Meritor Heavy Vehicle Braking Systems (UK) Limited
Grange Road
Cwmbran
Gwent
NP44 3XU

Remediation Implementation Plan – Chlorinated Volatile Organic Compound Groundwater Remediation
Grange Road
Cwmbran
Gwent
NP44 3XU
South Wales

January 2012
909363805_04

Prepared by:

ARCADIS (UK) Limited
2 Craven Court
Newmarket
CB8 7FA
Tel: 01638 674767
Fax: 01638 668191
www.arcadis-uk.com

Report Details

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		Anil Waduge Senior Consultant	Victoria Morten Principal	Mark Webb Director

If you have any queries regarding this project, please contact Victoria Morten.

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List of Abbreviations that may be used in this report

ARCADIS	ARCADIS (UK) Limited
BGS	British Geological Survey
CCTV	Closed Circuit Television
cis-DCE	cis-1,2-dichloroethene
CoC	Contaminants of Concern
CVOC	Chlorinated Volatile Organic Compounds
DEFRA	Department for Environment, Food and Rural Affairs
DQRA	Detailed Quantitative Risk Assessment
EA	Environment Agency
EPR	Environmental Permitting Regulations
ESA	Environmental Site Assessment
GAC	Granular Activated Carbon
HDPE	High Density Polyethylene
HGV	Heavy Goods Vehicle
IRZ	*In-Situ* Reactive Zone
K	Hydraulic Conductivity
LIF	Laser Induced Fluorescence
LNAPL	Light Non-Aqueous Phase Liquid
mAOD	Metres above Ordnance Datum
mbgl	Metres below ground level
Meritor	Meritor Heavy Vehicle Braking Systems (UK) Limited
MTL	Mobile Treatment Licence
O&M	Operation and Maintenance
OS	Ordnance Survey
PID	Photoionisation Detector
RIP	Remediation Implementation Plan
RoI	Radius of Influence
Sirius	Sirius Geotechnical and Environmental Limited (Sirius)
SPZ	Source Protection Zones
SSAC	Site-Specific Assessment Criteria
SSSI	Site of Special Scientific Interest
T	Transmissivity
TCBC	Torfaen County Borough Council
TFP	Total Fluids Pumping
TPH	Total Petroleum Hydrocarbons
VC	Vinyl Chloride
VOC	Volatile Organic Compounds

1 INTRODUCTION

In January 2012, ARCADIS (UK) Limited (ARCADIS) was commissioned by Meritor Heavy Vehicle Braking Systems (UK) Limited (Meritor) to produce a Remediation Implementation Plan (RIP) to address the Chlorinated Volatile Organic Compounds (CVOC) impacts identified in soil and groundwater, comprising mainly trichloroethene (TCE), beneath the Meritor facility located on Grange Road, Cwmbran, Gwent NP44 3XU, South Wales (the Site).

The environmental works were conducted at the request of Meritor whom ARCADIS understands will divest the freehold ownership of the northern two thirds of the Site (Zones 1 & 2), including a parking area to the north of the main production building, for redevelopment. ARCADIS also understands that Meritor will retain the southern third of the Site and will undertake the refurbishment of the existing production building and southern yard area (Zone 3).

The work was conducted in accordance with the Global Master Services Agreement (2008) between ARCADIS and Meritor, Inc (formerly ArvinMeritor, Inc). The work was also performed in accordance with Welsh legislation and regulatory guidance for the assessment of contaminated land, an overview of which is presented in Appendix A.

The Site information presented in this report has been obtained during previous phases of assessment (see Section 1.3). This report should be read in conjunction with the previous environmental reports as the information contained in those reports forms the basis of the conceptual model for the Site.

1.1 Planning Conditions

ARCADIS has been supporting Meritor with professional and technical environmental services relating to a Site-wide environmental assessment of the Meritor facility, Cwmbran. The environmental assessment has been conducted in support of planned redevelopment of the Site, as evidenced by a joint planning application submitted to Torfaen County Borough Council (TCBC) in February 2011 by Meritor and Morrisons Supermarkets Plc.

A planning application (reference Application Number 11/P/00101) has been submitted to the Local Planning Authority, TCBC, for the redevelopment of the northern zones at the Site (Zones 1 & 2) and for the refurbishment of the southern zone (Zone 3). Detailed redevelopment plans which have been provided to ARCADIS and are presented in the planning application indicated that three main commercial developments will be carried out on Site, as follows:

- **Zone 1** – Employee car park to the north of the main production plant, to be redeveloped with a new supermarket, associated petrol filling station and two smaller retail units (as well as a pedestrian bridge from the Site into Cwmbran town centre).

