabilisation in line with the specialist contractor's agreed working plan and subject to continual revision and refinement under the same (in reaction to ongoing site observation and testing/validation results).

Oversize vegetation (large shrubs and small trees) will be shredded using portable shredders prior to replacement with any recovered loose soils on selected final site surfaces.

Selected arisings from water main replacement trenching and demolition works will be brought into the treatment area for treatment and reuse, if the timings are compatible.

Any other residual materials that are designated as unsuitable for on-site reuse or treatment will be segregated and securely stored awaiting off-site disposal.

9.7 Water Treatment

All water arisings on the site, from excavation void dewatering and surface run-off from treatment areas and site roadway drainage, will be collected locally and pumped (run-off), or pumped directly to the on-site water treatment area for settlement and free phase oil separation /additional treatment if needed. Treated water will be drawn off for use in soils treatment as required, with surplus volumes being discharged to the local foul sewer (subject to confirmatory testing to ensure compliance with the discharge consent). In the event that specific contamination levels are preventing the reuse or discharge of the collected water, further treatment modules will be brought to site to effect further treatment and allow appropriate local discharge of the water to ground / surface water drainage.

9.8 Traffic/Pedestrian Management

As mentioned in Section 9.3, the remediation work areas will maintain strict segregation from other site operations. Where necessary, existing site traffic and pedestrian routes will be temporarily altered to protect this segregation and the people involved.

It is recognised that the proposed remediation works rely on the close co-operation between site managers/supervisors and excavation and material transport operatives. Careful management of pedestrian and machine traffic within site working areas is therefore critical to the safe completion of the proposed works. Designated machine and pedestrian routes will be rigorously defined and maintained throughout the works, with all site personnel being briefed on requirements and changes on a daily basis.

Up to date plans will be prominently displayed in site accommodation and at the entrance to the dirty work area at all times.

9.9 Security

The existing Main Works site perimeter is considered adequately secure (subject to regular inspection and vigilance of all site personnel). Existing site tenants, users and visitors will only be able to enter and leave via the single access point at the southeast corner of the Main Works site and will not be able to gain access to any remediation working areas which are separately barriered off.

Any site security breaches (either during working hours or while site is closed) will be reviewed by the site management and any reaction or procedural change initiated as appropriate.

9.10 Proposed Subcontractors

Specialist sub-contractors are to be employed for the following remediation activities:

- Stabilisation/solidification treatment of screened excavation materials (HBR Limited – operating under a mobile treatment Environmental Permit issued by NRW, with accompanying Site Specific Working Plan (SSWP)).
- Groundwater recovery and pre-treatment (Geo2).

- Jetting and inspection of surface water drains (tbc – local approved sub-contractors).
- Off-site disposal of ACM (tbc – subject to duty of care documentation and environmental permits issued by NRW / EA).
- Visual inspection and instrumental monitoring (screening) of excavated materials for radioactivity (Aurora Health Physics)

9.11 SHEQ

Site remediation works will be subject to ongoing safety, health and environmental management in accordance with agreed plans and contractor/sub-contractor procedures. Environmental monitoring of ambient air (odours and asbestos fibres) and groundwater and surface water will be conducted at regular intervals throughout the works to provide documented evidence of the success of site controls. Any potential or actual problems revealed by the monitoring will be investigated immediately by the site manager and appropriate reactions/changes to procedures agreed with the regulators and site operatives. Monitoring will commence in advance of any substantial site works in order to provide a baseline dataset for the monitored parameters (not necessary for waters, as data has already been gathered during recent site investigations). Individual monitoring actions are listed in Table 19 below and included in the separate SHEQ Plan.

Table 19: SHEQ Monitoring

Potential Impact	Receptors	Monitoring
Dust	On-site staff (tenants) & construction workers	Qualitative - twice daily visual assessment at two working area boundary location points by nominated person. Quantitative - real-time dust quantification analysis carried out twice daily at the nominated location points using hand-held dust monitor. Monitoring to commence in advance of works to provide baseline data. Additional monitoring to be carried out during high risk activities (e.g. screening, crushing and S/S treatment) as necessary.

Potential Impact	Receptors	Monitoring
Noise	On-site staff (tenants) & construction workers	Qualitative - twice daily assessment at two location points (agreed with site tenants), and during specific high risk activities (e.g. crushing, breaking out and piling). Quantitative - real-time noise monitoring carried out twice daily at the nominated location points using hand-held noise monitor. Monitoring to commence in advance of works to provide baseline data. Additional monitoring to be carried out during high risk activities (e.g. crushing/breaking out and piling) as necessary.
Vibration	On-site staff (tenants) & construction workers	Qualitative – twice daily assessment at two nominated locations (agreed with site tenants) by nominated person. Ongoing at locations to be agreed to protect gas plant. Quantitative - real-time vibration to be carried out twice daily at two working area boundary locations by nominated person using Vibrock V901 vibration monitor. Monitoring to commence in advance of works to provide baseline data. Additional monitoring to be carried out during high risk activities (e.g. crushing/breaking out, piling and demolition) as necessary.
Odour	On-site staff (tenants) & construction workers	Qualitative - olfactory assessment carried out twice daily at two nominated locations (agreed with site tenants) by nominated person. Quantitative - real-time monitoring to be carried out twice daily the two nominated locations and at excavation face by nominated person using hand-held PID. Monitoring to commence in advance of works to provide baseline data. Additional monitoring to be carried out during high risk activities (e.g. hydrocarbon excavation) as necessary.

Potential Impact	Receptors	Monitoring
Air-borne asbestos	On-site staff (tenants) & construction workers	Quantitative air-borne asbestos analysis - carried out by specialist sub-contractor at site boundary locations, and within working area using personnel monitors, during periods when asbestos containing materials are exposed or being handled. Details to be finalised with specialist sub-contractor. Monitoring to commence in advance of works to provide baseline data.
Water quality	Bedwell Brook French drain discharge chamber.	Qualitative - twice daily inspection of upstream and downstream entry/exit points for gross discolouration or oily sheens/slicks. Quantitative - weekly sampling at downstream exit point, starting prior to commencement of works and extending one week beyond effective completion. An additional set of monitoring samples to be taken three months after completion of the works. Additional - inclusion of upstream/ midstream re-sampling if visual inspections or analytical results give cause for concern.

10. VERIFICATION PLAN

Each element of the site remediation work will be subject to separate and specific verification / validation to demonstrate that the works have been completed in an appropriate manner and that the specified remediation targets have been met.

Site working methods and management procedures will include pre-agreed responses to verification / validation failures and other potential problems due to unexpected ground conditions or additional contamination impacts. Such responses will also be subject to ongoing review and refinement throughout the works.

Due to the nature of the site and the identified pollutant linkages being remediated, the site will also be subject to surface water and groundwater monitoring at established off-site and on-site locations, allowing the comparison of post-remediation water and sediment quality against pre-remediation conditions and environmental quality standards as appropriate.

All site works and the results of verification and monitoring testing will be recorded in a comprehensive verification report that will be produced on completion of the site works, with an addendum produced following the 3 month post-remediation monitoring round.

10.1 Area AC1

10.1.1 Groundwater Recovery Volumes

Comprehensive records will be kept of the volume of groundwater recovered from each borehole, with regular checks of pumping rates and automatic data logging of pump operating times.

Total pumped volumes will be compared against estimated pore volumes on a weekly basis and the final pumped volume to pore water estimate ratio recorded for Area AC1-1 and Area AC1-2.

10.1.2 Water Quality Testing and Trend Evaluation

Field monitoring of gross water quality parameters (pH, electrical conductivity and redox potential) will be conducted on a daily basis, with data being plotted as a time series graph to allow trends to be evaluated. Field monitoring parameters will be calibrated against actual concentrations of selected target contaminants (ammonia, total phenol and cyanide) through regular chemical testing (weekly samples from 3 locations in each treatment area).

Additional laboratory testing for the standard NG suite of parameters will be conducted on samples from selected boreholes on commencement of treatment and on a monthly basis throughout the groundwater recovery period (including a final sampling round on completion).

In addition, confirmation of the achievement of the specified leachability targets for replaced, treated materials in Area AC2 is an integral part of the verification process for Area AC1 (see Section 10.2.2 below).

10.2 Area AC2

10.2.1 Verification of Excavation Extents

The extent of each nominated remediation area excavation will be confirmed on the basis of both visual inspection of the sub-surface conditions revealed by the ongoing machine excavation and the testing of representative samples from the base and sides of each excavation area, sampling to be undertaken once visible signs of gross contamination are absent. Verification samples shall be submitted to the on-site test kit soils analysis as per Appendix B4 Annex B of the Core Specification. Approximately 10% of these samples will be sent to an accredited laboratory for chemical analysis, as per the Core Specification, as a cross-check:

- Gross Hydrocarbon/Tar Impacted Soils
- It is anticipated that a total of 324 verification samples shall be required for TPH testing. This is based on:

- One sample per 10m² basal area for remediation areas AC2-1, AC2-2, AC2-3 and AC2-4, giving a sub-total of 288 samples; and
- One per 10m² of the side wall areas not constrained by retained buildings or services (western wall of AC2-1, AC2-2 and AC2-3; eastern wall of AC2-4), giving a further 36 samples.

10.2.2 Verification of Material Suitable and Unsuitable for Reuse

- Excavated Material

Prior to reuse/backfilling of excavated suitable soil products and site-won material not requiring treatment, stockpiles will be subject to visual checks and validation testing at a frequency of 1no. composite sample per 250m³ (composite sample to be formed from selective spot sampling from the near surface of the stockpile in accordance with the protocol provided in Annex B of the Core Specification. Validation samples from these material stockpiles are to be submitted to the chemical analytical laboratory for soil analysis.

The results will be screened against the values in Appendix D. Verification sample numbers for excavations from the gross hydrocarbon impacted areas are estimated at 21 samples, including 3 QA/QC duplicate samples.

- Treated Materials

Treated materials will all be subject to initial visual inspection to confirm the absence of visible agglomerations of free phase tars or oils or large lumps of untreated / unreacted materials.

Material treated for re-use on site by the solidification/stabilisation shall be tested for leachability using a standard 10:1 eluate leachate test, in accordance with BS EN 12457, also at a rate of 1 sample per 250m³. It is anticipated that a total of 4,380m³ will require stabilisation, and therefore 22no. tests will be required, including 4 QA/QC duplicate samples. The results will be screened against the values in Table 15.

In addition, representative blocks of treated material will be formed using standard concrete block moulds at a similar rate (and from the same batches) of 1 per 250m³. Once cured, the block samples will be submitted for 64 day monolith tank testing to provide a less conservative estimate of likely leachability of the placed treated materials. The results of this monolith leaching testing will then be considered against the original leachability targets (Table 15) and in the context of the site risk assessment to confirm that the placed material does not pose a risk to controlled water receptors.

By way of clarifying this position the use of the 10:1 batch leachate testing is considered to be a conservative analysis regime [*Guidance on the use of Stabilisation / Solidification for the Treatment of Contaminated Land: Environment Agency*], which will indicate contaminant leachability in an environment that is ultimately more aggressive than typical site conditions at the Wrexham site. That said it provides a useful and relatively prompt set of data which indicates that if target values can be achieved under such 'artificially aggressive conditions' then they would by extrapolation be achieved under 'normal conditions'. In the event of samples not achieving remediation target values under the 10:1 eluate leachate test, then the 64-day tank test will enable a more realistic representation of material leaching under site conditions than the more aggressive batch testing. The principal drawbacks of the tank testing are the prolonged delay between material treatment and backfilling; and receipt of analysis results, hence our proposed preference of a two-stage validation approach which we believe will provide confidence in the achievement of remediation targets in a prompt and cost-effective manner.

A comprehensive record will be kept of all leaching test results and the subsequent actions taken.

10.3 Area AC3

Representative samples of sediments cleared from the drains will be taken (minimum 2 No.) and submitted for chemical analysis for the standard NG suite of parameters.

Photographic records of the condition of the receiving drainage pond area will be kept on a weekly basis during the course of the works.

Records from the re-inspection of the cleared drains will be included in the verification report.

Water samples will be taken on a weekly basis during site works from the pond area and from the outfall. Samples will be tested for extractable TPH (using the available site testing facilities).

Following completion of the drain cleaning and outfall reconstruction, validation samples will be collected from the discharge point and the pond area, followed by a final sample, three months after completion of site works. Samples will be tested by a commercial, accredited laboratory, for TPH (including aromatic / aliphatic banding) and gross quality field parameters will be recorded on each sampling occasion.

10.4 Area AC4

Representative samples of sediments cleared from the surface water drains and the Bedwell Brook channel will be taken (minimum 4 No. from each) and submitted for chemical analysis for the standard NG suite of parameters.

Records from the re-inspection of the cleared drains will be included in the verification report.

Photographic records of the condition of the Bedwell Brook channel and outfalls will be kept on a weekly basis during the course of the works.

The upstream and downstream conditions at the site boundary will be visually inspected on a daily basis during the active works period.

Water samples will be taken on a weekly basis during site works from upstream of the railway embankment culvert, the identified outfall pipes, and the downstream location beyond the final sediment trap / polishing facility. Samples will be tested for suspended solids, extractable TPH, pH, and electrical conductivity (using the available site testing facilities).

Following completion of the drain cleaning, channel excavation and outfall reconstruction, validation samples will be collected from the discharge points and the downstream culvert entrance, followed by final samples, three months after completion of site works. Samples will be tested by a commercial, accredited laboratory, for TPH (including aromatic / aliphatic banding) and gross quality field parameters will be recorded on each sampling occasion.

Sediment samples from two locations within the Bedwell Brook channel will be taken at the same time as water samples and subject to the same testing regime (plus lead).

10.5 Imported Material

Import of material is not expected. However, if required, imported material will be required to be from specified sources only and to demonstrably comfortably comply with the remediation criteria derived for the site. Imported material shall be sampled at a frequency of one per 250m³ and samples shall be submitted to the chemical analytical laboratory for the soils analysis as per Appendix B4 Annex B of the Core Specification.

Verification of import is to be completed, results confirmed and material identified as suitable for reuse prior to import.

10.6 Material Unsuitable for Reuse/Treatment

Materials deemed unsuitable for reuse/treatment on-site include the liquid hydrocarbon contents of any newly exposed tar tanks or other large underground sumps / wells (none anticipated at present), visible fragments of fibrous asbestos materials contained in excavated Made Ground and large plastic and metal refuse and cables arising in excavated materials and from the clearance of the tip face in Area AC4. These materials are to be separately collected and disposed of off-site at an appropriately licensed landfill/ treatment centre. Representative sample results and waste descriptions shall be submitted to the relevant waste facility to confirm acceptance along with appropriate WAC sampling of representative material where necessary, depending on the waste streams.

For groundwater collected from site–dewatering and not suitable for use in the soils treatment process, samples will be collected from site storage tanks and submitted for laboratory testing prior to any agreement for discharge to local foul sewer (details of sewer discharge consent awaited from Welsh Water).

10.7 On-Site Testing

In order to minimise programme and provide a rapid turnaround on sample analysis and therefore minimise contamination volumes, on-site testing kits will be employed for the analysis of TPH, PAHs, ammonia, phenols and cyanides.

The site will be provided with a dedicated indoor work-station for the preparation and analysis of verification samples, including the preparation of sub-samples for laboratory analysis of not less than 10% of the total number of test kit analyses.

11. REGULATORY LIAISON AND PLANNING

During the design phase, consultations and applications are underway to secure all necessary regulatory agreements, permits, consents & licences required to undertake the proposed works. Table 20 below summarises the Regulatory agreements required for this project.

Table 20: Regulatory Approvals

Permit/Consent/Licence/Approval	Statutory Authorising Agency
Planning Permission for the remediation works.	Wrexham County Borough Council
Temporary Trade Effluent Consent (for treated groundwater disposal).	Welsh Water
Mobile Plant Environmental Permit (for soils treatment and replacement).	Natural Resources Wales
Groundwater Abstraction Licence (for groundwater recovery and excavation dewatering).	Natural Resources Wales

Initial discussions with Wrexham CBC (WCBC) and Natural Resources Wales (NRW) have resulted in the general confirmation of the above requirements.

Due to the significant contaminated land and controlled waters pollution issues addressed by the works, it is noted that WCBC and NRW specialist officers will be formally consulted as part of the planning application process. Additional consultation may take place with the WCBC ecologist and environmental health officer in order to assess issues potentially affecting protected species and existing site tenants.

NRW will be involved at the site directly by way of granting a Mobile Plant Environmental Permit to cover the soil treatment element of the work and the issuing of groundwater abstraction licences and discharge consents for the groundwater recovery and treatment elements of the works. The individual licence applications are the responsibility of the specialist contractors carrying out the soil and water treatment activities.

11.1 Regulator Close Out

The key to the successful closure of a remediation project is keeping the regulators involved in what is happening on the site throughout the remediation process. In this regard, ongoing consultation and discussions with WCBC and NRW has been allowed for at key stages in Stage 2 works. The results of these contacts will be recorded and incorporated into the verification report along with the qualitative and quantitative results from site records and supervision.

It is intended to prepare the validation report on an ongoing basis during the project, so that there is always a body of evidence on site to show how the remediation is progressing, and what areas have been completed and signed off. The validation report will be prepared in accordance with Appendix C11, Annex C, of the National Grid Core Specification.

12. REFERENCES

Area AC Factual Report, IKM REP-002, February 2014.

Area B West Factual Report, IKM REP-004, February 2014.

Area B East Factual Report, IKM REP-003, February 2014.

Core Specification, NGPH, 2013.

Appendix B
Preliminary Ecological Appraisal Report
(Evolution Ecology, 2013)



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National Grid - Maelor Works, Wrexham

Preliminary Ecological Appraisal Report

(Extended Phase 1 Habitat Survey Report)

18th November 2013



Preliminary Ecological Appraisal

Preliminary Ecological Appraisal Report

(Extended Phase 1 Habitat Survey)

At

National Grid
Maelor Works
Marchwiel
Wrexham
LL13 0UW

for

James Wood
I & H Brown Ltd

On behalf of

National Grid Gas Property Holdings Limited

Preliminary Ecological Appraisal

Executive Summary

This section provides conclusions drawn from the desktop study and the site survey to determine the importance of the different habitat types on-site. It is also necessary to conclude what effects the proposed works will have on any locally protected wildlife species, with particular reference to mammals, amphibians, birds and reptiles.

“Planning authorities have a duty to consider biodiversity when assessing planning applications. Where there is a reasonable likelihood that a planning proposal might affect important protected species or habitats, the council will require information on the species and habitat likely to be affected, and an assessment of the impacts of the proposals. This information will need to be provided before a planning decision is made and if this information is not provided, the council may refuse to register the application.

This Duty was introduced by the Natural Environment and Rural Communities Act (The NERC Act) and came into force on 1 October 2006. This act clarified existing commitments with regard to biodiversity, raised the profile of biodiversity. It aimed to make the consideration of biodiversity a natural and integral part of policy and decision making.

In addition to the NERC Act there is also national and international biodiversity legislation. This includes legislation in relation to protected species and sites which operates outside of the planning system. Local Authorities and developers have a duty to comply with this legislation. Planning Policy Statement 9 - Biodiversity and Geological Conservation Local Policy in relation to biodiversity can be found in the Local Development Framework, retained Local Plan policies and in the emerging Core Strategy.”

For further information please go to
http://www.enfield.gov.uk/info/200052/advice_for_developers/1083/ecological_assessments_for_planning_applications

With regards to Rabbits (*Oryctolagus cuniculus*), although not protected under UK or European law, avoidance measures should be incorporated into the proposed works to ensure that no rabbits are intentionally harmed during the conduct of the trial pits/boreholes. This will include rabbit exclusion fencing which would effectively prevent any rabbits from entering their warrens and/or carrying out the ground investigations away from known warrens.

Preliminary Ecological Appraisal

As mentioned previously, Badger (*Meles meles*) setts were identified on the northern and southern boundaries of the western extension. With this being the case and although not identified directly onsite, it will still be necessary for avoidance measures to take place. This will mean maintaining a minimum distance of 10m from each sett entrance at any given point when conducting the trial pits/boreholes. Typically a minimum distance of 20m should be maintained away from Badger sett entrances when heavy machinery is to be used. However, as the embankments slope up and away from the site, this measurement can be reduced, as any tunnels created by Badgers are likely to lead away from the site.