- **Zone 2** – Central portion of the Meritor Site including the Heavy Goods Vehicle (HGV) entrance, loading bay and the northern third of the existing production building to be redeveloped as commercial offices with a hotel (and associated bar/ restaurant) and car parking areas.

- **Zone 3** – The remainder of the production building (south of building column row M) and the southern yard area and visitors car park to be retained as a heavy vehicle braking systems production building with associated employee and visitor car parking areas; an engineering centre; and Meritor's offices.

TCBC has imposed environmental planning conditions for the redevelopment of Zones 1 & 2 and for the refurbishment of Zone 3. The information contained in this report can be used to assist in the discharge of the environmental planning conditions.

The general Site location and the physiogeographic features of the surrounding area are presented on Figure 1 at a map scale of 1:50,000. The current Site layout is presented on Figure 2, the proposed redevelopment areas are presented on Figure 3.

1.2 Report Objectives

The purpose of the RIP is to present the selected remediation strategy and define the implementation approach for remediation of CVOC (mainly TCE) beneath Zone 3, including monitoring and validation requirements, in order to mitigate the identified risks and liabilities associated with the CVOC beneath the Site.

1.3 Scope of Work

The RIP for CVOC remediation in the Zone 3 area includes the following aspects:

- Summary of Site, and specifically Zone 3, characteristics including constraints on remediation approach;
- Statement of remediation objectives and remediation criteria;
- Remediation technology description and specification;
- Development of implementation methodology; and,
- Development of monitoring and validation requirements.

1.4 Previous Environmental Works

The Site has undergone a series of phases of intrusive Site investigations, risk assessment and remediation since December 2009, when ARCADIS was commissioned to undertake an updated Phase I Environmental Site Assessment (ESA) of the Site and to develop a scope of works for a subsequent Phase II ESA. The environmental works to date conducted by Meritor are detailed in the following reports:

- *Phase I Environmental Site Assessment*, Meritor Heavy Vehicle Braking Systems (UK) Limited, Cwmbran, ARCADIS report reference 909361804_02, January 2010.
- *Phase II Environmental Site Assessment Report*, Meritor Heavy Vehicle Braking Systems (UK) Limited, Cwmbran. ARCADIS report ref: 909361904_03, February 2010.
- *Phase IIB Environmental Site Assessment Report*, Meritor Heavy Vehicle Braking Systems (UK) Limited, Cwmbran. ARCADIS report reference 909362203_03, May 2010.
- *Detailed Quantitative Risk Assessment Report*, Meritor Heavy Vehicle Braking Systems (UK) Limited, Cwmbran, ARCADIS report reference 909362002_01, May 2010.
- *Remediation Options Appraisal Report*, Meritor Heavy Vehicle Braking Systems (UK) Limited, Cwmbran, ARCADIS report reference 909362302_02, August 2010.
- *Revised Detailed Quantitative Risk Assessment Report*, Meritor Heavy Vehicle Braking Systems (UK) Limited, Cwmbran, ARCADIS report reference 909362802_01, January 2011.
- *Remediation Method Statement*, Meritor Heavy Vehicle Braking Systems (UK) Limited, Cwmbran, ARCADIS report reference 909362819_01, January 2011.

- *Supplementary Site Investigation Report*, Meritor Heavy Vehicle Braking Systems (UK) Limited, Cwmbran, ARCADIS report reference 909362509_01, April 2011.
- *Remediation Pilot Testing (Oil Recovery) Report*, Meritor Heavy Vehicle Braking Systems (UK) Limited, Cwmbran, ARCADIS report reference 909362711_01, June 2011.
- *Updated Detailed Quantitative Risk Assessment*, Meritor Heavy Vehicle Braking Systems (UK) Limited, Cwmbran, ARCADIS report reference 909363202_01, June 2011.
- *Baseline Site-Wide Groundwater Monitoring Report*, Meritor Heavy Vehicle Braking Systems (UK) Limited, Cwmbran, ARCADIS report reference 909362902_01, September 2011.
- *Light Non-Aqueous Phase Liquid Assessment,* Meritor Heavy Vehicle Braking Systems (UK) Limited, Cwmbran, ARCADIS report reference 9093633.03_01, August 2011.
- *Remediation Implementation Plan (LNAPL Recovery),* Meritor Heavy Vehicle Braking Systems (UK) Limited, Cwmbran, ARCADIS report reference 909363022_06, January 2012.
- *Location of Historic Abstraction Well Letter Report,* Meritor Heavy Vehicle Braking Systems (UK) Limited, Cwmbran, ARCADIS report reference 909363603_01, January 2012.
- *Quarterly Groundwater Monitoring – November 2011 Update Letter Report,* Meritor Heavy Vehicle Braking Systems (UK) Limited, Cwmbran, ARCADIS report reference 909363703_01, January 2012.

This report follows on from, and should be read in conjunction with the previous reports detailed above.

1.5 Reliability of Information/ Limitations

This report is only valid when read in its entirety. Any information or advice included in this report should not be relied on unless considered in the context of the whole report. Reference should be made to the notes on study limitations at the end of this report.

A copy of ARCADIS' study limitations are presented in Section 9.

1.6 User Reliance

There are neither third party rights nor benefits conferred under this report. Use of this report is strictly limited to Meritor and Meritor, Inc and its direct and indirect subsidiaries, which are the sole parties to whom ARCADIS intends to confer any rights. Any reliance on the contents of this report by any other party is the sole responsibility of that party.

2 SITE CHARACTERISTICS

ARCADIS used information obtained from an inspection of the property, previous environmental works on-Site, and reference materials to formulate the property description.

2.1 Site Location and Description

2.1.1 Site Location

Information from Ordnance Survey (OS) maps indicates that the Site is located at National Grid Reference ST 296951 (National Grid Co-ordinates 329684,195192) on Grange Road, Cwmbran, Wales.

The Meritor facility is located in an area of mixed land use that includes residential, light industrial and commercial properties. The Site is bounded by Grange Road to the west, Edlogan Way to the north, a railway line to the east and a factory to the south. The facility lies on the flood plain of the Afon Lwyd at an elevation of 55 metres Above Ordnance Datum (mAOD). The topography of the facility is generally flat with the immediately surrounding area sloping gently to the south.

The general Site location and the physiogeographic features of the surrounding area are presented on Figure 1, on a map scale of 1:50,000.

2.1.2 Use of the Property and Description of Structures

The majority of the on-Site buildings were constructed in the 1930s to 1940s using a steel frame structure clad with metal sheeting. The facility is currently used for the manufacture of braking systems for HGVs. The gross area of the facility is 25.73 acres. At the time of the *Phase I ESA* (909361804_02, January 2010 referenced previously), the number of staff working at the Site was reportedly approximately 600 people.

The external locations surrounding the facility comprise concrete and bituminous surfaced roads and pavements. There are small areas of open space to the west consisting of gardens and roadside verges.

The 2010 Site layout is presented on Figure 2.

2.1.3 Current Uses of the Adjoining Properties

At the time of the *Phase I ESA* Site walkover (909361804_02, January 2010 referenced previously), land-use in the immediate vicinity of the facility comprised light industrial, residential, and commercial buildings together with sports fields and a school.

North:	A small industrial estate (approximately 300 m from facility boundary).
East:	Beyond the railway track lie sports playing fields, the (river) Afon Lwyd and a school (approximately 550 m from the facility boundary).
South:	Crane Process Flow Technologies Limited, who manufacture valves and a large car park lies beyond to the south-west. Residential properties are located beyond the units and car park.
West:	Immediately west of the Site lies the Lufthansa Resource Technical Training Limited building (the building is now redundant). Beyond Grange Road lies residential housing and flats (approximately 80 m from the facility boundary), and Cwmbran town centre.

2.2 Summary of Site History

The historic use of the Site was determined from inspection of 1:2,500, 1:10,000 and 1:10,560 scale OS map extracts contained within the Enviro*check*® Report for the Site produced by Landmark Information Group, dated December 2009, previous environmental works undertaken at the Site by ARCADIS, Information Obtained from www.Cwmbran.info and historic photographs. Reference should be made to the *Phase I ESA* (909361804_02, January 2010) referenced previously for further information on the Site use history.

2.3 Topography

The Site lies on the flood plain of the Afon Lwyd at an elevation of 55 mAOD. The topography of the facility is generally flat, although the ground level of the surrounding area is sloping gently to the south.

2.4 Geology

2.4.1 Regional

A review of the 1:50,000 scale British Geological Survey (BGS) solid geological map (Sheet Number 249, Newport, 1975) indicates that the Site is underlain by the Raglan Mudstone Formation within the Old Red Sandstone Formation. The Raglan Mudstone Formation consists of fine-grained, well-cemented sandstone which gently dips to the west.