With regards to reptiles and amphibians, there is a possibility that the site could be utilized by both of these groups. As mentioned previously, the pond located on site (but outside of the area for the proposed ground investigation works) is deemed to be of low value for GCN, as the HSI conducted by Ecosulis labelled the pond as being 'Poor'. However, as GCN have been identified on the ecological data search to be within the immediately surrounding area, there is a high likelihood that the area could be utilized as a foraging habitat for this species. This is said because GCN are known to migrate and forage within a 500m radius of breeding ponds, and the nearest GCN record was identified to be approximately 320m to the north-east of the site. If the areas of interest (scrub and woodland) are to be maintained as they currently stand (or if minimal vegetation clearance is to occur), there will be no issue from a GCN point of view with the conduct of the trial pits/boreholes. However, if the land tested is found to be contaminated, and the further removal of the soil [and subsequently the habitats which grow within it] is required, an amphibian presence/absence survey (during the optimal survey period: March - June) will be required to identify if these species reside within the area. If they are found to be on site, a development licence from Countryside Council for Wales to legally disturb GCN and their habitat would be required, and an individual mitigation strategy would need to be devised.

There is a possibility that hibernating reptiles (inc GCN) may occupy some of the disused rabbit warrens within the woodland on the north-western boundary. Similarly to the GCN, if this area is to be left as is during the trial pits/boreholes there will be no issues with regards to reptiles (as avoidance measures, by retaining as greater distance as possible from the warrens, will suffice). However, if the woodland is to be heavily impacted by the works, it will be necessary to conduct a reptile survey (during the months of April-May or September) to establish whether or not they are present within the gasworks site. Again, if it is discovered that they are, mitigation measures may need to be carried out for each species discovered.

Finally, birds are protected (Wildlife and Countryside Act 1981) during the nesting season (March – August) so any works which are likely to impact nesting birds (such as tree felling) should occur outside of the nesting season.

Preliminary Ecological Appraisal

Phase 1 habitat surveys can be conducted all year round and the site survey was carried out in November 2013. However, the optimal time for undertaking these surveys would be between the months of April and September. If surveys are undertaken outside this period, it is quite likely that a follow-up botanical survey will be required. It is therefore recommended because the site has a number of different types of habitats that a follow up flora survey is carried out in the optimal survey period.

To summarise the following surveys are required if the land investigated for contamination is to be removed off site.

1. GCN presence / absence pond survey (March – June).
2. Reptile presence / absence survey (April/May – September).
3. Update flora survey (April – September).

Preliminary Ecological Appraisal

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Preliminary Ecological Appraisal

1 INTRODUCTION

1.1 Background

This report has been prepared at the request of James Wood (I & H Brown Ltd) on behalf of National Grid Property Holdings Ltd, to provide an overview of the landscape and habitat types, any ecological features of interest and the potential to provide habitats for legally protected species at the former gaswork site located at Maelor Works, Marchwiel, Wrexham, LL13 0UW (OS Grid Reference: SJ 38108 48134). A site survey was undertaken on the 18th November 2013, by Evolution Ecology Ltd.

Aim

The aim of this survey was to identify which, if any, habitats and flora species may be affected by any alterations to the site, and to assess the habitat needs for them to exist on the site alongside any proposed re-development in accordance with the Preliminary Ecological Appraisal (Extended Phase 1 Habitat Survey) criteria.

Surveyor Details

The site was surveyed by Mr Paul Keeling BSc (Hons) MCIEEM – Senior Ecologist and Miss Charlotte Richardson BSc (Hons) – Ecologist.

1.2 Site Description

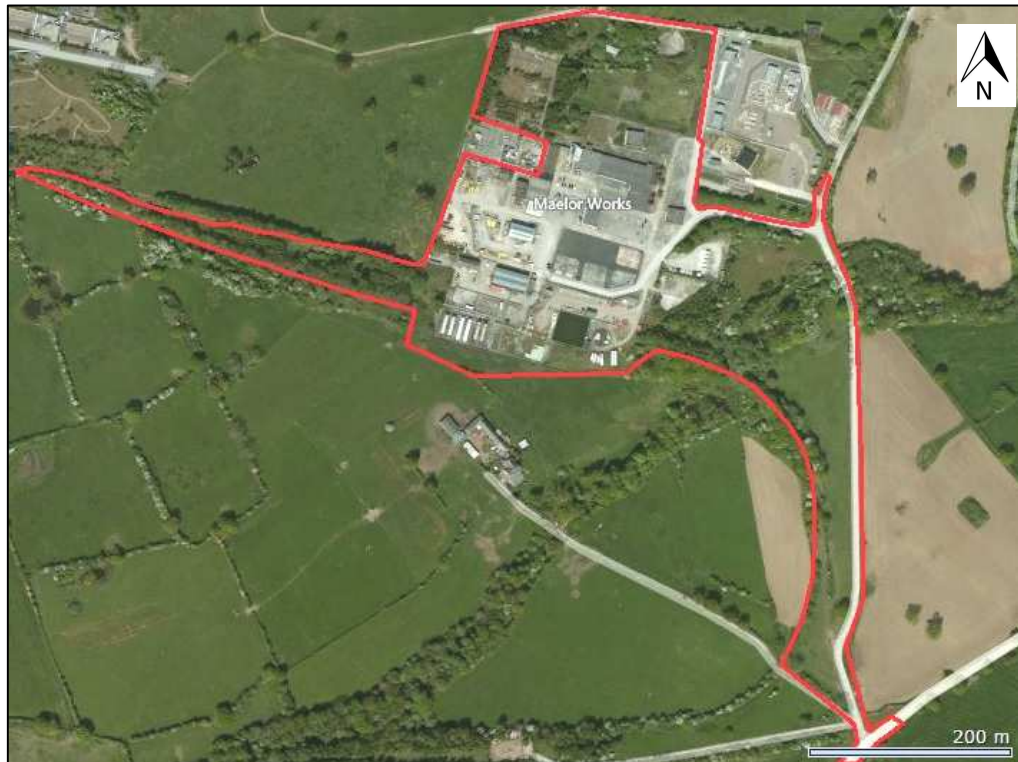
The former gasworks site located at Maelor Works is situated approximately 5km to the south-east of the town of Wrexham, with residential areas to the south-west and a large industrial estate expanding from the north-west to the north-east of the site. Open countryside occupies the vast majority of the surrounding area (to all sides) which comprises of; agricultural grasslands, scattered trees and hedgerows. Additionally, running water courses are present in the surrounding area, (one of which - a small brook which diverts from the River Clywedog - runs through the site itself), as are a number of standing water bodies.

The site is made up of predominantly buildings and hard standing towards the centre, but some areas (of varying size) to the west, north, east, south and south-east of the site are occupied by more ecologically beneficial habitats. These include; semi-natural broad-leaved woodland, dense and continuous scrub, semi-improved grassland and standing water. The surveyed site measures approximately 13.92ha, but the approximate total area of the sites to undergo the proposed works measure only approximately 6.26ha. Proposals have been made to conduct trial pits and

Preliminary Ecological Appraisal

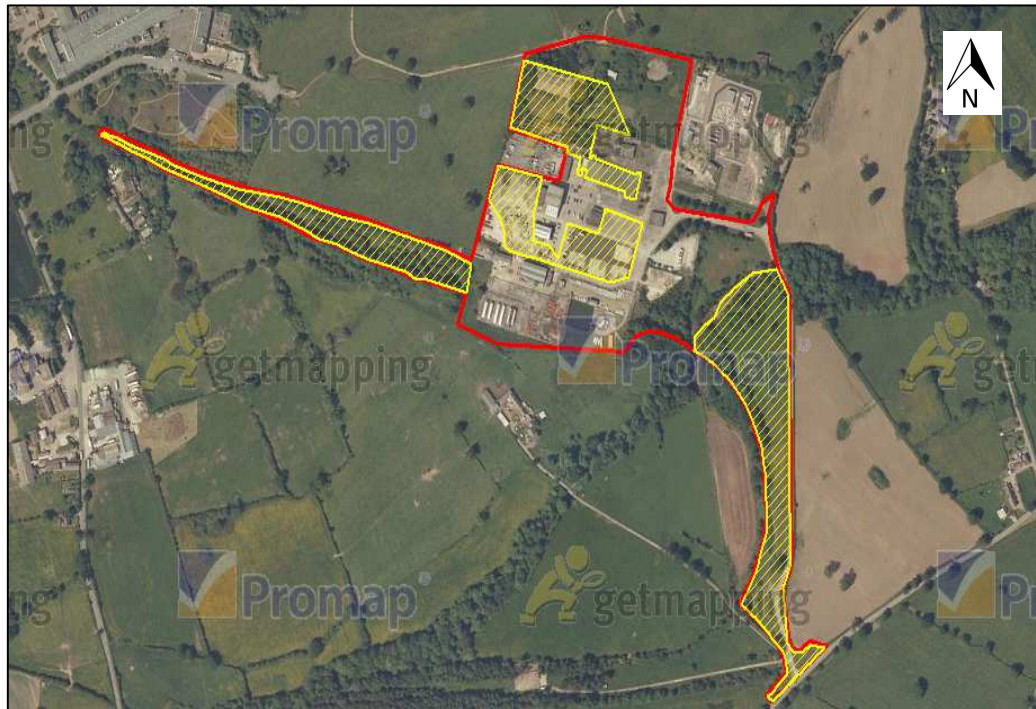
boreholes in order to allow ground investigation works/contamination testing to take place. Each of the habitat types at this site has varying ecological value and these will be assessed individually in turn.

Figure 1: A map showing the location of the site in relation to the surrounding landscape (indicated by the red boundary).



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Figure 2: This map illustrates the approximate locations where the proposed works are to take place (hatched in yellow) in relation to the National Grid Property Holdings Ltd boundary (red line).



Preliminary Ecological Appraisal

2 METHODOLOGY

2.1 Desktop Study (Ecological Data Search)

North Wales Environmental Information Service (COFNOD) was commissioned to carry out an ecological data search of all protected species and sites recorded within 2km radius of the site.

2.2 Preliminary Ecological Appraisal (Extended Phase 1 Habitat Site Survey)

To fulfil the brief, a Preliminary Ecological Appraisal (Extended Phase 1 Habitat Survey) was conducted according to the methodology of the JNCC (2010). Preliminary Ecological Appraisal is a standard technique for classifying British habitats. The aim is to provide records of habitats that are of significant ecological value.

Additional Target Notes

Additional target notes were made where applicable to record:

- Key habitat features.
- Urban ecological features not covered in sufficient detail in the Phase 1 Methodology.
- Important habitats too small to be mapped and to identify dominant species.
- Other features of ecological interest.

2.3 Protected Fauna and Flora Species

Potential signs and suitable habitats for the presence of European and Domestically protected species (amphibians, reptiles, mammals and birds) were recorded according to the Biodiversity Action Plan (BAP) and Birds of Conservation Concern (RSPB, 2009).

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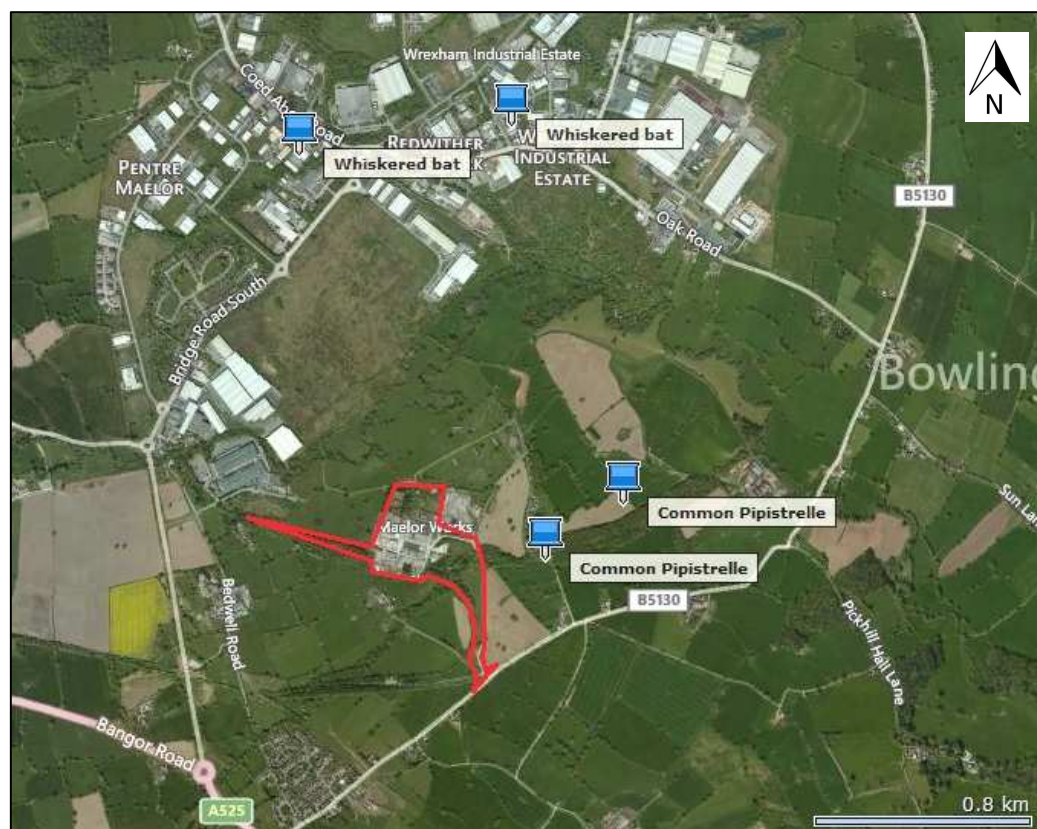
3 FIELD SURVEY RESULTS

3.1 Desktop Survey (Ecological Data Search)

North Wales Environmental Information Service (COFNOD) was commissioned to carry out an ecological data search of all protected species and sites recorded within 2km radius of the site. The search uncovered records of numerous protected species, but none of which have been recorded directly on the site. This being said, a few records were identified immediately adjacent to the site.

With regards to bats, two distinct species were recorded; the Common Pipistrelle (*Pipistrellus pipistrellus*) and the Whiskered bat (*Myotis mystacinus*). The closest of these records was of a Common Pipistrelle (*Pipistrellus pipistrellus*) and it was located approximately 500m to the east of the gasworks site.

Figure 3: A map illustrating the approximate locations of some of the bat species recorded in the surrounding area of the gasworks site.



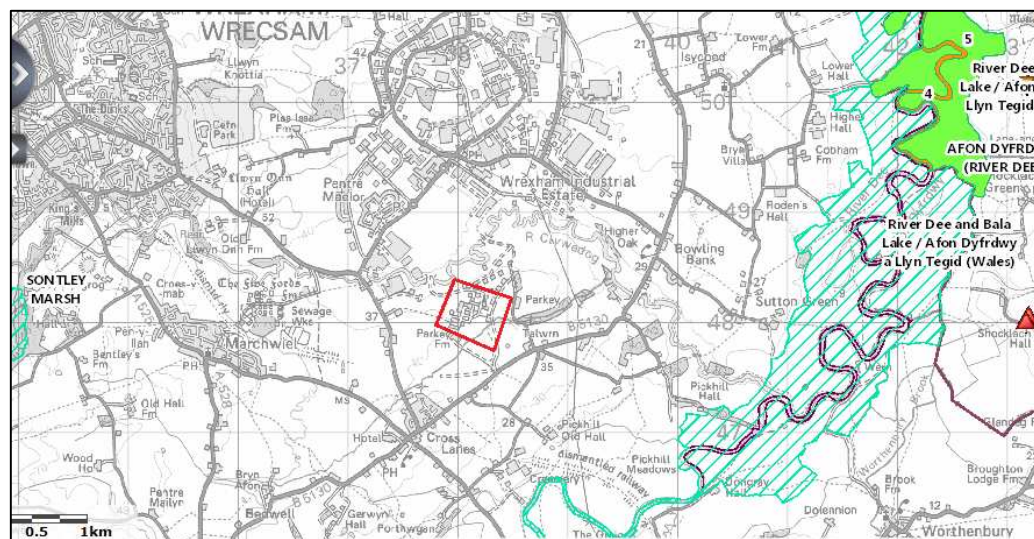
Preliminary Ecological Appraisal

A number of declining bird species have also been recorded within the 2km search radius. These included: Kingfisher (*Alcedo atthis*), Kestrel (*Falco tinnunculus*), Red Kite (*Milvus milvus*) and Fieldfare (*Turdus pilaris*). All of these species have been noted as having either amber (unfavourable conservation status) or red population status (globally threatened) however, they were not recorded within the boundary of the proposed trial pits/boreholes and building demolition. Other records of protected species in the surrounding area include: Badger (*Meles meles*), Otter (*Lutra lutra*) and Grass Snake (*Natrix natrix* – within a nearby pond) but again, none of these records were obtained from anywhere within the gaswork site boundary.

Finally, a number of Great Crested Newt (*Triturus cristatus*) records were identified within the immediately surrounding area. The closest of these records was identified as being approximately 320m to the north-east of the site, but again, no records were identified within the gasworks site boundary itself.

The ecological data search and MAGIC have also revealed that the site itself contains no sites with statutory or non-statutory designations. The nearest statutory site designation is of a Site of Special Scientific Interest (SSSI – River Dee and Bala Lake) and is located roughly 3.6km to the east of the site. Similarly, Sontley Marsh is another nearby SSSI, but this is located even further away to the west at a distance of approximately 4.1km. Bearing this information in mind, there are no records of any such designations on the site itself (or within the immediately surrounding area), meaning that the proposed works are unlikely to have a substantial impact upon the wider surrounding landscape.

Figure 4: A MAGIC map which shows the statutory and non-statutory sites within the surrounding area of the site (the approximate site boundary is illustrated by the red square).



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3.2 Preliminary Ecological Appraisal (Extended Phase 1 Habitat Site Survey) and Limitations

The site is dominated by a number of habitat types, predominantly buildings and hard standing, but with some areas dominated by woodland, tall ruderal, scrub and semi-improved grassland and in one area, a small standing water body. All of these habitat types have varying ecological value and will be addressed individually. The dominant species, if any, will be noted and their ecological value will be assessed to conclude what affects the proposed works will have on the habitats that are situated on-site. Each habitat is colour coded and can be found in Appendix A: Preliminary Ecological Appraisal (Extended Phase 1 Habitat Survey) Map. This Phase 1 has been conducted using JNCC (Joint Nature Conservation Committee, 2010) Handbook for Phase 1 habitat survey.

Limitations/constraints: As the site consists predominantly of buildings and hard standing, there was generally little in the way of accessibility issues. This being said, it was difficult to access some areas (particularly to the north of the site) due to the density of the vegetation. However, this was not much of an issue, as the habitats present were fairly standard, as were the floral species. Additionally, access to another area of the site (the woodland area towards the east of the site) was not available, as this part of the site was sectioned off by a chain link fence. This being said, a visual inspection was made through the fence, which concluded that this area was of similar habitat composition to some of those already recorded (i.e. woodland/scrub). Other than these issues, no other constraints were noted during the survey.

Phase 1 habitat surveys can be conducted all year round and the site survey was carried out in November 2013. However, the optimal time for undertaking these surveys would be between the months of April and September. If surveys are undertaken outside this period, it is quite likely that a follow-up botanical survey will be required. See below for further details.

A1.1 – Semi-natural Broad-leaved Woodland

There are a number of areas within the site boundary which are dominated by semi-natural broad-leaved woodland, the most extensive of these being on the southern boundary of the western extension and also to the east of the site, surrounding the running water course. The woodland within the western extension consisted of a number of species, including; Silver Birch (*Betula pendula*), Hawthorn (*Crataegus monogyna*), Dog-rose (*Rosa canina*) and Elderberry (*Sambucus nigra*). This area had a varying age

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structure (some trees older than others) which often provides a greater variety of habitats for invertebrate species, and in turn, birds. Although this stretch of land is fenced off from the adjacent embankment along the southern boundary and the fields to the north, two badger setts were identified within these areas. The first had two entrances (at least one of which is thought to be active) and was located in the south-eastern corner, adjacent to the main gasworks site. The second was also located outside the proposed works boundary, but this time on the northern side (within the adjacent fields). As both of these setts are within very close proximity to the proposed development works, it will be necessary to ensure that the works are conducted at least 10m away from each sett. This distance to maintain is less than the usual (20m when using machinery) when a badger sett is discovered, but as the setts are situated within lands which raise above ground level (therefore leading away from the site), it is unlikely that any badgers will be disturbed as the tunnels should lead away from the site to the north and south. As well as the badger setts located offsite, there is also a rabbit warren within the northern field to the north-east of this section. But, as rabbit are not protected under UK or European legislation, this will not be an issue. The locations of all of the setts/warrens within this area can be found on the Phase 1 Habitat Map within the appendix.

Figure 5: The woodland and semi-improved grassland within the western extension. Silver Birch (*Betula pendula*) trees are once again abundant throughout the wooded areas.