2.4.2 BGS Borehole Records

Four historical borehole records for the Site and the surrounding area were obtained from the BGS as summarised in the table below:

BGS Borehole Record	National Grid Reference	Location	Borehole Depth	Details
ST29NE80 (1942)	ST 2983 9526	Grange Works on Grange Road	146 m	Borehole commissioned by Joseph Lucas Industries Limited. The ground conditions comprised Made Ground over Soil, overlying brown gravel and clay with boulders to a depth of 1.2 mbgl. The gravel and clay was underlain by boulders and clay to a proven depth of 6.0 mbgl overlying marl and bands of sandstone and sandy marl to a depth of 8.0 mbgl. The interbedded bands of marl and sandstone continued to a depth of 146 mbgl. A note added to the borehole log indicates that the borehole location was “concreted over” by August 1950.

BGS Borehole Record	National Grid Reference	Location	Borehole Depth (m)	Details
ST29NE79 (1904)	ST 2942 9530	Cwmbran's Electricity Generating Station	10.5 m	The ground conditions encountered comprised hard red marl from ground level to 1.7 mbgl into underlying red rock proven to a maximum depth of 3.48 mbgl considered to represent the Old Red Sandstone. A note added to the borehole log indicates that by August 1950 a South Wales Electricity Board Sub-Area Engineering Headquarters (Eastern Division) building was present over the location of the borehole.
ST29SE85 (1976)	ST 2960 9468	Crane Process Flow Technologies Limited	29.5	The ground conditions encountered comprised tarmac over Made Ground proven to a depth of 1 mbgl. The Made Ground was underlain by dirty gravel proven to 6 mbgl. The drift deposits were underlain by interbedded bands of marl and sandstone proven to a depth of 29.5 mbgl
ST 39SW92 (1990)	Unknown	Lane two of the Llantarnam By-Pas	10.5	The ground conditions encountered comprised topsoil and clay proven to a depth of 2 mbgl overlying reddish-brown mudstone (marl) to a depth of 9 mbgl. The marl was underlain by greenish grey sandstone proven to a depth of 10.5 mbgl.

Reference should be made to the *Phase I ESA* (909361804_02, January 2010) referenced previously for further information on the borehole logs supplied by the BGS.

2.4.3 Site Condition

Several phases of intrusive investigation have been undertaken at the Meritor facility, including Site investigations by ARCADIS in 1998, 2010 and 2011 and an investigation undertaken by Sirius Geotechnical and Environmental Limited (Sirius) in 2009. The findings of the intrusive investigations are summarised below:

Who	Date	Area of Investigation	Max. Borehole Depth in Investigation (m)	Findings
ARCADIS	October 1998	Site Wide	3.0	Concrete was encountered in seven of 13 locations resulting in shallow refusal. Ground conditions recorded comprised Made Ground, underlain by alluvial deposits consisting of soft clay and sandy gravel, and silty sandy gravel.

Who	Date	Area of Investigation	Max. Borehole Depth in Investigation (m)	Findings
Sirius	February – March 2009	Northern Employee Car Park (Zone 1)	10.0	Made Ground typically comprised bituminous surfacing, concrete or hardcore hardstanding over a mixed granular and cohesive fill. The Made Ground overlaid cohesive stratum described as soft and firm, locally very stiff, slightly sandy slightly gravelly clay. Underlying the natural cohesive deposits were deposits, typically described as locally clayey sand and gravel with a medium cobble content. Sirius encountered occasional boulders, with a maximum recorded dimension of 0.40 m x 0.70 m. Sirius reported that mudstone was encountered beneath the superficial deposits where boreholes were progressed to a sufficient depth. Sirius reported that a weathering profile was seen within the mudstone, although variable, with an upper layer of completely weathered material (recovered as sandy gravelly clay).
ARCADIS	January - February 2010	Site-Wide	15.5	Concrete or bituminous surfacing overlying Made Ground comprising gravelly clay and clayey or gravelly sand. The Made Ground was underlain by sandy or gravelly clay and clayey or gravelly sand with occasional cobbles. This was overlying sandy gravel and cobbles of sandstone proved to a maximum depth of 5.6 mbgl. The Alluvium deposits were underlain by mudstone with bands of sandstone, proven to a maximum depth of 15.5 mbgl, considered to be representative of the Raglan Mudstone Formation.