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In addition to the first area of woodland, a further three patches were discovered to the north-west of the site. One of these areas ran adjacently to the site boundary on the north-western corner and was situated on a steep embankment. This woodland consisted predominantly of semi-mature Silver Birch (*Betula pendula*) trees and in addition to this, in excess of 100 rabbit warren entrances (which were of missed use) and droppings were discovered. As mentioned previously, two further patches of woodland were located in the northern portion of the site. These were adjacent to one another and both consisted of young Silver Birch (*Betula pendula*) trees with stands of Bramble (*Rubus fruticosus*), Nettle (*Urtica dioica*), Creeping Thistle (*Cirsium arvense*) and Rosebay Willowherb (*Chamerion angustifolium*) also being abundant. The final area of woodland is quite possibly the densest and most mature (although still not classed as 'mature'), and it is located to the east of the site. As access to this area was restricted (as mentioned previously) it is difficult to ascertain the precise species present. However, from a distance, Silver Birch (*Betula pendula*) was observed. Due to the fact that this woodland is located upon a steep embankment which leads to a running water course, it is unlikely that any of the proposed works will be able to take place within this area. This is correlated with the information received by I & H Brown Ltd regarding the areas to be impacted, this woodland of which, is not one.

Figure 6: This image illustrates the area of Silver Birch (*Betula pendula*) woodland along the north-western boundary of the site. A number of the rabbit warren entrances can also be seen.



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With regards to birds, all of the woodland areas hold some potential in terms of foraging; however, due to the age structure of some of the areas (particularly the two central sections to the north of the site) they are unlikely to hold nesting opportunities. This is said as birds prefer to make their nests in well-established mature trees and none of the trees recorded could be classed as 'mature'. This being said, some small birds may utilize the semi-mature trees within the western extension, the area along the north-western boundary and the area towards the south-east of the site, as some of these semi-mature trees appear to be nearing 'mature' status.

In addition to birds, as there are a number of rabbit warrens on the embankment of the north-western woodland, there is a possibility that this area may be used by reptiles. This is said because some reptiles will often use disused rabbit warrens to hibernate within over the winter months. The amount of suitable habitat nearby (i.e. standing water for amphibians and woodland/scrub for reptiles) would suggest that reptiles hibernating within this section of the woodland could be a possibility.

Please see Appendix A: Preliminary Ecological Appraisal (Extended Phase 1 Habitat Survey) Map, for the location of the semi-natural broad-leaved woodland (A1.1).

A2.1 – Dense and Continuous Scrub

Dense and continuous scrub was present within three main areas of the site. These were; within the central portion of the northern semi-improved rough grassland, along the northern boundary of the western extension and along the western edge of the south-eastern semi-improved grassland. These stands consisted of species including; Bramble (*Rubus fruticosus*), Blackthorn (*Prunus spinosa*) and Gorse (*Ulex europaeus*). Dense scrub can often be of interest to foraging small mammals, which may in turn attract predatory reptiles and birds. Not only is this habitat useful for foraging purposes, but the density of the vegetation works well as a protective barrier and thus provides shelter. The patches of scrub onsite are ultimately of potential interest to small mammals, reptiles and birds which means that care should be taken when conducting any disturbance works around these habitats. Although not classed as a specific habitat, one area on the northern boundary within the western extension has a dense pile of cut trees/branches. These piles work in a similar way to the scrub in that they provide dense shelter for all of the above mentioned fauna.

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Figure 7: The dense scrub which separates the northern semi-improved grassland from B2 can be observed to the left of the photograph.



Please see Appendix A: Preliminary Ecological Appraisal (Extended Phase 1 Habitat Survey) Map, for the location of the Dense and Continuous Scrub (A2.1).

A3.1 – Broad-leaved Scattered Trees

A number of scattered trees were identified onsite, predominantly to the north of the central hard standing area and within the field to the south-east of the site. With regards to those located to the north of the site, they were all young Silver Birch (*Betula pendula*) specimens which were scattered along the boundaries of the semi-improved rough grassland and dense and continuous scrub habitats. Generally, these trees were of relatively low ecological value due to their immature status. Further scattered semi-mature trees were identified along the western boundary of the south-eastern field, but due to their distance away and access issues, it was not possible to identify them. In addition to these semi-mature trees within the south-eastern field, one large mature Oak (*Quercus robur*) tree was identified within the centre of the southern portion of the field. Mature trees such as this can often be utilized by roosting bats or nesting birds which means that they are of ecological importance. Finally, in addition to the areas already mentioned, a number of scattered Ash (*Fraxinus excelsior*) trees were identified [along with Hawthorn (*Crataegus*

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monogyna) and Dog-rose (*Rosa canina*)] across the far southern boundary of the western extension. Within these scattered trees in this area, one further rabbit warren was discovered.

Overall, the scattered trees onsite appear to be of varying ecological importance, with the lone Oak (*Quercus robur*) tree being of the highest value to protected species.

Please see Appendix A: Preliminary Ecological Appraisal (Extended Phase 1 Habitat Survey) Map, for the location of the Broad-leaved Scattered Trees (A3.1).

B6 – Poor Semi-improved Rough Grassland

Poor semi-improved rough grassland was one of the most extensive habitats onsite (after the hard standing). It occupied the vast majority of the remaining western extension (after scrub and woodland), the areas to the north and south of the central hard standing and the field which extends from the east to the south-east of the site. The species discovered within these stands are typical of the habitat type and include; Nettle (*Urtica dioica*), Creeping Buttercup (*Ranunculus repens*), Creeping Thistle (*Cirsium arvense*), Spear Thistle (*Cirsium vulgare*), Bramble (*Rubus fruticosus*), White Dead Nettle (*Lamium album*) and Broad-leaved Dock (*Rumex obtusifolius*). In addition to these species, some stands of scattered Hawthorn (*Crataegus monogyna*) were present within the south-eastern field and it was also recognized that this area was being grazed by horses (which contribute greatly to keeping the vegetation relatively low and thus preventing succession). Semi-improved rough grassland is often used by mammals for foraging purposes so it can sometimes attract reptiles (who prey after small mammals) and amphibians. This is indeed the case with regards to the semi-improved grassland to the north of the hard standing, as multiple skulls and droppings were found which were identified as those of European Rabbits (*Oryctolagus cuniculus*). Finally, due to the lack of suitable shelter, this habitat is thought to be of foraging use only.

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Figure 8: The poor semi-improved grassland to the north of the site can be seen in the foreground, followed by the patch of scrub and scattered trees to the rear.



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G1 – Standing Water

There is one small standing water body located on site, but it is outside of all of the proposed work zones (refer to figure 2). It is located directly to the west of the most northerly building and is approximately 10m² in size. A number of floral species which are typical colonizers of pond margins have established within/on the edge of the pond. These include; Common Reed (*Phragmites australis*), Bulrush (*Typha latifolia*) and Rush species (*Juncus spp.*).

Figure 9: The pond located towards the north of the site. This image illustrates some of the species present (Rushes are abundant), the small size of the pond and its shaded nature (by the overhanging tree).



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A Habitat Suitability Index (HSI) was conducted on this pond by Ecosulis in 2010 to establish its potential for housing the Great Crested Newt (*Triturus cristatus*) which is a European Protected Species (EPS). The results from this HSI can be found in table 1.

Table 1: The results from the HSI assessment conducted by Ecosulis in 2010.

HSI Criteria	Score for pond at Maelor Works
Location	1.0
Pond area	0.02
Pond drying	0.1
Water quality	0.67
Shade	0.8
Water fowl	1.0
Fish	1.0
Ponds	1.0
Terrestrial habitat	1.0
Macrophytes	0.3
Calculation	$(1.0 \times 0.02 \times 0.1 \times 0.67 \times 0.8 \times 1.0 \times 1.0 \times 1.0 \times 1.0 \times 0.3)^{0.1}$
HSI score	0.45
Pond suitability	<u>Poor</u>

After comparing these results with the current condition of the pond, it can be concluded that no change has occurred in the pond's suitability since this HSI was conducted. Ultimately, due to the high level of shade and small size of the pond, it would appear that the potential of this pond for housing protected amphibians (GCN) is low. However, there are at least four other ponds within 500m radius of the site (one of them is known to have GCN), which along with the pond on site, may form part of a network of GCN breeding ponds.

Please see Appendix A: Preliminary Ecological Appraisal (Extended Phase 1 Habitat Survey) Map, for the location of the Standing Water (G1).

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G2 – Running Water

One running water course passes through the site. It passes under the road which leads to the site and through the eastern woodland area. This water course is situated well below ground level at the bottom of the wooded embankment so the proposed works are unlikely to affect it.

Figure 10: A view of the running water course that cuts through the site. The steep embankments can be observed to either side, particularly to the left in this image.



Please see Appendix A: Preliminary Ecological Appraisal (Extended Phase 1 Habitat Survey) Map, for the location of the Running Water (G2).

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J1.2 – Amenity Grassland

One area which contained amenity grassland was discovered onsite and this was found towards the east of the site. Amenity grassland is of very low ecological value as it is often regularly maintained (i.e. via mowing etc.) meaning that it is not a stable habitat. Some of the species which were present within this grassland include; Creeping Buttercup (*Ranunculus repens*) Broad-leaf Plantain (*Plantago major*) and Creeping Thistle (*Cirsium arvense*).

Please see Appendix A: Preliminary Ecological Appraisal (Extended Phase 1 Habitat Survey) Map, for the location of the Amenity Grassland (J1.2).

J3.6 – Buildings

Although there are a number of buildings onsite, only one of them is within the boundaries of the proposed works. The vast majority of the buildings within the central hard standing area have not been individually classified, as they will be unaffected by the trial pits/boreholes and are all of low ecological value for protected species (the offices are regularly used, have internal lighting installed, are flat roofed and show little potential ingress points). Due to this, the only buildings which have been classified are the disused ones which may exhibit some potential for housing protected species. These are; the one which is likely to be affected by the proposed works within the central hard standing area and the building to the east of the northern pond (as it is within close proximity to the proposed work zone).

The building within the hard standing area (B1) is proposed to be demolished as a part of the trial pit/borehole works. An external inspection of the building was conducted which revealed that it was a single-storey, flat roofed structure with no fascia/soffit boards. All of the windows and doors appeared to be in tact which again reduces the likelihood of bats/birds utilizing the building, as it lowers the number of potential access points into the structure. Bearing all of these points in mind, it is unlikely that the proposed works will affect any local bat or breeding bird populations.

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Figure 11: Building 1 (B1) and some of the hard standing from a south-eastern viewpoint.



The second building inspected (B2) located to the east of the pond, was of similar construction to B1, but on a much smaller scale. It was a flat roofed building with no fascia/soffit boards, but it had one noticeably broken window, which would be large enough to allow entry for birds up to the size of a Barn Owl (*Tyto alba*). As the building was locked, it was not possible to gain entry to the inside, but as it is not likely to be affected by the trial pits/boreholes, this should not be an issue. With regards to bats, although they would be able to gain access through the broken window, there would be no suitable areas inside to roost within (due to the lack of a roof void, roofing felt and roof tiles). Overall, it would appear that this building is of moderate potential for bird species, but low for bats.

Please see Appendix A: Preliminary Ecological Appraisal (Extended Phase 1 Habitat Survey) Map, for the precise location of the Buildings (J3.6).

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Table 2: Features of buildings and built structure classification, which may indicate the potential for bats. The full guidance can be found in the Bat Conservation Trust Good Practice Survey Guidelines (P53).

Likelihood of bats being present	Feature of the building or built structure and its location
Higher	Pre-20th century or early 20th century construction². Agricultural buildings of traditional brick, stone or timber construction. Large and complicated roof void with unobstructed flying spaces. Large (>20 cm) roof timbers with mortice joints, cracks and holes. Entrances for bats to fly through. Poorly maintained fabric providing ready access points for bats into roofs, walls, bridges, but at the same time not too draughty and cool. Roof warmed by the sun, in particular south facing roofs. Weatherboarding and/or hanging tiles with gaps. Low level of disturbance by humans. Bridge structures, follies, aqueducts and viaducts over water and/or wet ground. For rarer species, buildings or built structures in the core area of their distribution. Buildings and built structures in proximity to each other providing a variety of roosting opportunities throughout the year. Buildings or built structures close to good foraging habitat, in particular mature trees, parkland, woodland or wetland, especially in a rural setting
Lower	Modern, well-maintained buildings¹ or built structures that provide few opportunities for access by bats. Small, cluttered roof space. Buildings and built structures comprised primarily of prefabricated steel and sheet materials. Cool, shaded, light or draughty roof voids. Roof voids with a dense cover of cobwebs and no sections of clean ridge board. High level of regular disturbance. Highly urbanised location with few or no mature trees, parkland, woodland or wetland. High levels of external lighting.

Notes

¹ The features listed here may not be indicative of use of the site by bats during winter or spring. This table should be read in conjunction with Box 2.1 - Chapter 2, which provides triggers for bat surveys.

² Pre-1914 buildings may present the greatest likelihood of providing roost space for bats due to their design, materials used and age. Pre-1990 buildings, especially when close to good foraging habitat, and with favoured features such as cavity walls and soffits, also have a high likelihood of providing roost sites for some bat species.

³ Post-1990 buildings are generally less likely than older buildings to house roosts; however, some modern designs provide access to suitable roosting spaces for bats. Pipistrelles in particular occupy modern buildings and built structures providing that there are suitable access gaps (> 8mm) and provided the structure has appropriate characteristics for roosting

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J5 – Other Habitat: Hard Standing

The Hard standing area is situated throughout most of the site in the form of concrete paving, but it is most prominent towards the centre. Hard standing is considered to be of low ecological value as it possesses no suitable ecological features which could be utilized by protected species. However, reptiles have been known to use this man-made habitat to their advantage by basking upon it when the sun heats the ground.

With this being the case, as the trial pits/boreholes are only proposed to take place in certain sections of the hard standing, the remainder should remain unaffected and therefore, still suitable for reptile usage in the future.

Finally, the area which the gasholder used to occupy has been included within this habitat type and has been target noted on the Phase 1 Habitat Map.

Figure 12: The area of hard standing which is situated next to the woodland located on the north-western boundary of the main site. Although hard standing usually has little potential for protected species, in this case, this area is thought to have basking potential for reptiles.



Please see Appendix A: Preliminary Ecological Appraisal (Extended Phase 1 Habitat Survey) Map, for the precise location of the Hard Standing (J5).

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3.3 Protected Fauna Species

Bird species recorded during the field survey

As the survey was conducted outside of the bird nesting season, truly representative results of the birds which utilize the site could not be gained. This being said, a number of potential nesting areas were uncovered including; the building to the east of the pond, the mature Oak (*Quercus robur*) tree within the south-eastern grassland, the dense areas of scrub and the woodland areas. In relation to the lone Oak, birds generally make their nests within mature trees as they tend to house more opportunities for invertebrate colonization (cracks in the trunk etc.). The hard standing areas are only likely to be used by passerine (perching) birds, as they provide very little in the way of potential nesting or foraging habitat.

Overall, it would appear that the site has relatively high potential for nesting birds (due to the aforementioned suitable habitats). But as the majority of the areas which have potential are outside of the proposed work zones, it is unlikely that any nesting bird populations will be negatively impacted (ground investigation works proposed during the winter months). This being said, as a precautionary measure, any works which are to occur within close proximity to potential nesting bird habitat (i.e. dense scrub and semi-mature/mature trees) should occur out of the bird nesting season to ensure that they remain undisturbed.

Mammals

Although no mammals were directly discovered on site, multiple signs were identified from different species which suggest that mammals have been occupying the area. A number of Rabbit (*Oryctolagus cuniculus*) skulls and droppings were identified within the semi-improved grassland towards the north of the site, which suggests that this species have in the past and possibly still do occupy the site. This is in correlation with the evidence found within the woodland embankment to the north-west (and in other areas) of active and disused rabbit warrens with more than 100 entrances. With evidence of high rabbit usage being present, although not protected by law, it is recommended that the works proposed within the woodland be moved to the woodland boundary (within the lard standing) or as close to it as possible. This will not only protect the rabbits occupying the area, but it will also protect any herpetiles present from harm (as discussed in the 'Reptiles/Amphibians' section).

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Signs of Badger (*Meles meles*) activity were uncovered along the boundaries of the western extension. A sett with 2 entrances was discovered along the southern boundary just off site, but due to its proximity to the proposed development area, this should be taken into account. The same can be said for another sett located off site to the north within the adjacent grassland. Because of this, it is vital that a distance of 10m be kept away from the sett entrances at any given point to ensure that no badgers are negatively impacted. As mentioned previously, this distance is less than usual (which is typically 20m away with heavy machinery), because the setts are located on bank sides which slope up and away from the site (thus meaning that any tunnels will also lead away). If this proposed avoidance measure is incorporated, there will be no issues from a Badger point of view with regards to the conduct of the trial pits/boreholes.

No signs of Water Vole (*Arvicola amphibius*), Otter (*Lutra lutra*) or Bat species were identified on the site, however, the large Oak (*Quercus robur*) tree within the south-eastern semi-improved rough grassland may have potential for bats if any suitable cracks are present. Due to the ecological potential of this tree [for providing suitable habitats for a number of species], it is recommended that avoidance measures be carried out to leave as greater distance as possible between the tree and the proposed works when they begin, in order to safeguard any protected species which may be using it.

Insects

No insect species were noted during the preliminary ecological appraisal, which is likely to be down to the time of the year at which the survey was conducted (November 2013). However, a number of the features on-site (with particular reference to the semi-improved rough grassland, scrub, and woodland) provide excellent foraging opportunities for insects. These in turn provide a food source for other organisms such as small mammals and birds, which ultimately makes these habitats of moderate importance to local fauna.

Reptiles/Amphibians

Although no clear signs of usage were identified, the site is thought to hold potential for housing herpetiles (reptiles and amphibians), with particular reference to reptiles. The HSI conducted on the only standing water body on site concluded that this pond has poor suitability for housing GCN. As this is the only amphibian of direct conservation concern, and because the pond is outside of the proposed works zone (ground investigation works), there are no constraints from an amphibian

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point of view with regards to the conduct of the trial pits/boreholes, as no GCN breeding habitat will be lost. This being said, the site does house some potential with regards to reptiles, as many of the habitats on site provide ample opportunities for them to thrive. The woodland on the north-western corner of the site has multiple disused rabbit warrens, which may be used by hibernating herpetiles (inc GCN). The hard standing areas (particularly those close to the woodland) provide a suitable location to bask upon, as they are open habitats with little in the way of physical obstructions (i.e. trees, buildings etc.) which could block the sun. Finally, the semi-improved rough grassland and scrub habitats could be used for hunting purposes, as small mammals are likely to be present, and it is also known that some reptiles [particularly Grass Snakes (*Natrix natrix*)] prefer to bask near a water source, one of which is located within close proximity. Bearing this information in mind, the site has a relatively high potential for housing reptiles, so any areas which they are thought to inhabit should be treated with care or avoided in order to preserve their local populations.

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4 CONCLUSIONS AND RECOMMENDATIONS

This section provides conclusions drawn from the desktop study and the site survey to determine the importance of the different habitat types on-site. It is also necessary to conclude what effects the proposed works will have on any locally protected wildlife species, with particular reference to mammals, amphibians, birds and reptiles.

“Planning authorities have a duty to consider biodiversity when assessing planning applications. Where there is a reasonable likelihood that a planning proposal might affect important protected species or habitats, the council will require information on the species and habitat likely to be affected, and an assessment of the impacts of the proposals. This information will need to be provided before a planning decision is made and if this information is not provided, the council may refuse to register the application.

This Duty was introduced by the Natural Environment and Rural Communities Act (The NERC Act) and came into force on 1 October 2006. This act clarified existing commitments with regard to biodiversity, raised the profile of biodiversity. It aimed to make the consideration of biodiversity a natural and integral part of policy and decision making.

In addition to the NERC Act there is also national and international biodiversity legislation. This includes legislation in relation to protected species and sites which operates outside of the planning system. Local Authorities and developers have a duty to comply with this legislation. Planning Policy Statement 9 - Biodiversity and Geological Conservation Local Policy in relation to biodiversity can be found in the Local Development Framework, retained Local Plan policies and in the emerging Core Strategy.”

For further information please go to
http://www.enfield.gov.uk/info/200052/advice_for_developers/1083/ecological_assessments_for_planning_applications

With regards to Rabbits (*Oryctolagus cuniculus*), although not protected under UK or European law, avoidance measures should be incorporated into the proposed works to ensure that no rabbits are intentionally harmed during the conduct of the trial pits/boreholes. This will include rabbit exclusion fencing which would effectively prevent any rabbits from entering their warrens and/or carrying out the ground investigations away from known warrens.