Who	Date	Area of Investigation	Max. Borehole Depth in Investigation (m)	Findings
ARCADIS	March – April 2010	Site-Wide	33	Concrete (or gravelly or clayey soils in certain locations) overlying Made Ground consisting of gravelly clay and clayey or gravelly sand. The Made Ground was underlain by sandy or gravelly clay and clayey or gravelly sand with occasional cobbles. This was overlying sandy cobbles and boulders proved to a maximum depth of 6.0 mbgl. The Alluvium deposits were underlain by a red mottled grey mudstone in several boreholes, proven to a maximum depth of 33 mbgl considered to be representative of the Raglan Mudstone Formation.
ARCADIS	March – April 2010	Off-Site In Adjacent Playing Fields	27	The ground conditions encountered off-Site consisted of similar conditions to those encountered on-Site.
ARCADIS	September – December 2010	Southern Yard Area (Zone 3)	10.5	Underlying concrete hardstanding Made Ground was encountered, comprising clayey sand, gravel and sandy gravelly clay with fragments of brick, concrete and clinker. Proven to a maximum depth of 2.4 mbgl. In a number of locations, including borehole EX5, concrete was proven to a notable depth (>2.0 mbgl). The Made Ground was underlain by sandy or gravelly clay and clayey or gravelly sand with occasional cobbles, proven to a maximum depth of 5.7 mbgl. The Alluvium was underlain by a red mottled grey mudstone proven to a maximum depth of 10.5 mbgl considered to be representative of the Raglan Mudstone Formation.

Reference should be made to the *Phase I ESA* (909361804_02, January 2010), the *Phase II ESA* (909361904_03, February 2010), the *Phase IIB ESA* (909362203_03, May 2011) and the *Supplementary Site Investigation* (909362509_01, April 2011) referenced previously for further information on the ground conditions beneath the Site.

2.5 Hydrogeology

2.5.1 Regional Hydrogeology

The EA formerly classified the Old Red Sandstone underlying the Site as a Minor Aquifer, as defined in their "Policy and Practice for the Protection of Groundwater – Groundwater Vulnerability 1:100,000 Map Series (Sheet 36 – Gwent, South and Mid Glamorgan, 1996). However, the nomenclature associated with the designation of aquifers has undergone a period of transition. The Environment Agency (EA) now refers to Principal Aquifers, Secondary Aquifers or Unproductive Strata, depending on the importance of the aquifers in terms of groundwater as a resource (supporting abstractions, ecosystems *etc*).

The EA website (www.environment–agency.gov.uk) accessed November 2011, indicates that the Alluvium and the Raglan Mudstone Formation underlying the Site are classified as Secondary Aquifers. Secondary Aquifers include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage. Secondary aquifers are subdivided into two types A and B. Both the Alluvium and the Raglan Mudstone Formation are classified as Secondary Aquifer A, indicating they have permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

2.5.2 BGS Borehole Records

Four historical borehole records for the Site and the surrounding area were obtained from the BGS. The hydrogeological information obtained from the logs is summarised in the table below:

BGS Borehole Record	National Grid Reference	Location	Borehole Depth	Details
ST29NE80 (1942)	ST 2983 9526	Grange Works on Grange Road	146 m	The borehole log indicates that groundwater strikes occurred at depths of 17 mbgl and 30 mbgl and that groundwater was resting at approximately 1 mbgl following the monitoring well installation. A note added to the borehole log indicates that the borehole location was visited in August 1950 and was then "concreted over due to insufficient water".
ST29NE79 (1904)	ST 2942 9530	Cwmbran's Electricity Generating Station	10.5 m	The borehole log indicates that groundwater was resting at 1 mbgl in the installed monitoring well.
ST29SE85 (1976)	ST 2960 9468	Crane Process Flow Technologies Limited	29.5	The borehole log indicates that a groundwater strike occurred at a depth of 3.7 mbgl and that groundwater was resting at a depth of 1.3 mbgl following the monitoring well installation.
ST 39SW92 (1990)	Unknown	Lane two of the Llantarnam By-Pas	10.5	The borehole log indicates that groundwater seepage occurred at depths of 5.3 mbgl

Reference should be made to the *Phase I ESA* (909361804_02, January 2010) referenced previously for further information on the borehole logs supplied by the BGS.

2.5.3 Source Protection Zones

The digital groundwater Source Protection Zone (SPZ) Data Register accessed in November 2011 and the Enviro*check*® Report, indicates that Site is not located within a groundwater SPZ, as defined by the EA.

2.5.4 Groundwater Abstractions

The Enviro*check*® Report for the Site produced by Landmark Information Group, dated December 2009 provides no record of licensed groundwater abstractions located within a 2 km radius of the Site.

2.5.5 Site-Specific Hydrogeology 1998 – 2009

Several phases of intrusive investigation have been undertaken at the Meritor facility, including Site investigations by ARCADIS in 1998, 2010 and 2011 and an investigation undertaken by Sirius Geotechnical and Environmental Limited (Sirius) in 2009. The findings of the intrusive investigations are summarised below:

Who	Area of Investigation	Findings
ARCADIS	Site Wide	Groundwater was encountered between 0.8 m and 1.3 mbgl resting within the Made Ground. Insufficient Site data was available to enable a definite groundwater flow direction to be inferred.
Sirius	Northern Employee Car Park (Zone 1)	Sirius reported perched groundwater within the Made Ground was encountered. In addition, that monitoring of the standpipes, installed within cable percussive boreholes, and indicated groundwater levels between 1.24 m and 3.04 mbgl, indicating a hydraulic gradient to the south and east.

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Reference should be made to the *Phase I ESA* (909361804_02, January 2010), referenced previously for further information on the hydrogeological conditions beneath the Site.

2.5.6 Site-Specific Hydrogeology 2011

During the most recent Site-wide groundwater monitoring visit conducted between 15th February 2011 and 23rd March 2011, resting groundwater levels were recorded. During the groundwater monitoring visit, the rest groundwater levels were recorded in the monitoring wells screening the Alluvium on-Site:

Alluvium On-Site:

Date	Range in Resting Depths to Groundwater in the Alluvium (mbgl)	
	Minimum	Maximum
February – March 2011	0.65 (BH130)	4.27 (BH204AS)

Notes:

mbgl Metres below ground level

No groundwater was encountered in monitoring wells BH134 and BH908, LNAPL was encountered in and to the base of the monitoring wells. No groundwater or LNAPL was encountered in monitoring wells BH116, BH302_S, BH916 or BH931 *i.e*. the monitoring wells were dry.
During the groundwater monitoring visit, the rest groundwater levels were recorded in the monitoring wells screening the Alluvium off-Site:

Alluvium Off-Site:

Date	Range in Resting Depths to Groundwater in the Alluvium (mbgl)	
	Minimum	Maximum
February – March 2011	0.52 (BHOS409)	1.77 (BHOS 414)

Notes:

mbgl Metres below ground level

During the groundwater monitoring visit, the rest groundwater levels were recorded in the monitoring wells screening the Raglan Mudstone Formation on-Site:

Raglan Mudstone Formation On-Site:

Date	Range in Resting Depths to Groundwater in the Raglan Mudstone Formation (mbgl)	
	Minimum	Maximum
February – March 2011	0.83 (BH202D)	4.84 (BH303D)

Notes:

mbgl Metres below ground level

The groundwater in monitoring well BH203D was overflowing on removal of the well cap.

During the groundwater monitoring visit, the rest groundwater levels were recorded in the monitoring wells screening the Raglan Mudstone Formation off-Site:

Raglan Mudstone Formation Off-Site:

Date	Range in Resting Depths to Groundwater in the Raglan Mudstone Formation (mbgl)	
	Minimum	Maximum
February – March 2011	1.90 (BHOS306S)	2.37 (BH3OS307)

Notes:

mbgl Metres below ground level

A plan showing the locations of the on- and off-Site monitoring well locations monitored during the Site-wide groundwater monitoring event is presented on Figure 4.

2.5.7 Interpretation of Groundwater Interaction

The groundwater in the Alluvium is partially confined by the overlying clayey deposits and groundwater rest level typically rises in comparison to its strike level. This behaviour was not observed beneath the adjacent playing fields that did not have consistent overlying clayey alluvial deposits.

In the Raglan Mudstone Formation there were no obvious groundwater strikes, but resting water levels were present in the overlying Alluvium at approximately 3.0 mbgl (see table below). In comparable installations, such as BH204AS, BH204AD and BH305, there was a vertical head difference of between 0.3 m and 0.97 m between the Alluvium and the Raglan Mudstone Formation installed to medium depths (10-15 mbgl).

Within the Raglan Mudstone Formation there was a distinct head difference between the 10-15 m deep monitoring wells and the deeper 30 – 33 m deep wells. The vertical head difference within the Raglan Mudstone Formation was most distinct in the east of the Site adjacent to the railway line with a head difference of 1.85 m. In all cases there was a downward vertical head difference within the Raglan Marl.