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As mentioned previously, Badger (*Meles meles*) setts were identified on the northern and southern boundaries of the western extension. With this being the case and although not identified directly onsite, it will still be necessary for avoidance measures to take place. This will mean maintaining a minimum distance of 10m from each sett entrance at any given point when conducting the trial pits/boreholes. Typically a minimum distance of 20m should be maintained away from Badger sett entrances when heavy machinery is to be used. However, as the embankments slope up and away from the site, this measurement can be reduced, as any tunnels created by Badgers are likely to lead away from the site.

With regards to reptiles and amphibians, there is a possibility that the site could be utilized by both of these groups. As mentioned previously, the pond located on site (but outside of the area for the proposed ground investigation works) is deemed to be of low value for GCN, as the HSI conducted by Ecosulis labelled the pond as being 'Poor'. However, as GCN have been identified on the ecological data search to be within the immediately surrounding area, there is a high likelihood that the area could be utilized as a foraging habitat for this species. This is said because GCN are known to migrate and forage within a 500m radius of breeding ponds, and the nearest GCN record was identified to be approximately 320m to the north-east of the site. If the areas of interest (scrub and woodland) are to be maintained as they currently stand (or if minimal vegetation clearance is to occur), there will be no issue from a GCN point of view with the conduct of the trial pits/boreholes. However, if the land tested is found to be contaminated, and the further removal of the soil [and subsequently the habitats which grow within it] is required, an amphibian presence/absence survey (during the optimal survey period: March - June) will be required to identify if these species reside within the area. If they are found to be on site, a development licence from Countryside Council for Wales to legally disturb GCN and their habitat would be required, and an individual mitigation strategy would need to be devised.

There is a possibility that hibernating reptiles (inc GCN) may occupy some of the disused rabbit warrens within the woodland on the north-western boundary. Similarly to the GCN, if this area is to be left as is during the trial pits/boreholes there will be no issues with regards to reptiles (as avoidance measures, by retaining as greater distance as possible from the warrens, will suffice). However, if the woodland is to be heavily impacted by the works, it will be necessary to conduct a reptile survey (during the months of April-May or September) to establish whether or not they are present within the gasworks site. Again, if it is discovered that they are, mitigation measures may need to be carried out for each species discovered.

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Finally, birds are protected (Wildlife and Countryside Act 1981) during the nesting season (March – August) so any works which are likely to impact nesting birds (such as tree felling) should occur outside of the nesting season.

Phase 1 habitat surveys can be conducted all year round and the site survey was carried out in November 2013. However, the optimal time for undertaking these surveys would be between the months of April and September. If surveys are undertaken outside this period, it is quite likely that a follow-up botanical survey will be required. It is therefore recommended because the site has a number of different types of habitats that a follow up flora survey is carried out in the optimal survey period.

To summarise the following surveys are required if the land investigated for contamination is to be removed off site.

4. GCN presence / absence pond survey (March – June).
5. Reptile presence / absence survey (April/May – September).
6. Update flora survey (April – September).

Preliminary Ecological Appraisal

5 REFERENCES

- Bat Conservation Trust (2012). Bat Surveys – Good Practice Guidelines. 2nd Edition. Bat Conservation Trust: London.
- Berthinussen, A. & Altringham, J.D. (2012) The effect of a major road on bat activity and diversity. *Journal of Applied Ecology* 49: p.p. 82–89.
- Biodiversity 2020: A strategy for England's wildlife and ecosystem services (2011)
- Circular 06/05 Biodiversity and Geological Conservation – Statutory Obligations and Their Impact System (2005)
- The Conservation of Habitats and Species Regulations 2010. SI 2010/490.
- The Conservation (Natural Habitats, etc.) (Amendment) Regulations 2007. SI 2007/1843, London: HMSO.
- Countryside and Rights of Way Act 2000 (c.37). London: HMSO.
- Defra (2007a) Securing a Healthy Natural Environment: an action plan for embedding an ecosystems approach. PB12853. Defra London
- Defra (2007b) An Introductory Guide to Valuing Ecosystems Services. PB12852. Defra London
- Dietz, C., von Helversen, O. & Nill, D. (2009) *Bats of Britain, Europe and Northwest Africa*. London: A. C. Black
- Hutson, A.M., Spitzenberger, F., Aulagnier, S., Coroiu, I., Karataş, A., Juste, J., Paunovic, M., Palmeirim, J. & Benda, P. (2008) *Pipistrellus pipistrellus*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1
- Institute of Ecology and Environmental Management, Professional Guidance Series
- Institute of Ecology and Environmental Management (2006), *Guidelines for Ecological Impact Assessment in the United Kingdom*
- Institute of Environmental Assessment (1995), *Guidance for Baseline Ecological Assessment*
- Joint Nature Conservation Committee (2005) *The Marine Habitat Classification for Britain and Ireland, Version 04*
- Joint Nature Conservation Committee (2010) *Handbook for Phase 1 Habitat Survey – a technique for environmental audit*
- Millennium Ecosystem Assessment (2005)
- National Planning Policy Framework (2012)
- The natural choice: securing the value of nature (2011) (Natural Environment White Paper)
- Natural Environment and Rural Communities (NERC) Act 2006,
- RSPB (2002) *The Population Status of Birds in the UK*,
- RSBP (2009) *Birds of Conservation Concern 3*
- Rydell J & Racey, P A (1993) Street lamps and the feeding ecology of insectivorous bats. Recent Advances in Bat Biology, Zool Soc Lond Symposium abstracts
- UK Biodiversity Action Plan (2007). UK List of Priority Species. Joint Nature Conservation Committee.
- Wildlife and Countryside Act 1981 (and amendments) (c.69). London: HMSO.

Preliminary Ecological Appraisal

6 APPENDICES

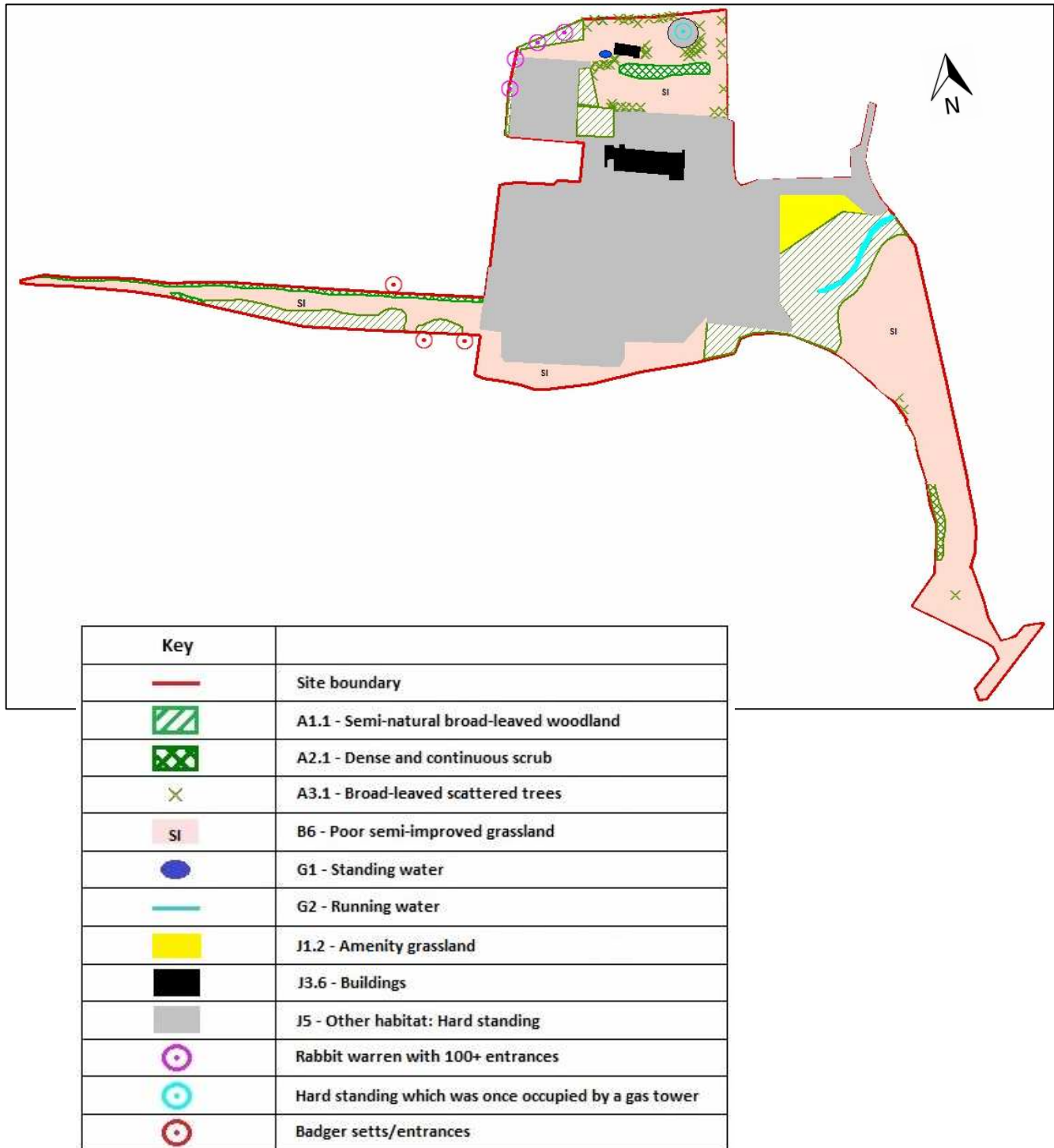
Appendix A: Preliminary Ecological Appraisal (Extended Phase 1 Habitat Map)

Appendix B: Site Plans

Appendix C: Photographic Records

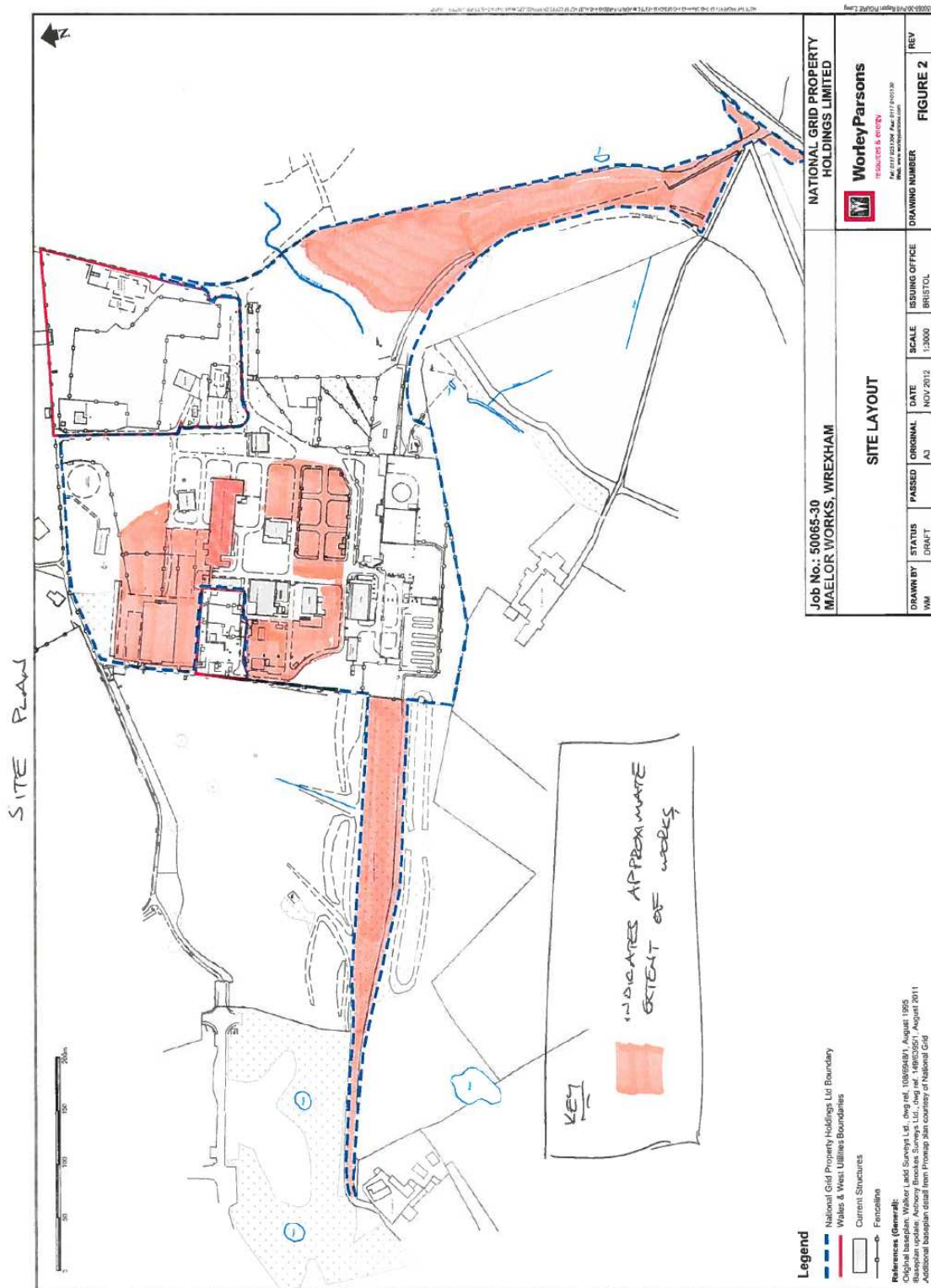
Preliminary Ecological Appraisal

Appendix A: Preliminary Ecological Appraisal (Extended Phase 1 Habitat Map).



Preliminary Ecological Appraisal

Appendix B: A site plan which shows the approximate extent of the proposed works (trial pits and boreholes). These are indicated in pink.



Preliminary Ecological Appraisal

Appendix C: Photographic Records

Another view of building 1 (B1) which is proposed to be demolished as a part of the proposed works.



A view of the east side of B1 from a north-eastern viewpoint.



Preliminary Ecological Appraisal

A view of the northern side of B1 from a north-eastern viewpoint.



A close up of the pond, which has low potential for housing breeding GCN during the optimal survey period.



Preliminary Ecological Appraisal

The pond located outside the development zone, with the adjacent building in the background. The broken window which may allow bird access is indicated by the red circle.



One of the main areas of hard standing located on site. This particular area is located within the 'proposed works' zone, but the building to the right however, is not.



Preliminary Ecological Appraisal

This photograph was taken from the entrance point to the western extension. For access reasons, entry to this area was only available via a farm which was located off site to the west.



The semi-improved rough grassland located to the south-east of the site.



Preliminary Ecological Appraisal

The chain link fence and gate which limited access to the eastern woodland/scrub area.



Preliminary Ecological Appraisal

7 LIMITING CONDITIONS/DISCLAIMERS (Unless stated otherwise)**1. The Service**

- 1.1 Evolution Ecology Ltd agrees to supply Ecological consulting services of a preliminary nature or a more thorough service as advised or as commissioned.

2. Fees

- 2.1 The client(s) will settle the agreed fee in full, within 30 days of receiving the invoice. Reports will remain the property of Evolution Ecology Ltd until full payment has been received. No liability is accepted for the contents of a report that is not paid in full. Any queries should be notified to Evolution Ecology Ltd within 7 days of the invoice date.
- 2.2 If the client(s) fails to pay within the time specified in 2.1 then Evolution Ecology Ltd shall charge the client(s) interest on the outstanding fee, both before and after any judgment, at the rate of 4% per annum above the HSBC Bank base rate, until payment is made in full (A part of a month being treated as a full month for the purposes of calculating interest).
- 2.3 In the event that it is necessary to recover any outstanding fees from the client(s), the client(s) will fully reimburse any costs and expenses incurred during the recovery period, including court costs. Evolution Ecology Ltd reserves the right to make a charge for every letter sent and telephone/fax call made, in connection with the recovery.

3. The Report

- 3.1 If any part of the report is lost, or altered without the written consent of Evolution Ecology Ltd, then the entire report becomes invalid.
- 3.2 The general format of reports is a certified product and cannot be shown, copied or distributed to third parties without the permission of Evolution Ecology Ltd. No liability is accepted for the contents of the report, other than to that of the client(s).
- 3.3 The report will purport not to express any opinion or comment as to the condition or structural integrity of any building and no reliance should be made on any such comments.

Preliminary Ecological Appraisal

4. Insurance Cover

- 4.1 All work carried out by Evolution Ecology Ltd is covered by a £1,000,000 professional indemnity insurance.

5. Quality of Craftsmanship

- 5.1 When appointing an Ecologist, please use only suitably qualified and experienced companies (The Local Authority and the Institute of Ecology and Environmental Management may be able to provide a select list of such companies).
- 5.2 Evolution Ecology Ltd will not accept liability for any works undertaken by any other companies, or contractors.

Appendix C
Protected Species Survey Report
(Evolution Ecology, 2014)



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Maelor Works, Wrexham

Protected Species Survey Report

May/June 2014



Protected Species Survey Report

Protected Species Report

(with reference to badgers, bats, birds, great crested newts, otters and water voles)

at

National Grid

Maelor Works

Marchwiell

Wrexham

LL13 0UW

for

James Wood

I & H Brown Ltd

On behalf of

National Grid Gas Property Holdings Limited

Protected Species Survey Report

0. Executive Summary

This report has been prepared at the request of James Wood (I & H Brown Ltd) on behalf of National Grid Property Holdings Ltd, to provide an overview of the likelihood of protected fauna species being present at the former gaswork site located at Maelor Works, Marchwiel, Wrexham, LL13 0UW (OS Grid Reference: SJ 38108 48134). A number of site surveys were undertaken throughout May and June 2014 by Evolution Ecology Ltd.

The former gaswork site located at Maelor Works is situated approximately 5km to the south-east of the town of Wrexham, with residential areas to the south-west and a large industrial estate expanding from the north-west to the north-east of the site. Open countryside occupies the vast majority of the surrounding area (to all sides) which comprises of; agricultural grasslands, scattered trees and hedgerows. Additionally, running water courses are present in the surrounding area, (one of which - a small brook which diverts from the River Clywedog - runs through the site itself), as are a number of standing water bodies.

A Preliminary Ecological Appraisal was conducted [by Evolution Ecology] of the site in its entirety on the 18th November 2013. This survey revealed that many areas within the site boundary possess the potential to house protected species, and it is because of this, that the protected species surveys to be discussed were commissioned. It has been discussed since with the client that the only areas of the site which are to be impacted by the proposed works [at this time] are:

- The aforementioned brook which cuts through the site towards the east – which is to be dredged in order to remove contaminated sediments;
- The woodland habitat surrounding the brook – which is proposed to be cut back (roughly 5m each side) to allow machine access;
- The standing water body which is situated roughly 100m from the most south-westerly point of the brook – which is again proposed to be dredged in order to remove contaminated sediments;
- Two of the buildings within the centre of the compound - which are proposed to be demolished.

Recommendations**Preliminary Ecological Appraisal – Flora**

With regards to the flora identified on the proposed redevelopment area, there are no habitats of legal conservation concern (i.e. BAP Priority Habitats etc.). However, a number of areas do hold the capacity to provide important nesting/foraging/sheltering habitats for a number of fauna species. In relation to the proposed works, the main areas to be affected are the woodland area to the east, the brook (within the woodland) and the pond (with a medium population of smooth/palmate newts).

Firstly, vegetation clearance will need to take place (up to 5m from the watercourse on each bank side) along the [entirety of the] brook, within the clients ownership, in order to allow the access of the required machinery onsite. As the site currently stands, it is anticipated the abundance of ramsons (*Allium ursinum*) plants within the ground are likely to contribute towards providing an important food source for a number of invertebrate species such as hoverflies, butterflies and longhorn beetles (one species from the latter of which was

Protected Species Survey Report

identified onsite – a [possible] Welsh oak longhorn beetle *Pyrrhidium sanguineum*). With this being the case, it is recommended that all of the ramsons bulbs within this area be scraped up and stockpiled along the bankside during the autumn/winter months (when plants are dormant), in order for them to be relayed once the works have been completed. This should help towards restoring the original understorey habitat which currently holds such high value for local invertebrates.