Borehole Set	BH411/ BH306	BH132/ BH301	BH204A/ BH305	BH102/ BH303
Screened Unit	Groundwater Elevation (mAOD)			
Alluvium	49.77	52.59	50.46	51.51
Raglan Mudstone Formation (15m)	49.46 (-0.31)	52.04 (-0.55)	49.49 (-0.97)	51.09 (-0.42)
Raglan Mudstone Formation (30m)	49.03 (-0.43)	51.67 (-0.37)	49.03 (-0.46)	49.24 (-1.85)

Notes
Based on groundwater elevation data from 29th April 2010
Figures in parentheses are elevation differences (m) relative to the aquifer unit above

The measured groundwater elevations suggest that the water bodies may be directly in connection with each other despite no obvious groundwater strikes noted within the mudstone deposits. As groundwater is present within the mudstone in fissures and joints there is considered to be no unsaturated zone in the Raglan Mudstone Formation.

Groundwater elevation data have been used in combination with topographic data to calculate the relative resting groundwater elevations at the Site. The groundwater elevation data has been used to infer a groundwater flow direction to the south and south-east within the Alluvium towards the Afon Lwyd.

Based on the groundwater elevations in the monitoring wells, screened at approximately 15 m within the Raglan Mudstone Formation, a groundwater flow direction to the south-south-east with a more prominent flow direction to the south-east in the southern portion of the Site was inferred. Using the groundwater elevations from the deeper installations a flow direction to the east south-east was inferred. The deeper groundwater had a more easterly component of flow than the shallower deposits. The groundwater in the Raglan Mudstone Formation is likely to be directly in continuity with the Afon Lwyd.

A plan showing the locations of the on- and off-Site monitoring well locations is presented on Figure 4.

2.6 Hydrology

Inspection of the OS map for the area (Landranger 171, Cardiff and Newport, 1997) indicates the nearest surface water feature to the Site is the Afon Lwyd, located 250 m to the east. Information obtained from the EA website (www.environment–agency.gov.uk) indicates the water quality of the river was classified by the EA as 'C', *i.e.* fair quality in 1998.

Information obtained from the EA website, accessed in November 2007, indicates that there has been a notable improvement in the river quality and between 2004 and 2006 the river was classified by the EA as 'B', *i.e.* good.

The Cwmbran Brook is located 400 m to the west of the Site and is culverted beneath Cwmbran town centre, which discharges to the Afon Lwyd located to the south of the facility.

2.6.1 Flooding Risk

The EA's 'What's In Your Backyard?' search engine indicates that the Afon Lwyd is at risk of flooding in areas without defences. The northern section of the Site is indicated to be within an area classified as being at low risk from flooding, and the southern section of the Site is in an area classified as affected in the event of extreme flooding. Some river defences are present to the south-east of the Site, along the Afon Lwyd.

2.6.2 Surface Water Abstractions

The Enviro*check*® Report provides one record of an active licensed surface water abstraction located within a 2 km radius of the Site. The abstraction is located approximately 986 m south-west of the Site from the Cwmbran Brook and is licensed to Torfaen County Borough Council for intake to the boating lake.

A plan showing the surface water abstractions in the area is presented on Figure 5.

2.7 Ecologically Sensitive Sites

The Countryside Council for Wales 'Interactive Maps' on-line facility, indicates that there are a number of ecological receptors surrounding the Site, as defined by Table A of Annex 3 of the Department for Environment, Food and Rural Affairs (DEFRA) Circular 01/2006 '*Contaminated Land: Implementation of Part 2A of the Environmental Protection Act 1990*'. The ecological receptors are summarised below:

Site	Type	Managed By	National Grid Reference	Approx. Distance from Site (Miles)
Coed Meyric Moel	Wildlife Trust Centre	Gwent Wildlife Trust	ST 272 940	1.7 south-west
Henllys Bog	Site of Special Scientific Interest (SSSI)		ST 263 926	2.6 south-west
Allt-yr-yn	Local Nature Reserve		ST 296 886	4.3 south
Craig Y Wenallt	Woodland Trust Centre	Woodland Trust	ST 260 910	3.5 south-west
Dan-y-graig	Wildlife Trust Centre	Gwent Wildlife Trust	ST 234 903	4.9 south-west

3 SUMMARY OF CONTAMINANT DISTRIBUTION

3.1 Contaminants of Concern

Previous phases of investigation have identified the presence of contaminants beneath the Meritor facility. Contaminants include LNAPL (oils), CVOC, and Total Petroleum Hydrocarbons (TPH) in soil and groundwater. The predominant Contaminants of Concern (CoC) present in groundwater beneath the Site are CVOC, therefore, this report focuses on managing the environmental risks and liabilities associated with CVOC. A RIP to address the LNAPL encountered beneath the Site has previously been produced for the Site (ARCADIS Ref: 909363022, January 2012).