The second measure which should be adhered to throughout the proposed works, is the retention of all semi-mature/mature trees within the woodland habitat. As mentioned previously, a 5m buffer either side of the brook will need to be cleared to allow machine access, however, it is suggested that this clearance, occurs without impacting the longevity of the trees. This could be done by cutting branches back and altering the proposed machinery path to accommodate the trees. This also [most importantly] applies to the mature common lime (*Tilia × europaea*) specimen and the standing deadwood, both of which are located almost centrally along the northern brook bankside. Because of the instability of the standing deadwood, for health and safety reasons, an 8m exclusion zone will need to be erected around it (as a precautionary measure, just in case the movement of the machinery impacts its stability). Ultimately, if the trees are retained/incorporated into the proposed works and if they are cut back and managed accordingly, this will allow light to enter the woodland once again, which should diversify the range of understorey floral species which are able to colonize and enhance the quality of the brook. Additionally, potential bat roosting features and known nesting trees will be saved, so that they can be continuously used in the future by these species. As a further conservation measure, any of the branches which are cut from the trees or any deadwood discovered, should be stockpiled (log piles) in an appropriate area, which will create an excellent sheltering habitat for a number of species, both fungal and faunal (i.e. invertebrates).

Finally, [in relation to the woodland], it is recommended that if it need be moved, the tree which has fallen across the brook and unintentionally formed a natural 'wildlife bridge', should be placed back in its original position after the works have been completed. This is said, as it is considered that this natural structure has formed an important migratory route from the north to the south of the brook for small mammals [such as mice and shrews], which may have otherwise been inaccessible to them.

The final measure to consider in relation to the habitats present onsite is the pond which is currently known to harbour a healthy medium population of smooth/palmate newts during the breeding season (March-June). Under the current proposals, it is anticipated that the pond will be drained, and the contaminated sediment present on the pond bed, be removed (again with the use of machinery which is likely to access the site through the immediately adjacent security fence to the west). Because of the ecological value attached to this pond, it is recommended that the pond water be stored [outside of the amphibian breeding season] and any newts collected (bottle traps and nets), whilst the contaminated sediment is being removed. At the same time that this is being conducted, the immediately surrounding vegetation should be cut back (with particular reference to the overhanging trees) in order for 80/90% of the pond to be open to direct sunlight. This should allow the colonization of further emergent/floating plant species (which could be used for egg laying), and should ultimately

Protected Species Survey Report

further improve the ponds suitability for invertebrates (which are an important food source for amphibians). Once these measures have been achieved, the pond can be refilled and allowed to recolonize naturally. These measures should ultimately ensure that the medium population of smooth/palmate newts which are known to use the pond, should continue to have a suitable breeding area in the long term.

Badgers/ Rabbits

With regards to badgers (*Meles meles*) and rabbits (*Oryctolagus cuniculus*) an exclusion zone will need to be put in place so that the proposed works will not negatively impact the badger clan (including rabbits) which are present within the most south-westerly section of the woodland habitat. Additionally, by ensuring that the works remain between 20m and 30m away (which will be dependent upon the type of machinery used) from the nearest active sett entrance, there should be no issues with the continuation of the proposed vegetation clearance and contaminated sediment removal within the woodland and running water habitats.

Bats

With regards to the proposed demolition of the buildings, there are no issues in relation to bats, as both of the buildings were deemed as being unsuitable for roosting specimens. This was supported by the results of the dusk emergence survey which was conducted on B2, which identified passing bats only. With this being the case, the buildings can be demolished as planned, with no negative impacts upon local bat colonies being predicted.

With regards to the trees of interest within the woodland habitat (i.e. the mature common lime and the standing deadwood with woodpecker holes), no bats were detected emerging from either of these habitats during the two dusk emergence surveys conducted on this area. Although no bats were identified, this is thought to be due to the density of the vegetation within the woodland, which would currently prevent a clear flight path when emerging from the trees. With this being the case, these trees should be retained throughout the vegetation clearance works, as they are likely to provide suitable roosting habitats for these species, once the woodland has been managed slightly to increase the light availability and reduce the vegetation density.

Birds

The main areas of concern with regards to nesting birds are the semi-mature/mature tree specimens, both within the woodland and surrounding the pond which is to undergo contaminated sediment removal. Evidence of nesting birds was discovered within the woodland (in the form of an egg shell on the ground and cuckoo and wood pigeon calls) and as such, it is imperative that any works which are likely to disturb breeding birds, occur outside of the bird nesting season (which is between the months of March-August). If this is achieved and the trees within the woodland be retained, there is no reason why the proposed works would have any negative impacts upon local breeding bird populations.

Great Crested Newts

Protected Species Survey Report

No evidence of great crested newt (*Triturus cristatus*) presence was identified throughout any of the four presence/absence surveys. However, a healthy medium population (peak count of 43) of smooth/palmate newts was identified within the pond. With this being the case (and as discussed in detail within section 5.1), it is recommended that the pond be restored [post-sediment removal] to its former layout and enhanced via managing the immediately surrounding vegetation. These measures should ultimately improve the habitat in the long term for breeding smooth/palmate newts, and may also improve its suitability for any local GCN. These works need to take place during Autumn/Winter.

Otters and Water Voles

With regards to water voles, no evidence of their utilization of the brook became apparent throughout the survey, as no footprints, feeding remains or burrows were identified. With this being the case, [and as the nearest water vole record was over 1500m from the site], it is anticipated that the proposed contaminated sediment removal works within the running water course are unlikely to harm any water voles or damage their resting habitat.

The only evidence of otter utilization was the presence of two potential footprints which were identified upon the northern embankment of the brook. However, as no further evidence was revealed (such as otter holts, feeding remains or signs of tail drag), it is anticipated that this brook would be of commuting use only to local otter populations. This being said, similarly to the water vole records, the nearest otter record to the site was approximately 1465m away, so it is quite unlikely that this area would be used as a regular commuting route. With this being the case, the proposed contaminated sediment removal works within the running water course are unlikely to harm any otters or damage their resting habitat.

Additionally, the site supervision works (to be discussed within section 5.7) should also function to ensure that [although unlikely] no commuting otters or water voles are harmed during the proposed works.

Site Supervision

Finally, in addition to all of the proposed conservation/mitigation measures, site supervision by a licenced ecologist will need to be arranged throughout the duration of the works (particularly within the woodland and around the pond). It may not be necessary for the site to be attended daily by the ecologist, however, a timetable of works will be discussed further once detailed plans of the proposed works have been received.

Protected Species Survey Report

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Protected Species Survey Report

1. INTRODUCTION

1.1 Background

This report has been prepared at the request of James Wood (I & H Brown Ltd) on behalf of National Grid Property Holdings Ltd, to provide an overview of the likelihood of protected fauna species being present at the former gaswork site located at Maelor Works, Marchwiel, Wrexham, LL13 0UW (OS Grid Reference: SJ 38108 48134). A number of site surveys were undertaken throughout May and June 2014 by Evolution Ecology Ltd.

1.2 Site Description

The former gaswork site located at Maelor Works is situated approximately 5km to the south-east of the town of Wrexham, with residential areas to the south-west and a large industrial estate expanding from the north-west to the north-east of the site. Open countryside occupies the vast majority of the surrounding area (to all sides) which comprises of; agricultural grasslands, scattered trees and hedgerows. Additionally, running water courses are present in the surrounding area, (one of which - a small brook which diverts from the River Clywedog - runs through the site itself), as are a number of standing water bodies.

A Preliminary Ecological Appraisal was conducted [by Evolution Ecology] of the site in its entirety on the 18th November 2013. This survey revealed that many areas within the site boundary possess the potential to house protected species, and it is because of this, that the protected species surveys to be discussed were commissioned. It has been discussed since with the client that the only areas of the site which are to be impacted by the proposed works [at this time] are:

- The aforementioned brook which cuts through the site towards the east – which is to be dredged in order to remove contaminated sediments;
- The woodland habitat surrounding the brook – which is proposed to be cut back (roughly 5m each side) to allow machine access;
- The standing water body which is situated roughly 100m from the most south-westerly point of the brook – which is again proposed to be dredged in order to remove contaminated sediments;
- Two of the buildings within the centre of the compound - which are proposed to be demolished.

Protected Species Survey Report

1.3 Surveyor Details

The site was surveyed and the protected species surveys were conducted by licenced ecologist(s): Mr Paul Keeling BSc (Hons) MCIEEM – Senior Ecologist, Miss Charlotte Richardson BSc (Hons) - Assistant Ecologist and Mr Richard Millington – Assistant Ecologist.

Figure 1: A map which illustrates the layout of Maelor Works in relation to the immediately surrounding landscape and the areas which are proposed to be affected by the planned works. The areas highlighted in green (and labelled B1 and B2) represent the two buildings which are to be demolished, the red circle illustrates the location of the pond to be dredged, the blue line shows the rough location of the stream to be dredged and the two yellow lines represent the areas in which vegetation clearance will be required.



2. LEGISLATION

2.1 Habitat Legislation

“Planning authorities have a duty to consider biodiversity when assessing planning applications. Where there is a reasonable likelihood that a planning proposal might affect important protected species or habitats, the council will require information on the species and habitat likely to be affected, and an assessment of the impacts of the proposals. This information will need to be provided before a planning decision is made and if this information is not provided, the council may refuse to register the application.

This Duty was introduced by the **Natural Environment and Rural Communities Act (The NERC Act)** and came into force on 1 October 2006. This act clarified existing commitments with regard to biodiversity, raised the profile of biodiversity. It aimed to make the consideration of biodiversity a natural and integral part of policy and decision making.

In addition to the NERC Act there is also national and international biodiversity legislation. This includes legislation in relation to protected species and sites which operates outside of the planning system. Local Authorities and developers have a duty to comply with this legislation. Planning Policy Statement 9 - Biodiversity and Geological Conservation Local Policy in relation to biodiversity can be found in the Local Development Framework, retained Local Plan policies and in the emerging Core Strategy.”

For further information please go to
http://www.enfield.gov.uk/info/200052/advice_for_developers/1083/ecological_assessments_for_planning_applications

2.2 Badger Legislation

The main piece of legislation in England and Wales which aims to safeguard badgers (*Meles meles*) is the **Protection of Badgers Act 1992**. This species and their setts are legally protected under this legislation from intentional cruelty which includes activities such as badger-baiting, snaring and poisoning. In combination with this, under the Protection of Badgers Act 1992, it is illegal to:

- Wilfully kill, injure, take or attempt to kill, injure or take a badger;
- Possess a dead badger or any part of a badger;

Protected Species Survey Report

- Use badger tongs in the course of killing, taking or attempting to kill a badger;
- Dig for a badger;
- Sell or offer for sale or control any live badger;
- Mark, tag or ring a badger; and
- Interfere with a badger sett by:
 - Damaging a sett or any part thereof;
 - Destroying a sett;
 - Obstructing access to a sett;
 - Causing a dog to enter a sett; and
 - Disturbing a badger while occupying a sett.

It is important that the location of any setts onsite or nearby are known in order for us to adhere to these regulations during the proposed works. For additional information please visit:

http://www.badger.org.uk/Attachments/Resources/469_S4.pdf

2.3 Bat Legislation

All of the bat species found within the UK are **European Protected Species (EPS)** and are also protected under domestic legislation, as are their breeding and resting sites (roosts). The two primary sets of legislation which protect bats and their roosts are the **Wildlife and Countryside Act (W&CA) 1981** and the **Conservation of Habitats and Species Regulations 2010**. Under these pieces of legislature, it is an offence (unless licenced) to:

- Intentionally kill, injure or handle a bat;
- Possess a bat (whether live or dead);
- Disturb a roosting bat, or sell or offer a bat for sale without a licence;
- Damage, destroy or obstruct access to any place used by bats for shelter, whether they are present or not.

Because of the legal protection afforded to bats, it is important that any roosting areas are identified and incorporated into a mitigation package, to ensure that the proposed works abide by the current laws.

For further information regarding bats and the law, please visit:

<http://www.naturalengland.org.uk/ourwork/regulation/wildlife/species/bats.aspx#legal>; http://www.bats.org.uk/pages/bats_and_the_law.html; http://www.lbp.org.uk/downloads/Publications/SpeciesInfo/NE_EU_bats.pdf.

2.4 Bird Legislation

In the UK, all wild birds, their nests and their eggs are protected under the **Wildlife and Countryside Act 1981** and additional legislation including the **Countryside and Rights of Way Act 2000** and the **Natural Environment and Rural Communities (NERC) Act 2006**.

This means that under the current laws, it is an offence to:

- Kill, injure or take any wild bird;
- Take, damage or destroy the nest of any wild bird while it is in use or being built;
- Take or destroy the egg of any wild bird;
- Have in one's possession or control any wild bird (dead or alive) or any part of a wild bird which has been taken in contravention of the Act or the Protection of Birds Act 1954;
- Have in one's possession or control any egg or part of an egg which has been taken in contravention to the Act. This includes items taken or killed before the passing of the Act;
- Have in one's possession or control any live bird of prey of any species in the world (with the exception of vultures and condors) unless it is registered and ringed in;
- Have in one's possession or control any bird of a species occurring on Schedule 4 of the W&CA 1981 unless registered (and in some cases ringed) in accordance with the Secretary of State's regulations;
- Disturb any wild bird listed on Schedule 1 of the W&CA 1981 while it is nest building, or at a nest containing eggs or young, or disturb the dependent young of such a bird.

In addition to this, some rarer species are afforded additional protection, such as the barn owl (*Tyto alba*) which is afforded the highest level of protection possible under the **Wildlife and Countryside Act 1981**. This means that for being convicted of attempting any of the following actions, there is a maximum fine of up to £5,000:

- Killing or injuring a barn owl;
- Catching a barn owl;
- Taking or destroying any egg of a barn owl;
- Damaging or destroying the active nest site with eggs or young or before eggs are laid;
- Disturbing the dependent young of a barn owl.
- Possessing, offering for sale or selling a barn owl (excluding captive bred specimens);
- Releasing or allowing the escape of a barn owl into the wild.

Protected Species Survey Report

For further information regarding birds and the law, please visit:

<http://www.rspb.org.uk/ourwork/policy/wildbirdslaw/>;

<http://www.naturenet.net/law/birds.html#Bas>;

http://www.rspb.org.uk/images/wbatl_tcm9-132998.pdf;

http://www.rspb.org.uk/advice/law/barn_owls_law/.

2.5 Great Crested Newt Legislation

The great crested newt (*Triturus cristatus*) is fully protected under Schedule 5 of the **Wildlife and Countryside Act 1981** (as amended) and Schedule 2 of **The Conservation of Habitats and Species Regulations 2010** (as amended) making it a European Protected Species. The table below (as taken from the Great Crested Newt Conservation Handbook) illustrates the activities which are classified as being punishable by law, under the current legislation protecting this species.

Table 1: This table illustrates the actions which are punishable by law with regards to great crested newts under both the W&CA (1981) and the Conservation of Habitats and Species Regulations (2010).

Actions prohibited under: Wildlife and Countryside Act 1981	Actions prohibited under: Conservation (Natural Habitats & c) Regulations 1994
Intentional killing	Deliberate killing
Intentional injuring	-
Intentional taking	Deliberate taking/destruction of eggs
Possession/control	Keeping
Intentional or reckless* damage to/destruction of/obstruction of any structure/place used for shelter/protection	Damage to/destruction of breeding site/resting place
Intentional or reckless* disturbance at occupied structure/place	Deliberate disturbance
Sale offering/advertising for sale (includes any part or derivative) or transport for sale	Sale/exchange, offering for sale (includes any part or derivative) and transport

For further information regarding great crested newts and the law, please visit:

http://www.naturalengland.org.uk/Images/GreatCrestedNewts_tcm6-21705.pdf

2.6 Otter Legislation

Otters (*Lutra lutra*) are protected under the **Wildlife and Countryside Act 1981** and also under the **Conservation of Habitats and Species Regulations 2010**, as a result of substantial declines in the recent past. Within these European regulations, Otters are classed as a

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European Protected Species (EPS) which means that they are given the highest level of legal protection. Of the above two, the Habitats and Species Regulations is the primary legislation which protects otters, and under this act, it is an offence to:

- Deliberately capture, injure or kill an otter;
- Deliberately disturb an otter in such a way as to be likely to significantly affect the local distribution or abundance of otters or the ability of any significant group of otters to survive, breed, rear or nurture their young;
- Damage or destroy an otter holt;
- Possess or transport an otter or any part of an otter;
- Sell (or offer for sale) or exchange an otter.

For further information regarding otters and the law, please visit:

http://www.naturalengland.org.uk/Images/wmlg02_tcm6-3750.pdf;

<http://www.naturalengland.org.uk/ourwork/regulation/wildlife/species/otters.aspx>

2.7 Water Vole Legislation

During the last 30 years, water vole (*Arvicola amphibius*) numbers have dramatically declined due to the spread of the invasive American mink (*Neovison vison*) and also due to habitat loss, which has left the current UK population of this species fragmented and minimal. For many years, the water vole received limited legal protection, as only their habitat was protected (not the water voles themselves). However, as of 6th April 2008, the water vole has received full protection under section 9 of the **Wildlife and Countryside Act 1981**. Legal protection under this act makes it an offence to:

- Intentionally kill, injure or take (capture) a water vole;
- Possess or control a live or dead water vole, or any part of a water vole;
- Intentionally or recklessly damage, destroy or obstruct access to any structure or place which water voles use for shelter or protection or disturb water voles while they are using such a place;
- Sell, offer for sale or advertise for live or dead water voles.

Offences under Section 9 of the W&CA 1981 carry a maximum penalty of imprisonment for up to six months or a fine [or potentially both]. In addition, the courts may order the forfeiture of any vehicle or other thing that was used to commit the offence.

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In addition to the protection afforded to the water vole under the W&CA 1981, the water vole is also considered to be a **UK BAP priority species (UK BAP)** under the **UK Biodiversity Action Plan**, due to its decline and need for conservation. For further information regarding water voles and the law, please visit:
<http://publications.naturalengland.org.uk/file/86043>;
<http://jncc.defra.gov.uk/page-5170>.

3. METHODOLOGY

3.1 Desktop Study (Ecological Data Search)

Before the Preliminary Ecological Appraisal was conducted in November 2013, North Wales Environmental Information Service (COFNOD) was commissioned to carry out an ecological data search of all protected species and sites recorded within 2km radius of the site. Please see results for further information.

3.2 Preliminary Ecological Appraisal (Extended Phase 1 Habitat Survey)

In November 2013, a Preliminary Ecological Appraisal (Extended Phase 1 Habitat Survey) was conducted according to the methodology of the JNCC (2010). Preliminary Ecological Appraisal is a standard technique for classifying British habitats. The aim was to provide records of habitats that are of significant ecological value and it is the results from this, which have prompted the commission of the protected fauna surveys contained within this report.

Additional Target Notes

During the initial Preliminary Ecological Appraisal, additional target notes were made where applicable to record:

- Key habitat features;
- Urban ecological features not covered in sufficient detail in the Phase 1 Methodology;
- Important habitats too small to be mapped and to identify dominant species;
- Other features of ecological interest.

3.3 Badger Survey

The badger surveys conducted by Evolution Ecology are conducted in line with the recommendations outlined by Natural England. The survey involves examining all suitable habitats (with particular reference to scrub, woodland and fence lines) for setts and other signs of badger activity. Such signs include:

- Badger paths;
- Latrines;
- Snuffle holes;
- Scratching posts;
- Badger hairs on fences/barbed wire/bushes etc.

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If any potential setts are discovered, attempts are made to establish the activity levels of the sett. If active, there may be fresh tracks nearby, hairs around the entrance or freshly disturbed dirt around the entry hole; if inactive, the entry hole may have cobwebs inside or it may have overgrown vegetation covering it). Once the activity levels of the sett are established, it would be beneficial, if possible, to establish the type of sett that it is. A list of the different types of badger sett and their definitions can be observed in table 2.

Table 2: A table which defines the definitions of the different types of badger sett.

SETT TYPE	DEFINITION
Main	Several holes with large spoil heaps and obvious paths emanating from and between sett entrances.
Annexe	Normally less than 150m from main sett, comprising several holes. May not be in use all the time, even if main sett is very active.
Subsidiary	Usually at least 50m from main sett with no obvious paths connecting to other setts. May only be used intermittently.
Outlier	Little spoil outside holes. No obvious paths connecting to other setts and only used sporadically. May be used by foxes and rabbits.

More information regarding the survey methodology of badgers and the different sett types can be found at:

http://www.naturalengland.org.uk/Images/Badgers_tcm6-21692.pdf;
<http://www.highland.gov.uk/NR/rdonlyres/21C6CD40-9B48-4768-A471-19F22633598B/0/BestPracticeGuidanceBadgerSurveysSeptember2006.pdf>.

3.4 Bat Scoping Survey

The actions of the surveyor(s) on site and during the production of the report were conducted in accordance with the Bat Conservation Trust guidelines (2nd edition). The aim of the survey is to undertake an appraisal of the buildings/mature trees and their surrounding area to establish the following:

- The probability of bats and their roost sites being present in the areas which are proposed to be affected by the proposed works;
- To assess the roost status;
- To assess suitable food resources and habitat requirements;
- If a roost site is found, to provide an impact assessment.

It is worth noting that dusk/dawn activity surveys can only be conducted during the optimal survey period (May-September). Any time before or after these months are not considered to be representative of

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presence/absence, as bats are generally in hibernation between these months.

3.4.1 Bat Dusk Activity Surveys

If anecdotal evidence of bat utilization is apparent during the scoping survey, it may be necessary to conduct bat detector emergence surveys. The object of these surveys is to detect active bats leaving possible roost sites identified in the external and internal surveys. This is achieved by:

- Being at the site 1 hour before sunset;
- Listening for social calls at potential roost sites;
- Standing at different transect points around the buildings [and trees], using the bat detector to hear the bats plus trying to see the first bats emerge;
- Standing at different transect points at foraging areas;
- Carrying out this survey up to 2 hours after the first bats emerge as this will cover the emergence period and possibly the first bats returning to the roost site [for some bat species].

Evidence will be used to determine whether a European Protected Species (EPS) licence will be required to ensure legal compliance during development. This will also include identifying which mitigation measures [if any] would be most appropriate.

Batcorder

The EcoObs batcorder is the first worldwide data recorder that distinguishes bat calls from other sound sources in real-time (online signal analysis). Calls are recorded digitally as call sequences. The batcorder is used alongside Batbox Duet and SSF Bat2 Heterodyne and Frequency Division bat detectors, and provides an unbiased statistical analysis of bat species recorded during survey on site. Recorded bat sound is subsequently analyzed using bcAdmin, batIdent and bcAnalyze software, which calculates a confidence interval of accuracy (CI=%) and is used in conjunction with visual and audible data recorded during survey to ascertain a holistic view of the bat species present.

3.6 Great Crested Newt Surveys

Surveys were undertaken following the techniques described in the Great Crested Newt Mitigation Guidelines (Natural England, 2001). This states that four survey visits are required to determine the presence/absence of GCN, and that a further two visits (i.e. a total of six) are required if GCN are present, in order to obtain an estimate of the population size in each pond.

A minimum of three of the following survey techniques were employed at the pond of interest.

- Torchlight Search: All ponds that contained water were searched after dusk using a Club-light CB2 torch. The perimeter [where accessible] was walked around and all marginal vegetation and pond edges searched for newts where visibility allowed. No torchlight searches took place if the air temperature was below 5°C.
- Bottle Trapping: Empty [modified] 2-litre drinks bottles, were placed in marginal vegetation in the accessible areas of each pond. The traps were set during the early evening of the first day on site, checked and emptied then removed by 9am the following morning. Each bottle had a pocket of air trapped inside in order for animal welfare issues to be avoided. All of the traps were counted both before and after the survey to ensure that none were left behind. The traps were set at a density of one trap per 2 metres around all accessible banks of the pond(s).
- Netting: A dip net was swept across the pond to catch any newts within reach of the pond perimeter.
- Egg Searching: Accessible emergent aquatic vegetation was searched for the eggs of all newt species. In the absence of suitable emergent vegetation, submerged leaves from bank side vegetation and litter were examined.
- Refuge search: Searches of the land were carried out for GCN resting places by looking under logs, bark, rocks, and debris (e.g. discarded furniture, carpets, and plywood).

Habitat Suitability Index (HSI)

The Great Crested Newt Habitat Suitability Index (HSI) is a quantitative measure of habitat quality (source: Oldham R.S., Keeble J., Swan M.J.S. & Jeffcote M. (2000)) and was used to evaluate the suitability of the pond located to the south-east of Maelor Works and its immediately surrounding area.

3.7 Otter and Water Vole Surveys

The surveys to assess otter and water vole presence/absence use a similar methodology (wading through watercourses and observing the bank sides for characteristic signs of use by these species), so in the interests of simplicity these surveys have been combined.

According to Natural England, otter surveys are required when an area which has potential to be used by an otter is likely to be impacted during a development. Although a licence is not required (only in the case of using non-intrusive survey methods), these surveys should be conducted by suitably experienced surveyors, who know the signs to look out for. Such signs include:

- Spraints;
- Footprints;
- Feeding remains;
- Otter holts;
- Slides.

Some of these signs (i.e. footprints and holts) are easier to identify during the spring months, before the surrounding vegetation is able to fully establish, however, otter surveys can be conducted all year round. For more information regarding the survey methods of otters, please visit: http://www.naturalengland.org.uk/Images/wmlq02_tcm6-3750.pdf.

Water vole surveys are conducted in accordance with the guidelines set out by Natural England in the 'Guidance for Planners and Developers' document. This involves examining waterways and their associated banks for signs of water vole presence, the species themselves are rarely openly seen. Such signs include:

- Faeces/latrines;
- Burrows (which are often visible on the bank side);
- Footprints;
- Feeding stations.

It is worth noting that water vole activity lessens during the winter months, so for the most representative results, any presence/absence surveys should be conducted between the months of April and October. This being said, outside of these months activity does not completely cease, so it is possible to identify potential burrows and also look for other signs of anecdotal evidence (such as footprints, faeces). For more information, please visit:

<http://publications.naturalengland.org.uk/publication/50006?category=9012>.

4. FIELD SURVEY RESULTS

4.1 Desktop Survey (Ecological Data Search)

North Wales Environmental Information Service (COFNOD) was commissioned to carry out an ecological data search of all protected species recorded within 2km radius of the site. The search uncovered records of numerous protected species, but none of which have been recorded directly on the site. This being said, a few records were identified immediately adjacent to the site. The approximate locations of the closest known record for each of the species groups of interest can be observed below in figure 2.

Figure 2: This map illustrates the location of Maelor Works (as indicated by the red pin) in relation to the closest known record for each protected fauna species within the groups of interest.



With regards to bats, two distinct species were recorded within the immediately surrounding area; the common pipistrelle (*Pipistrellus pipistrellus*) and the whiskered bat (*Myotis mystacinus*). The closest of any bat record was of a common pipistrelle (*Pipistrellus pipistrellus*) and it was located approximately 530m to the east of the gaswork site.

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Badgers (*Meles meles*) have been identified within the nearby area, and according to the ecological data search, the closest record was located roughly 1335m to the south-west of the site. This being said, it is worth pointing out that evidence of recent badger utilization was identified within the westerly woodland/semi-improved grassland habitat during the 2013 Preliminary Ecological Appraisal.

A number of declining bird species have also been recorded within the 2km search radius. These included; Kingfisher (*Alcedo atthis*), kestrel (*Falco tinnunculus*), red kite (*Milvus milvus*) and fieldfare (*Turdus pilaris*), all of which have been noted as having either amber (unfavourable conservation status) or red population status (globally threatened). This being said, none of these records were identified upon the site itself, and the nearest of any bird record to the site was of the red-listed cuckoo (*Cuculus canorus*) which was identified approximately 595m to the north-east.

A number of great crested newt (*Triturus cristatus*) records were identified within the immediately surrounding area. The closest of these records was identified as being approximately 270m to the north-east of the site, but again, no records were identified anywhere within the gaswork site boundary itself.

With regards to otters (*Lutra lutra*) and water voles (*Arvicola amphibius*) a number of records of their presence nearby were identified. Firstly, approximately 15 records of otter were revealed, however, the closest of these was identified as being roughly 1465m to the north-east of the site. Similarly, in relation to water voles, only two past records of their presence within a 2km radius of the site were identified, both of which were over 1500m away.

4.2 Preliminary Ecological Appraisal (Extended Phase 1 Habitat Survey)

The Preliminary Ecological Appraisal Report conducted [by Evolution Ecology] in November 2013 provides detailed information regarding the floral habitats present onsite. However, a number of limitations were identified during the surveys discussed within this report. Firstly, the woodland area surrounding the brook (which is proposed to undergo vegetation clearance) was densely overgrown in parts [particularly over and within the brook itself], so this slightly limited the number of areas which could be physically investigated for otter/water vole presence. Additionally, the brook bed itself consisted largely of a clay-like material, so walking along the brook became problematic in parts. This being said, Evolution Ecology feels confident that the information

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gathered during the survey(s) present an accurate representation of the brooks potential to house otters and/or water voles.

4.3 Badger Survey

A badger survey was conducted to establish whether or not any local badger populations would be affected by the proposed vegetation clearance works within the eastern woodland area.

As mentioned previously, it is known [from the Preliminary Ecological Appraisal conducted in November 2013] that badgers are present upon the southern woodland embankment [and the northern embankment which leads to an agricultural grassland habitat] to the west of the Maelor Works site. Bearing this in mind, the woodland area towards the east of the site was thoroughly searched for badger presence, in order to establish whether or not any potential setts would be disturbed by the proposed vegetation clearance works. Upon following the brook (from the east to the west), it became apparent that an active badger sett (which is likely to be an annexe or subsidiary. It was difficult to assess because rabbits are using some of the entrances to the sett, which has 15 plus entrances. Also, a fox could be using one of the entrances because animal bones were found near to an entrance) with the numerous associated entrances was present along the far westerly wooded embankment. In addition to the sett, a number of badger tracks were also noticeable which further suggests that the sett may well be active. This being said, no other anecdotal evidence, such as snuffle holes and/or latrines, were immediately apparent.

In addition to the presence of an active badger sett, rabbit (*Oryctolagus cuniculus*) burrows were also identified in abundance (stated above), within the same sett/area. With this being the case, it will also be necessary to consider the rabbits (from an animal welfare point of view) before any of the vegetation clearance works begin.

4.4 Bat Scoping Survey

A bat scoping survey was conducted on the two buildings which are proposed to be demolished [within the compound] and the woodland habitat to the east of the site on 8th May 2014, in order to establish the likelihood of these features supporting roosting bats. Please see table 3 respectively for the environmental variables.

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Table 3: Roost/scoping survey – Environmental Variables.

Environmental variables	Roost/scoping survey of the building(s) and woodland area – 8 th May 2014
Temp Start	19.3°C
Temp Finish	16°C
Humidity Start	80%
Humidity Finish	82%
Cloud Cover Start	70%
Cloud Cover Finish	30%
Wind Speed Average	Low
Precipitation	None

The first area inspected was the woodland habitat to the east of the Maelor Works compound. Upon closer inspection, it became apparent the woodland is currently densely overgrown, with mature hawthorn (*Crataegus monogyna*) and ivy (*Hedera helix*) along with nettle (*Urtica dioica*) and ramsons (*Allium ursinum*) being the dominant colonizers.

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Figure 3: This image illustrates the easterly woodland habitat. A number of semi-mature/mature trees can be observed, as can a dense scattering of nettle within the understory layer.



Due to the density of the vegetation, it is anticipated that continuous flight of bat [and/or bird] species within this area would not be easily achieved. Other scattered semi-mature and immature tree specimens were also identified which included species such as ash (*Fraxinus excelsior*), silver birch (*Betula pendula*) and wych elm (*Ulmus glabra*). Within the woodland, two trees were thought to provide potential roosting opportunities for bats, and these were located within relatively close proximity to one another to the north of the central portion of the brook woodland embankment. A mature common lime (*Tilia × europaea*) with a broken limb (which had fallen to the ground and ultimately allowed a small area to be opened up to sunlight) was present and it was considered that the loss of this limb may have created a potential roosting cavity within the tree. In addition to this, a standing [and relatively unstable] rotten deadwood tree (which could not be identified due to a lack of identifiable features) was discovered to the west of the common lime and it was covered in woodpecker holes of various sizes. These inactive woodpecker holes provide perfect ready-made roosting opportunities for bats. With this being the case, it is anticipated that dusk emergence surveys will need to be conducted within this woodland, in order to establish whether any bats are

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roosting within either of the trees of interest (i.e. the mature common lime and the standing deadwood).

After the inspection of the woodland, the two buildings of interest were investigated. For ease of reference, these have been categorized as B1 and B2 (please see figure 1 for their precise locations).

B1 was investigated first, and it was found to be of corrugated steel construction with intact [and new] windows and doors. In addition to this, the building possessed no fascia or soffit boards (which can often be used as potential access points into a building) and ultimately possessed minimal utilizable features. The only identifiable gaps were where the front corrugated panels meet the 'bargeboard' at the front of the building. However, it is anticipated that, even if bats could get beneath these gaps there would be nothing for them to 'grip' onto, as the corrugated material is too smooth. With this being the case, it is considered that B1 is of minimal roosting interest to local bat species, and as such, no further surveys will need to be conducted on this building. This conclusion also includes nesting birds.

Figure 4: A view of the front of B1 from an eastern viewpoint.



The second [and final] building to be inspected was B2 (again, see figure 1 for the precise location of this building). This building was derelict, single storey and of cavity brick wall construction. Although derelict buildings with cavity brick walls often provide ideal roosting opportunities for bats, the fact that the building is single storey with

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intact windows and doors [and where not intact, they have been boarded up], means that there are minimal access opportunities into the building and ultimately limited flight and roosting space (which would be abundant within a pitched roof building). With regards to the fascia/soffit boards, they are of wooden construction and are again largely intact, however, a few areas along the northern elevation do present large enough gaps for bat access. Bearing all of the information in mind, it is anticipated that [although relatively low] the building does house some potential for roosting bats. With this being the case, it is anticipated that at least one (possibly two) dusk emergence surveys be required in order to determine bat presence/absence within this building.

Figure 5: This photograph illustrates the size and layout of B2 as taken from a south-western viewpoint.



Overall, the results from the bat scoping survey have concluded the following:

- That two of the trees within the easterly woodland habitat (the mature common lime and the standing deadwood) have moderate/high potential to support roosting bats, due to a number of potential utilizable features being present (i.e. woodpecker holes and rotholes). Subsequent dusk activity surveys (at least two) will be required within this area to prove bat presence/absence.

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- That B1 is considered to be of low potential for supporting roosting bats, as it is of corrugated steel construction with no visible access points or roosting features. With this being the case, no dusk activity surveys will need to be conducted on this building.
- That B2 is much larger than the previously discussed building, and it is slightly older in terms of its construction. Although flat-roofed, a number of potential access points into the building were identified, so at least one (possibly two) dusk activity surveys will need to be conducted on this building in order to determine bat presence/absence.

4.4.1 Bat Dusk Activity Surveys

Bat dusk emergence surveys were carried out on the easterly woodland and B2, due to the scoping survey revealing these areas to have the potential to house protected bat species.

Firstly, B2 was surveyed on 8th May 2014 for bat activity at 8.40pm. During this survey, no bats were observed emerging from the building itself, but a number of common pipistrelle (*Pipistrellus pipistrellus*) bats were detected flying in the adjacent areas to the building and a noctule (*Nyctalus noctula*) was recorded [but not visually verified] passing over the building. Due to the lack of evidence discovered during this dusk survey and the minimal potential access points observed, it was anticipated that no further dusk surveys would be required, as the building is highly unlikely to support roosting bats. In addition to these points, it is thought that the building may be too light to support roosting bats, as the southern elevation in particular is illuminated by security lights.

Two dusk emergence surveys were conducted within the eastern woodland (on 27th May 2014 and 29th May 2014), which was deemed necessary due to the high suitability of some of the trees [two in particular] within said woodland. During these surveys, three surveyors were positioned within the woodland itself (with the trees of interest being within immediate sight) and upon the amenity grassland/hard standing which is immediately adjacent to the north/north-east of the woodland. These areas were selected in order for the greatest visibility [of potential bat flight paths/roost emergence] to be achieved. During both surveys, no bats were found to emerge from either of the trees of interest, which is likely to be due to the density of the tree shading. It is thought that this vegetative overgrowth may impact the ability of bats to gain a clear immediate flight path from the roost to an open foraging

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habitat. This being said, a number of bat species were once again identified passing over the site, including the common pipistrelle (*Pipistrellus pipistrellus*), noctule (*Nyctalus noctula*) and soprano pipistrelle (*Pipistrellus pygmaeus*). If the vegetation was cut back along the water course within the woodland (which is to occur under the current proposals), it is anticipated that this will have a positive impact upon local bat colonies, as it may allow them to roost and forage within the woodland (which at the moment, it relatively unusable). In addition to this, the standing deadwood and the mature common lime specimens provide potential roosting opportunities, and as such, it is recommended that these specimens be retained throughout the proposed works.

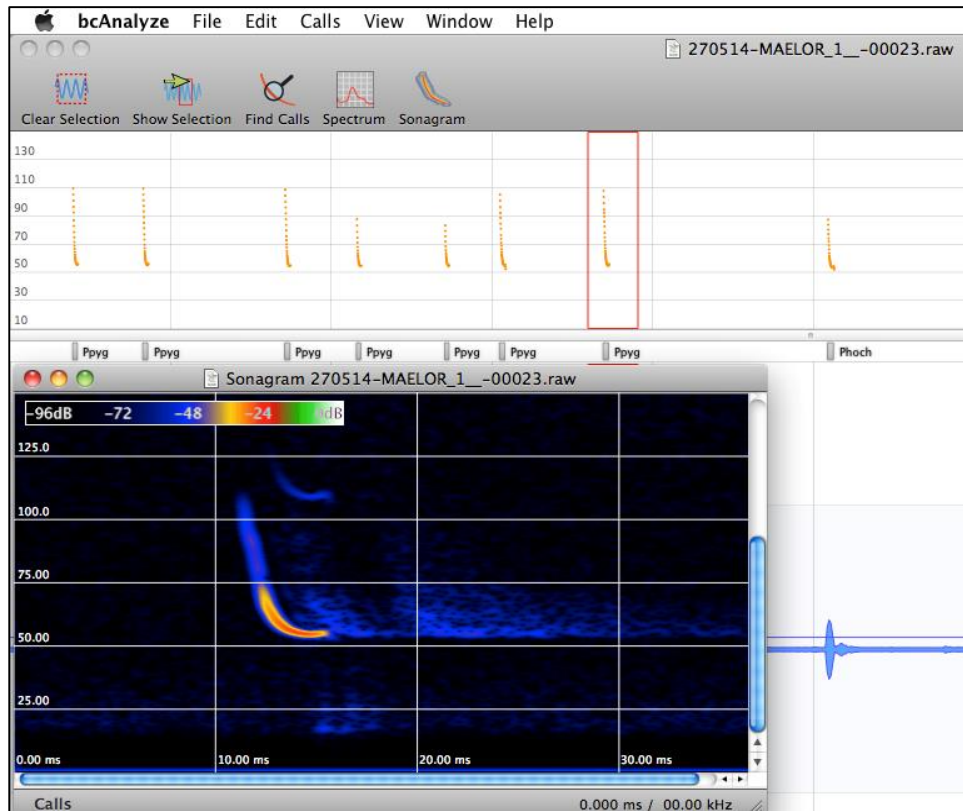
Please see figure 6 for a map illustrating the approximate locations of the surveyors during the dusk emergence surveys of the brook corridor and B2.

Figure 6: This image illustrates the approximate locations of the surveyors during the dusk emergence surveys of the eastern woodland area and B2. The yellow circles indicate the locations of the surveyors, the green outline represents B2 and the blue line illustrates the rough location of the brook.



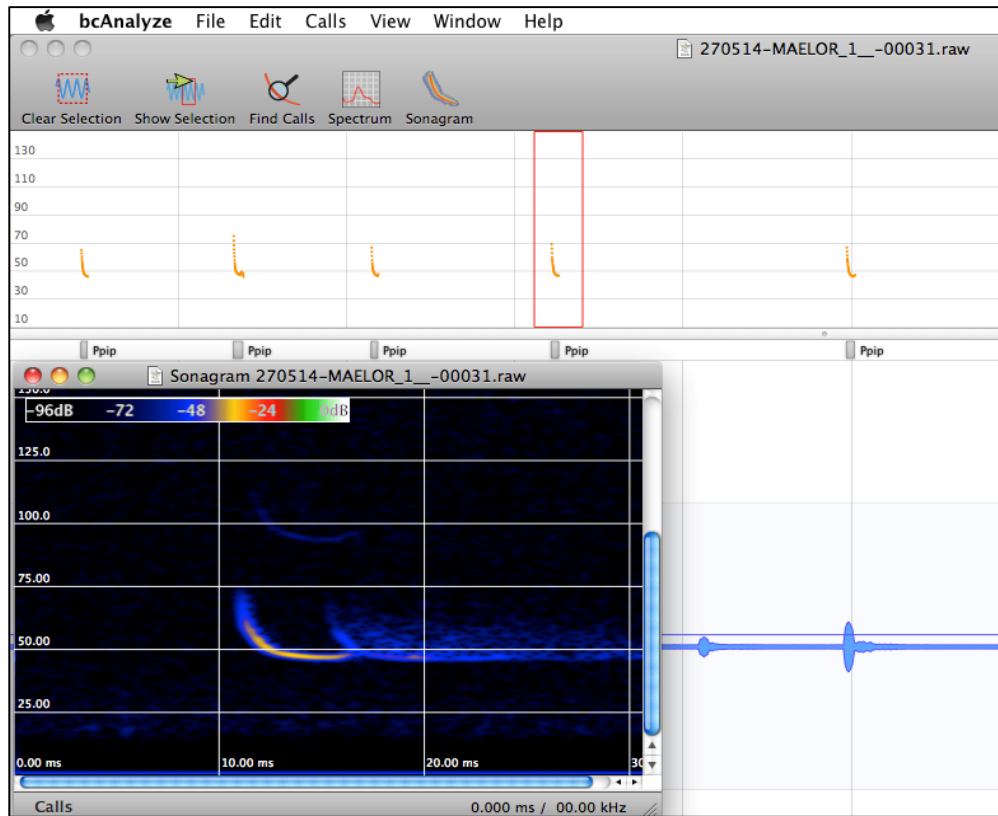
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Figure 6A: A sonogram of a soprano pipistrelle - Ppyg (*Pipistrellus pygmaeus*) which was detected during one of the dusk surveys, with a 95% CL (confidence interval of accuracy).



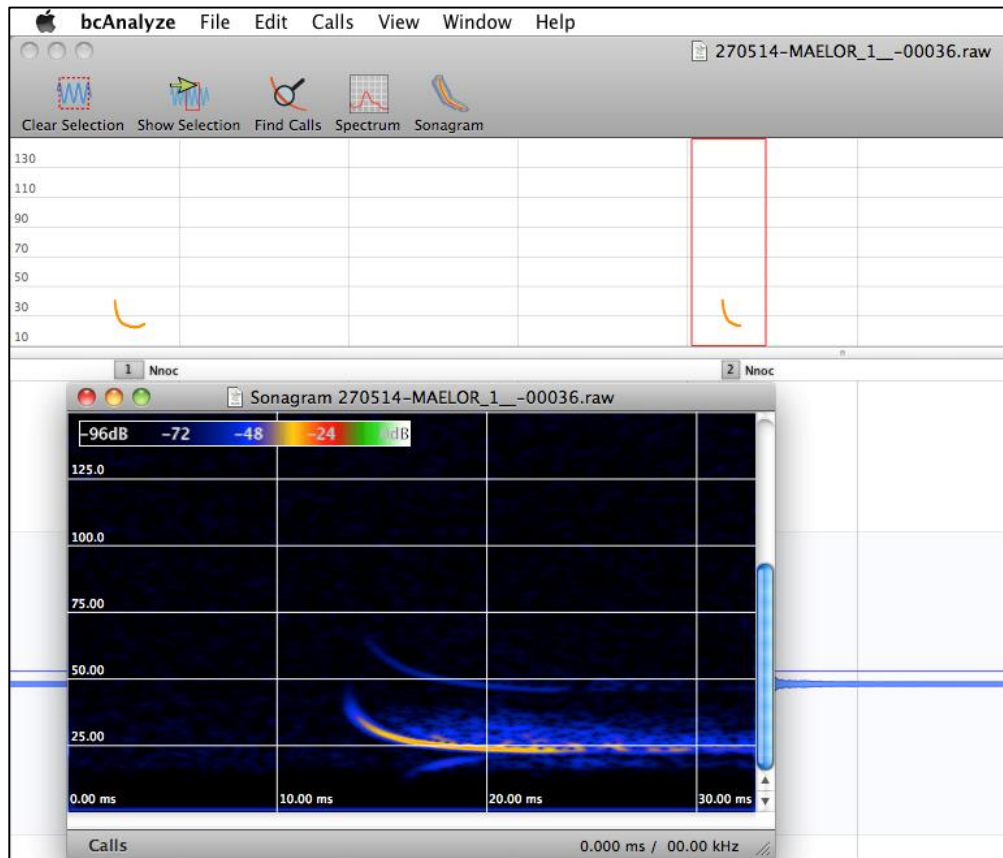
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Figure 6B: A sonogram of a Common Pipistrelle - Ppip (*Pipistrellus pipistrellus*) which was detected during one of the dusk surveys, with a 100% CL (confidence interval of accuracy).



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Figure 6C: A sonogram of a noctule (*Nyctalus noctula*) - Nnoc (*Pipistrellus pipistrellus*) which was detected during one of the dusk surveys, with a 100% CL (confidence interval of accuracy).



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4.5 Bird Survey

With regards to birds, their only presence onsite was identified within the eastern woodland habitat. This being said, all of the evidence discovered was anecdotal (i.e. bird calls and egg shells) and no visual sightings were made (which is largely due to the overgrown nature of the woodland vegetation). Within the woodland, numerous cuckoo (*Cuculus canorus*) calls were heard, as were those of the wood pigeon (*Columba palumbus*). In addition to this, an egg shell was found on the ground towards the most easterly section of the woodland, which is again thought to belong to the wood pigeon (due to its colour and size). This finding clearly illustrates that the area is being utilized by nesting birds. With this being the case, it is anticipated that nesting birds will need to be considered before attempting any vegetation clearance along the brook belt.

4.6 Great Crested Newt Survey

The vast majority of the Maelor Works site is thought to be of minimal use to great crested newts, as it predominantly consists of buildings and hard standing (please refer to the Preliminary Ecological Appraisal conducted in 2013 for a Phase 1 Habitat Map of the site). However, a number of scattered habitats do provide some potential foraging, commuting, breeding and hibernation areas for GCN, including semi-natural broad-leaved woodland, dense/continuous scrub, poor semi-improved rough grassland and standing water bodies. The standing water body located to the north of the site is not proposed to be affected by the proposed works, however, the pond situated to the south-east of the site is. Under the current guidelines, it will not be necessary to survey all ponds within a 500m radius of the pond of interest. This is said, as this pond will not be lost [in the long term] as it is proposed that it undergo contaminated sediment removal. The pond is immediately surrounded by woodland and tall ruderal, with emergent and floating vegetation colonizing some areas of the pond itself. Additionally, a number of young and semi-mature willow species (*Salix spp.*) have also established along the pond edge (and growth has continued into the pond itself). Pond dipping revealed a relatively diverse range of invertebrate species which could serve as a potential food source to great crested newts, including diving beetles (*Dytiscidae*), freshwater shrimp (*Gammarus pulex*) and waterlouse (*Asellus aquaticus*). Post-contaminant removal, it is proposed that the pond will be refilled and enhanced (remove overhanging trees, to increase the daylight), which should ultimately improve this habitat for local amphibians. In addition to the ponds located on site, the immediately [and wider] surrounding landscape houses numerous

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scattered standing water bodies, which provides the perfect landscape structure to support meta-populations of GCN.

A Habitat Suitability Index (HSI) was also conducted on the pond in order to establish its suitability to support great crested newts. Please see Table 4 on the next page.

Figure 7: A photograph which illustrates the relatively overgrown nature of the pond of interest. This has subsequently meant that the majority of the pond is devoid of emergent aquatic vegetation, with the exception of a small area located to the south-west. The remainder of the pond was colonized by aquatic floating plants (i.e. duckweed species - *Lemnoideae*) in varying densities during each survey visit.



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Field Survey Results

A summary of the field survey results obtained by Evolution Ecology Ltd.

Table 4: Habitat Suitability Index Results Summary

Pond ref	1
SI1 - Location	1
SI2 - Pond area	0.2
SI3 - Pond drying	1
SI4 - Water quality	1
SI4 - Shade	1
SI6 - Fowl	0.67
SI7 - Fish	0.33
SI8 - Ponds	0.55
SI9 - Terr'l habitat	0.67
SI10 - Macrophytes	0.7
HSI	0.64

HSI Categorisation

<0.50	Low Suitability
0.50-0.59	Below Average Suitability
0.60-0.69	Average
0.70-0.79	Good
>0.80	Excellent

The pond surveyed was assessed using the Great Crested Newt Habitat Suitability Index (HSI) [a quantitative measure of habitat quality] and this was used to evaluate the suitability of habitats for GCN (*Triturus cristatus*). As can be seen from the summary table above, the pond of interest has been classed as having 'average' suitability for supporting breeding great crested newts.

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Survey Results**Table 5:** The weather conditions for the great crested newt presence/absence surveys undertaken.

Date	Survey Type	Air Temp (°C)	Weather Conditions
08/05/2014	Scoping and presence/absence	19.3	Dry, 70% cloud cover
12/05/2014	Presence/absence	10.0	Dry, 100% cloud cover
27/05/2014	Presence/absence	24.0	Dry, 95% cloud cover
29/05/2014	Presence/absence	19.0	Dry, 30% cloud cover

The pond of interest was surveyed on four occasions. The survey methods used on the pond largely depended on its water level and clarity. However, at least four of the five aforementioned survey techniques (detailed and prescribed within the Great Crested Newt Mitigation Guidelines and the Herpetofauna Workers Manual) were undertaken on at least one occasion within the pond. Below (table 6) is a summary of the results for each pond showing peak counts of amphibians recorded.

Table 6: A summary table of the results obtained during the great crested newt presence/absence surveys.

Method	Peak count GCN	Peak count Smooth/Palmate	Peak count Common Frog	Peak Count Common Toad
Bottle Trapping	0	8	0	0
Torching	0	43	0	0
Netting	0	0	0	0
Egg Search	0	0	0	0

From the table, it is clear that although this pond does not support any breeding GCN, it does however, support a healthy medium population of smooth/palmate newts (as made clear by a peak torching count of 43 individuals). With this being the case, it can be said that this pond is an important breeding site for this species. However, the current proposals are unlikely to negatively influence this breeding population, as post-contaminant removal, the pond will be restored to its former state and enhanced accordingly.

4.7 Otter and Water Vole Survey

Records of otter and water vole within a 2km radius of the site prompted a survey for these species within the brook (which took place on 27th May 2014), as this is to be heavily impacted throughout the proposed sediment removal (i.e. dredging). One surveyor walked within the brook itself and another along the bank side, in order to gain the best possible overview of the brook and its bank sides.

As mentioned previously, the surrounding woodland/scrub is extremely dense which has meant that much of the brook is largely shaded (and in some areas, fallen vegetation has accumulated within the brook itself). Additionally, a tree was observed which had naturally fallen across the brook and ultimately formed a natural 'wildlife bridge'. It is highly likely that this naturally formed 'bridge' is an important migration route for some species (such as small mammals), which may otherwise be restricted from accessing the opposite site of the brook.

Through conducting this survey, it became apparent that the water level within this water course is extremely variable. At the time of the survey, the water level within the [approximately 150mm deep] channel was low. However, some of the ramsons (*Allium ursinum*) plants along the southern bank side showed evidence of mud/dirt on the leaves, which is likely to have occurred as a result of the water level within the channel reaching full capacity sometime in the recent past. The idea of consistently rising [and falling] water levels is further supported by an almost complete lack of vegetation upon the brook embankments themselves (particularly along the northern embankment), as this habitat would not be considered stable enough to support dense floral colonization. The brook bed itself was largely composed of clay/silt-like substances. Upon inspection of the bank sides and brook embankment, no evidence of otter holts or water vole burrows became apparent.

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Figure 8: This image illustrates the water level within the brook at the time of the survey, in relation to the water levels which have been reached in the recent past (as indicated by the mud upon the leaves of the overhanging ramsons (*Allium ursinum*) plants – red arrow).



Due to the shape and structure of the brook, it is anticipated that it has undergone some sort of human interference in the past. This could be in the form of a sluice gate [or something similar] further upstream which could restrict water flow and could ultimately explain the high variability in the water levels. In addition to this, further up- (to the west) and down- (to the east) stream, the water flow appears to be natural with pebble stone beds and meandering channels. This is in contrast to the area to be impacted, which has a bed made of clay/silt-like substances and is a largely straight continuous channel (which is not likely to occur naturally – especially when considering the layout of the brook further up and down stream).

The proposed vegetation clearance works are to take place within 5m (each side) of the brook (to allow machinery access), and as such, there is a potential risk that any water voles which may be utilizing the water course could be negatively affected. However, as no water voles were observed during the survey, and as no anecdotal evidence of their presence became apparent (i.e. footprints/tracks, burrows, droppings etc.), it is anticipated that the proposed works are highly unlikely to negatively affect any water vole habitats [and subsequently populations of this species].

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With regards to otters, as mentioned previously, no evidence of any otter holts was evident along the bankside of the brook. This being said, two potential otter footprints were identified along the northern embankment (figure 9). As these two were the only footprints identified [which could possibly belong to this species] and as no additional tracks were recorded past this point (i.e. tail drag or further footprints), it cannot be concluded exclusively that otters are using this watercourse. As there is a lack of evidence suggesting the presence of otter holts within the brook (also both up- and down-stream), a lack of any otter records within 1460m of the site and a lack of spraints/food remains, it can be concluded that the brook is of minimal interest to local otter populations. The only way in which it is likely is to be used is for commuting use, as due to the poor water quality, it is almost devoid of aquatic life (both flora and fauna). Ultimately, it is anticipated that the proposed works are unlikely to have a negative impact upon local otters.

Figure 9: A photograph of the potential otter footprints which were identified along the northern embankment in relation to a mammal ID guide, which illustrates the specific features associated with said field signs.

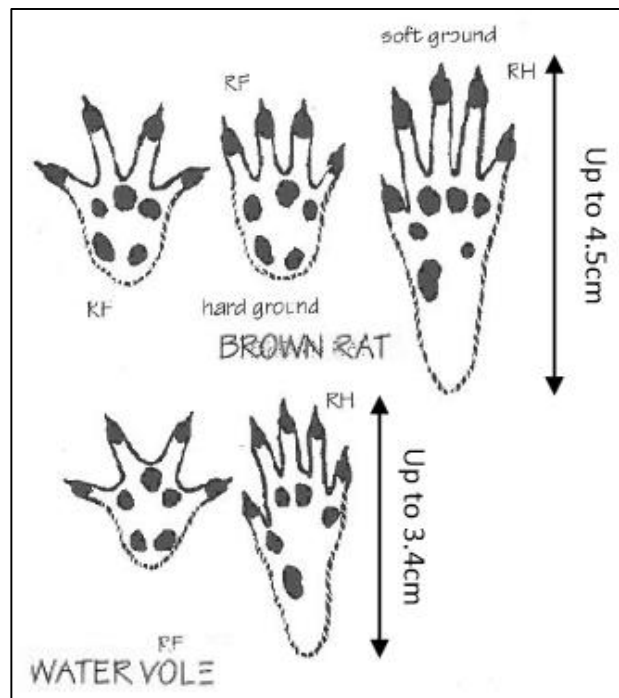


In addition to the protected species searched for, a number of non-protected species footprints were identified including brown rats (*Rattus norvegicus* – figure 10) and rabbits (*Oryctolagus cuniculus*). The discovery of the aforementioned anecdotal evidence further

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illustrates the ecological value which is attached to this hawthorn dominated woodland habitat and its associated brook.

Figure 10: An illustration which shows the approximate footprint pattern of the brown rat (*Rattus norvegicus*).



5. CONCLUSIONS/ RECOMMENDATIONS

5.1 Preliminary Ecological Appraisal – Flora

With regards to the flora identified on the proposed redevelopment area, there are no habitats of legal conservation concern (i.e. BAP Priority Habitats etc.). However, a number of areas do hold the capacity to provide important nesting/foraging/sheltering habitats for a number of fauna species. In relation to the proposed works, the main areas to be affected are the woodland area to the east, the brook (within the woodland) and the pond (with a medium population of smooth/palmate newts).

Firstly, vegetation clearance will need to take place (up to 5m from the watercourse on each bank side) along the [entirety of the] brook, withing the clients ownership, in order to allow the access of the required machinery onsite. As the site currently stands, it is anticipated the abundance of ramsons (*Allium ursinum*) plants within the ground are likely to contribute towards providing an important food source for a number of invertebrate species such as hoverflies, butterflies and longhorn beetles (one species from the latter of which was identified onsite – a [possible] Welsh oak longhorn beetle *Pyrrhidium sanguineum*). With this being the case, it is recommended that all of the ramsons bulbs within this area be scraped up and stockpiled along the bankside during the autumn/winter months (when plants are dormant), in order for them to be relayed once the works have been completed. This should help towards restoring the original understorey habitat which currently holds such high value for local invertebrates.

The second measure which should be adhered to throughout the proposed works, is the retention of all semi-mature/mature trees within the woodland habitat. As mentioned previously, a 5m buffer either side of the brook will need to be cleared to allow machine access, however, it is suggested that this clearance, occurs without impacting the longevity of the trees. This could be done by cutting branches back and altering the proposed machinery path to accommodate the trees. This also [most importantly] applies to the mature common lime (*Tilia × europaea*) specimen and the standing deadwood, both of which are located almost centrally along the northern brook bankside. Because of the instability of the standing deadwood, for health and safety reasons, an 8m exclusion zone will need to be erected around it (as a precautionary measure, just in case the movement of the machinery impacts its stability). Ultimately, if the trees are retained/incorporated into the proposed works and if they are cut back and managed

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accordingly, this will allow light to enter the woodland once again, which should diversify the range of understorey floral species which are able to colonize and enhance the quality of the brook. Additionally, potential bat roosting features and known nesting trees will be saved, so that they can be continuously used in the future by these species. As a further conservation measure, any of the branches which are cut from the trees or any deadwood discovered, should be stockpiled (log piles) in an appropriate area, which will create an excellent sheltering habitat for a number of species, both fungal and faunal (i.e. invertebrates).

Finally, [in relation to the woodland], it is recommended that if it need be moved, the tree which has fallen across the brook and unintentionally formed a natural 'wildlife bridge', should be placed back in its original position after the works have been completed. This is said, as it is considered that this natural structure has formed an important migratory route from the north to the south of the brook for small mammals [such as mice and shrews], which may have otherwise been inaccessible to them.

The final measure to consider in relation to the habitats present onsite is the pond which is currently known to harbour a healthy medium population of smooth/palmate newts during the breeding season (March-June). Under the current proposals, it is anticipated that the pond will be drained, and the contaminated sediment present on the pond bed, be removed (again with the use of machinery which is likely to access the site through the immediately adjacent security fence to the west). Because of the ecological value attached to this pond, it is recommended that the pond water be stored [outside of the amphibian breeding season] and any newts collected (bottle traps and nets), whilst the contaminated sediment is being removed. At the same time that this is being conducted, the immediately surrounding vegetation should be cut back (with particular reference to the overhanging trees) in order for 80/90% of the pond to be open to direct sunlight. This should allow the colonization of further emergent/floating plant species (which could be used for egg laying), and should ultimately further improve the ponds suitability for invertebrates (which are an important food source for amphibians). Once these measures have been achieved, the pond can be refilled and allowed to recolonize naturally. These measures should ultimately ensure that the medium population of smooth/palmate newts which are known to use the pond, should continue to have a suitable breeding area in the long term.

5.2 Badgers/ Rabbits

With regards to badgers (*Meles meles*) and rabbits (*Oryctolagus cuniculus*) an exclusion zone will need to be put in place so that the proposed works will not negatively impact the badger clan (including rabbits) which are present within the most south-westerly section of the woodland habitat. Additionally, by ensuring that the works remain between 20m and 30m away (which will be dependent upon the type of machinery used) from the nearest active sett entrance, there should be no issues with the continuation of the proposed vegetation clearance and contaminated sediment removal within the woodland and running water habitats.

5.3 Bats

With regards to the proposed demolition of the buildings, there are no issues in relation to bats, as both of the buildings were deemed as being unsuitable for roosting specimens. This was supported by the results of the dusk emergence survey which was conducted on B2, which identified passing bats only. With this being the case, the buildings can be demolished as planned, with no negative impacts upon local bat colonies being predicted.

With regards to the trees of interest within the woodland habitat (i.e. the mature common lime and the standing deadwood with woodpecker holes), no bats were detected emerging from either of these habitats during the two dusk emergence surveys conducted on this area. Although no bats were identified, this is thought to be due to the density of the vegetation within the woodland, which would currently prevent a clear flight path when emerging from the trees. With this being the case, these trees should be retained throughout the vegetation clearance works, as they are likely to provide suitable roosting habitats for these species, once the woodland has been

managed slightly to increase the light availability and reduce the vegetation density.

5.4 Birds

The main areas of concern with regards to nesting birds are the semi-mature/mature tree specimens, both within the woodland and surrounding the pond which is to undergo contaminated sediment removal. Evidence of nesting birds was discovered within the woodland (in the form of an egg shell on the ground and cuckoo and wood pigeon

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calls) and as such, it is imperative that any works which are likely to disturb breeding birds, occur outside of the bird nesting season (which is between the months of March-August). If this is achieved and the trees within the woodland be retained, there is no reason why the proposed works would have any negative impacts upon local breeding bird populations.

5.5 Great Crested Newts

No evidence of great crested newt (*Triturus cristatus*) presence was identified throughout any of the four presence/absence surveys. However, a healthy medium population (peak count of 43) of smooth/palmate newts was identified within the pond. With this being the case (and as discussed in detail within section 5.1), it is recommended that the pond be restored [post-sediment removal] to its former layout and enhanced via managing the immediately surrounding vegetation. These measures should ultimately improve the habitat in the long term for breeding smooth/palmate newts, and may also improve its suitability for any local GCN. These works need to take place during Autumn/Winter.

5.6 Otters and Water Voles

With regards to water voles, no evidence of their utilization of the brook became apparent throughout the survey, as no footprints, feeding remains or burrows were identified. With this being the case, [and as the nearest water vole record was over 1500m from the site], it is anticipated that the proposed contaminated sediment removal works within the running water course are unlikely to harm any water voles or damage their resting habitat.

The only evidence of otter utilization was the presence of two potential footprints which were identified upon the northern embankment of the brook. However, as no further evidence was revealed (such as otter

holts, feeding remains or signs of tail drag), it is anticipated that this brook would be of commuting use only to local otter populations. This being said, similarly to the water vole records, the nearest otter record to the site was approximately 1465m away, so it is quite unlikely that this area would be used as a regular commuting route. With this being the case, the proposed contaminated sediment removal works within the running water course are unlikely to harm any otters or damage their resting habitat.

Additionally, the site supervision works (to be discussed within section 5.7) should also function to ensure that [although unlikely] no commuting otters or water voles are harmed during the proposed works.

5.7 Site Supervision

Finally, in addition to all of the proposed conservation/mitigation measures, site supervision by a licenced ecologist will need to be arranged throughout the duration of the works (particularly within the woodland and around the pond). It may not be necessary for the site to be attended daily by the ecologist, however, a timetable of works will be discussed further once detailed plans of the proposed works have been received.

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6. REFERENCES

Bat Conservation Trust (2012). Bat Surveys – Good Practice Guidelines. 2nd Edition. Bat Conservation Trust: London.

Berthinussen, A. & Altringham, J.D. (2012). The effect of a major road on bat activity and diversity. *Journal of Applied Ecology* 49: p.p. 82–89.

Biodiversity 2020: A strategy for England's wildlife and ecosystem services (2011).

Circular 06/05 Biodiversity and Geological Conservation – Statutory Obligations and Their Impact System (2005).

The Conservation of Habitats and Species Regulations 2010. SI 2010/490.

The Conservation (Natural Habitats, etc.) (Amendment) Regulations 2007. SI 2007/1843, London: HMSO.

Countryside and Rights of Way Act 2000 (c.37). London: HMSO.

Defra (2007a) Securing a Healthy Natural Environment: an action plan for embedding an ecosystems approach. PB12853. Defra London.

Defra (2007b) An Introductory Guide to Valuing Ecosystems Services. PB12852. Defra London.

Dietz, C., von Helversen, O. & Nill, D. (2009). Bats of Britain, Europe and Northwest Africa. London: A. C. Black.

Froglife (2001). *Great Crested Newt Conservation Handbook*. Suffolk: Froglife.

Hutson, A.M., Spitzenberger, F., Aulagnier, S., Coroiu, I., Karataş, A., Juste, J., Paunovic, M., Palmeirim, J. & Benda, P. (2008). *Pipistrellus pipistrellus*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1.

Institute of Ecology and Environmental Management, Professional Guidance Series.

Institute of Ecology and Environmental Management (2006). Guidelines for Ecological Impact Assessment in the United Kingdom.

Institute of Environmental Assessment (1995). Guidance for Baseline Ecological Assessment.

Joint Nature Conservation Committee (2005). The Marine Habitat Classification for Britain and Ireland, Version 04.

Protected Species Survey Report

Joint Nature Conservation Committee (2010). Handbook for Phase 1 Habitat Survey – a technique for environmental audit.

Millennium Ecosystem Assessment (2005).

National Planning Policy Framework (2012).

The natural choice: securing the value of nature (2011) (Natural Environment White Paper).

Natural Environment and Rural Communities (NERC) Act 2006.

RSPB (2002). The Population Status of Birds in the UK.

RSBP (2009). Birds of Conservation Concern 3.

Rydell J & Racey, P A (1993). Street lamps and the feeding ecology of insectivorous bats. Recent Advances in Bat Biology, Zool Soc Lond Symposium abstracts.

UK Biodiversity Action Plan (2007). UK List of Priority Species. Joint Nature Conservation Committee.

Wildlife and Countryside Act 1981 (and amendments) (c.69). London: HMSO.

7. APPENDICES

Appendix A: Preliminary Ecological Appraisal (Extended Phase 1 Habitat Map)

Appendix B: Site Plan

Appendix C: Photographic Records

Appendix D: Badger Information

Appendix E: The Bat Year

Appendix F: Great Crested Newt Biology

Appendix G: Otter Information

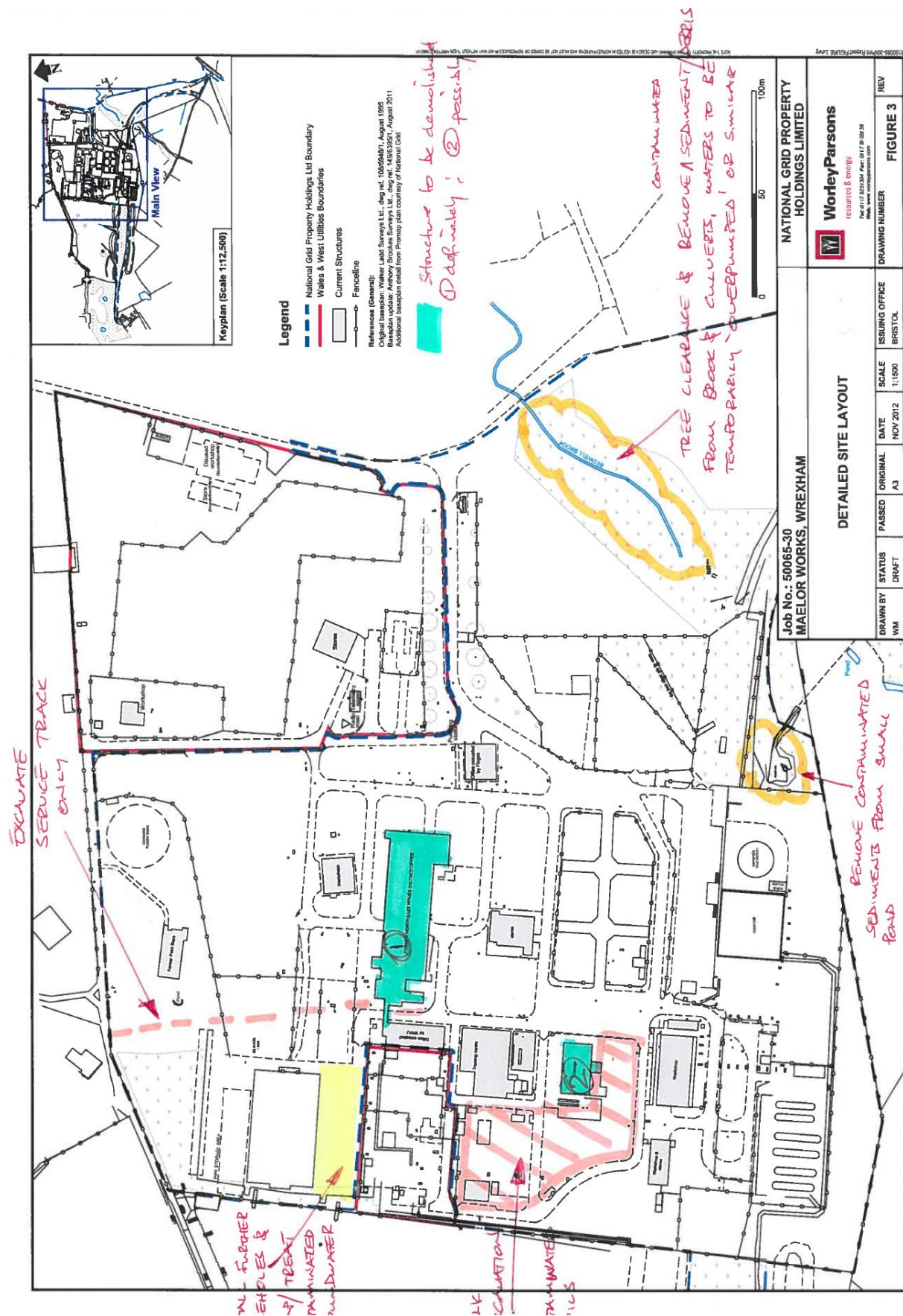
Appendix H: Water Vole Information

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Appendix A: Preliminary Ecological Appraisal (Extended Phase 1 Habitat Map) – As taken from the report created in November 2013.

Key	
	Site boundary
	A1.1 - Semi-natural broad-leaved woodland
	A2.1 - Dense and continuous scrub
	A3.1 - Broad-leaved scattered trees
	B6 - Poor semi-improved grassland
	G1 - Standing water
	G2 - Running water
	J1.2 - Amenity grassland
	J3.6 - Buildings
	J5 - Other habitat: Hard standing
	Rabbit warren with 100+ entrances
	Hard standing which was once occupied by a gas tower
	Badger setts/entrances

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Appendix B: A plan of the site as it currently stands

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Appendix C: Photographic Records

A view of the most westerly section of B2, as taken from a southern viewpoint.



A view of B1 from a south-eastern viewpoint. No dusk activity surveys were deemed necessary on this building due to its low potential to support bats.



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A photograph of the pond of interest, as taken from a southern viewpoint.



Another view of the pond of interest from a southern viewpoint. This image illustrates the overgrown nature of the immediately surrounding area.



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This image shows some of the aquatic vegetation emerging from the south-westerly section of the pond of interest.



This photograph shows the most easterly section of the brook which is to be affected by the proposed works, and it was taken from the roadside.



The most easterly section of the brook from a southern viewpoint.

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One of the partially active entrances to the badger sett within the eastern woodland area.



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The standing deadwood which is situated almost centrally to the northern bank side of the brook. This tree is thought to house potential for roosting bats.



One of the holes within the standing deadwood which is likely to have been created by a woodpecker.



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The mature common lime tree with a broken limb. This tree is thought to house potential for roosting bats.



Once again, the mature common lime tree with a broken limb can be observed. This tree is thought to house potential for roosting bats.



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Another view of the brook which is proposed to undergo contaminated sediment removal.



Brown rat footprints which were identified upon the northern embankment of the brook.



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The potential otter footprints which were discovered within close proximity to those of the brown rat. These were the only anecdotal signs of otter presence which were identified throughout the survey, and as such, it is considered that the brook is likely to be of commuting use only.



The most westerly section of the brook as taken from a south-eastern viewpoint. This is the point at which the brook emerges into the proposed works boundary, after being contained underground for a continuous stretch.



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This image shows the other side of the brook (to the north-east of the access road) which is not owned by the client, or to be included within the proposed works. It is immediately noticeable that this section of the brook has a more natural structure as the embankments are densely colonized by vegetation (unlike some areas of the brook to be dredged).



Another view of the other side of the brook (which is situated to the north-east of the site). This shows the pebble bed of the brook which is considered to be a natural feature.



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Appendix D: Badger Information**Behaviour**

Badgers are nocturnal and rarely seen during the day. When not active, badgers usually lie up in an extensive system of underground tunnels and nesting chambers, known as a sett. Each social group usually has a main sett where the majority of the group live most of the time, but there may be odd holes scattered around the territory that are used occasionally. Badgers can live in social groups of two to 23 adults, but usually around six. These defend an area around their main sett as a territory. Territories may be as small as 30ha, but are up to 150ha or more in the Highlands. Badgers mark the boundaries of territories with their distinctive latrines. They leave their faeces in collections of shallow pits, which in aggregate are called latrines.

**Diet and Feeding**

Badgers exploit a wide variety of food items, but earthworms form the majority of the diet.

Reproduction

Mating takes place between February and May, with implantation delayed until late winter. Only one female badger in a social group normally breeds, although sometimes two or more may do so. Litters of 2-3 cubs are born around February blind and hairless in the safety of the nest. They usually appear above ground at about 8 weeks, and weaning usually takes about 12 weeks. By late summer they are usually feeding independently but can be adversely affected by drought at this time causing starvation.

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Appendix E: The Bat Year**The Bat Year**

January Hibernating; using up fat reserves.



February Still hibernating; few fat reserves left.



March Some activity; occasional bat seen feeding.



April Awake and feeding at night.



May Females looking for nursery sites.

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June Young born, usually only one.



July Young still suckling.



August Young start catching insects; females leave nursery to find males.



September Mating season begins; start building fat reserves for hibernation.



October Search for suitable hibernation site.



November Hibernation begins although still some activity in warm weather.

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December Hibernating.

Appendix F: Great Crested Newt Biology

Description

The GCN is Britain's largest and most threatened newt. The body is generally dark brown to black in colour with a warty appearance, which gives the species its other common name, the warty newt. The underside is bright orange with black markings that are unique to each individual. Females tend to be slightly longer than males, and in the breeding season, the latter develop an obvious crest between the head and the tail, and a silver streak along the middle of the tail. The specific name *cristatus* derives from the Latin word meaning 'crested'. Outside the breeding season, males and females are fairly similar in appearance, but females always have an orange line on the tail. Juveniles generally look like females but may have a yellow stripe along the back.



Range

It is widespread throughout northern and central Europe extending east to the Ural Mountains in Russia. The species has a wide distribution in Britain, but is absent from Cornwall, Devon, and parts of Wales and Scotland and is generally uncommon. The population has undergone a very severe decline in the last 50 years.

Habitat

This species inhabits a wide range of habitats, including farmland, woods, grasslands, dunes, quarries, industrial and 'brown-field' sites, within which it favours large ponds with abundant weeds and no fish. The habitat structure within the site such as hedgerows, varied topography and the availability of refuges in which the individuals can hide is very important and can determine whether the species can occupy a site or not. Occasionally they will use garden ponds and commonly occur near natural springs. The condition of land between occupied sites is also an important factor, as many newt populations persist as metapopulations, a series of local populations between which individuals migrate. If there is little connectivity between patches of suitable habitat, migration will be unlikely.

Biology

GCN feed on a range of aquatic invertebrates, but occasionally tackle large prey items such as adult smooth newts and large dragonflies. They are mainly active at night, spending the day at the bottom of ponds or hidden in vegetation. Males have an extravagant display used in courtship, which involves the male standing on his front legs in front of a female with an arched back while he waves his tail around. If the female is receptive, the male transfers a spermatophore. Eggs are laid in

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February or March and are protected from predation by having the leaves of water plants folded over them. The appearance of vegetation showing a characteristic 'concertina' effect is a good indication of the presence of this species. GCN leave the water in August and September; their behaviour during their period on land is poorly understood.

Threats

The decline is due to a number of factors, including a large-scale loss of breeding ponds. Intensification of agriculture has resulted in many farm ponds becoming redundant, leading to neglect, and a decline in the suitability of the surrounding habitat. Many new ponds that would otherwise be suitable for this species are stocked with fish, which predate on both eggs and larvae. Ponds that survive in agricultural land often become polluted with pesticides and fertilisers.

Conservation

The GCN is a priority species under the UK Biodiversity Action Plan (BAP). The species action plan aims to maintain and enhance current populations with a target of the restoration of populations to at least 100 sites. A number of publications on this species have been produced; English Nature has published 'Great crested newt mitigation guidelines' targeted at developers and others involved in land-use changes, which could cause conflict with conservation of this species. Froglife has published 'The Great Crested Newt Conservation Handbook'.

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Appendix G: Otter Information**Distribution & Habitat**

The otter is a secretive semi-aquatic species which was once widespread in Britain. By the 1970s, otters were restricted mainly to Scotland, especially the islands and the north-west coast, western Wales, parts of East Anglia and the West Country (though they remained common and widespread also in Ireland). This decline was caused by organo-chlorine pesticides. Since these were withdrawn from use, otters have been spreading back into many areas, especially in northern and western England.

**Behaviour**

Otters can travel over large areas. Some are known to use 20 kilometres or more of river habitat. Otters deposit faeces (known as spraints, with a characteristic sweet musky odour) in prominent places around their ranges. These serve to mark an otter's range, defending its territory but also helping neighbours keep in social contact with one another. Females with cubs reduce sprainting to avoid detection.

Diet and Feeding

Fish, especially eels and salmonids are eaten, and crayfish at certain times of the year. Coastal otters in Shetland eat bottom-living species such as eelpout, rockling and butterfish. Otters occasionally take water birds such as coots, moorhens and ducks. In the spring, frogs are an important food item.

Reproduction

In England and Wales otter cubs, usually in litters of two or three, can be born at any time of the year. In Shetland and North-west Scotland most births occur in summer. Cubs are normally born in dens, called holts, which can be in a tree root system, a hole in a bank or under a pile of rocks. About 10 weeks elapse before cubs venture out of the holt with their mother, who raises the cubs without help from the male.

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Appendix H: Water Vole Information**Behaviour**

Water voles occur mainly along well vegetated banks of slow flowing rivers, ditches, dykes and lakes. They are sometimes confused with brown rats which often also live near water courses. Water voles excavate extensive burrow systems into the banks of waterways. These have sleeping/nest chambers at various levels in the steepest parts of the bank and usually have underwater entrances to give the animals a secure route for escape if danger threatens.



"Lawns" of closely cropped grass, occasionally with piles of chopped food, may surround burrow entrances. Water voles tend to be active more during the day than at night. Male voles live along about 130 metres of water bank, while females have ranges about 70 metres long. They deposit distinctive black, shiny faeces in latrines. Latrines occur throughout and at the edges of their range during the breeding season.

Diet and Feeding

They eat grasses and waterside vegetation: 227 plant species have been identified in their diet, and additional broadleaved plants may also be eaten at certain times.

Reproduction

Water voles usually have three or four litters a year, depending on the weather. In mild springs the first of these can be born in March or April, though cold conditions can delay breeding until May or even June. There are about five young in a litter, which are born below ground in a nest made from suitable vegetation, notably grasses and rushes. Although blind and hairless at birth, young water voles grow quickly, and are weaned at 14 days.

8. LIMITING CONDITIONS/DISCLAIMERS

1. The Service

- 1.1 Evolution Ecology Ltd agrees to supply Ecological consulting services of a preliminary nature or a more thorough service as advised or as commissioned.

2. Fees

- 2.1 The client(s) will settle the agreed fee in full, within 30 days of receiving the invoice. Reports will remain the property of Evolution Ecology Ltd until full payment has been received. No liability is accepted for the contents of a report that is not paid in full. Any queries should be notified to Evolution Ecology Ltd within 7 days of the invoice date.
- 2.2 If the client(s) fails to pay within the time specified in 2.1 then Evolution Ecology Ltd shall charge the client(s) interest on the outstanding fee, both before and after any judgment, at the rate of 4% per annum above the HSBC Bank base rate, until payment is made in full (A part of a month being treated as a full month for the purposes of calculating interest).
- 2.3 In the event that it is necessary to recover any outstanding fees from the client(s), the client(s) will fully reimburse any costs and expenses incurred during the recovery period, including court costs. Evolution Ecology Ltd reserves the right to make a charge for every letter sent and telephone/fax call made, in connection with the recovery.

3. The Report

- 3.1 If any part of the report is lost, or altered without the written consent of Evolution Ecology Ltd, then the entire report becomes invalid.
- 3.2 The general format of reports is a certified product and cannot be shown, copied or distributed to third parties without the permission of Evolution Ecology Ltd. No liability is accepted for the contents of the report, other than to that of the client(s).
- 3.3 The report will purport not to express any opinion or comment as to the condition or structural integrity of any building and no reliance should be made on any such comments.

4. Insurance Cover

- 4.1 All work carried out by Evolution Ecology Ltd is covered by a £1,000,000 professional indemnity insurance.

5. Quality of Craftsmanship

- 5.1 When appointing an Ecologist, please use only suitably qualified and experienced companies (The Local Authority and the Institute of Ecology and

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Environmental Management may be able to provide a select list of such companies).

- 5.2 Evolution Ecology Ltd will not accept liability for any works undertaken by any other companies, or contractors.

Appendix D

Photographs

Appendix D – Photographs of Site



Photograph 1: Pond to the north of the site



Photograph 2: Pond to the south-east of the site



Photograph 3: Bedwell Brook