3.2 CVOC Extent and Assessment

3.2.1 Soil Quality

Human Health

Multiple phases of intrusive investigation works, as outlined in Section 1.4, have been undertaken to delineate the CVOC distribution beneath the Site. The updated Detailed Quantitative Risk Assessment (DQRA) conducted for the Site evaluated and assessed the environmental risks and liabilities associated with CVOC impacts beneath the Site.

Based on the outcome of the updated DQRA (ARCADIS Ref: 909363202, June 2011), none of the measured concentrations of CoC in soil sampled across the Zone 1 (Supermarket Development) and the Zone 2 (Commercial Development) exceeded the SSAC derived for the protection of human health receptors.

A number of the measured concentrations of CoC (predominantly TCE, *cis*-1,2-dichloroethene [*cis*-DCE], Vinyl chloride) in soil sampled from Zone 3 exceeded the Site Specific Assessment Criteria (SSAC) (indoor air inhalation) derived for the protection of human health receptors. Figure 6 shows the locations of soil samples collected across Zone 3 with concentrations of CoC above the applicable SSAC derived for the protection of human health receptors.

Water Resources

None of the measured concentrations of CoC in soil samples from Zones 1 and 2 exceeded the SSAC derived for the protection of water resource receptors.

Measured concentrations of CoC (predominantly TCE, *cis*-DCE and vinyl chloride) in soil samples from the Zone 3 exceeded the applicable SSAC derived for the protection of water resource receptors. The soil sample locations where CoC were recorded above the applicable SSAC are shown on Figure 7.

3.2.2 Groundwater Quality

Human Health

None of the measured concentrations of CoC in groundwater samples collected from the monitoring wells located across Zone 1 and Zone 2 in February-March 2011 exceeded the applicable SSAC derived for the protection of human health receptors.

The measured concentrations of vinyl chloride in a limited number of groundwater samples collected across the monitoring wells located across the Zone 3 were found to exceed the SSAC derived for the protection of human health receptors.

Water Resources

A number of measured concentrations of CoC in groundwater samples across Zone 3 exceeded the applicable SSAC derived for the protection of water resources receptors and are presented on Figure 8.

In addition, groundwater sampled from one monitoring well (BH104) located in Zone 2 were also found marginally above the applicable SSAC derived for the protection of water resources receptors.

3.2.3 CVOC Assessment

There were no detections of CoC in soil or groundwater samples from Zone 1 exceeding the SSAC protective of human health and water resource receptors. As such, no remediation works are proposed in Zone 1.

In Zone 2, no measured concentrations of CoC in soil samples exceeded the SSAC protective of human health and water resource receptors. In groundwater samples, one detection of CoC exceeded the SSAC protective of water resources .

The measured concentrations marginally exceeded the SSAC protective of water resources. Given that the measured concentrations of CVOC in groundwater sampled from monitoring wells in the vicinity of this exceedance were below SSAC and concentrations of CVOC in groundwater sampled from down-gradient off-site monitoring wells have been detected at concentrations only marginally above laboratory MDL, the impacts in groundwater in Zone 2 are not considered to be significant. Therefore, no remediation activities in Zone 2 are being considered at this stage, however this will be reviewed if further contamination is identified in Zone 2 in the future.

In Zone 3, localised soil impacts with concentrations of CVOC exceeding the applicable SSAC protective of human health were identified as presented on Figures 6 and 7. Soil gas analysis conducted in Zone 3 during the Supplementary Site Investigation (909362509_01, April 2011) measured concentrations of CVOC at levels where subsequent modelling indicated that a potential theoretical risk could be present to commercial workers. However, analysis of indoor and outdoor air samples, also collected across Zone 3 during the Supplementary Site Investigation (909362509_01, April 2011), indicated no immediate unacceptable risk to human health *via* chronic exposure removing the requirement for remediation to protect commercial workers. However, control measures have been included within the remediation approach (Soil Vapour Extraction [SVE]) that will further reduce the occurrence of CVOC within unsaturated soils.

The applicable SSAC for soil protective of water resource receptors are based on CoC in soils leaching to groundwater, then migration off-Site to environmental receptors. It is considered that this potential pollutant linkage can be managed via the proposed remediation works, Enhanced Reductive Dechlorination (ERD) and SVE, for groundwater impacts beneath Zone 3.

The results of groundwater analysis across Zone 3 indicated that groundwater beneath Zone 3 is impacted by CVOC with concentrations exceeding the applicable SSAC derived for the protection of human health and water resources receptors. The anticipated distribution of dissolved phase CVOC, which requires remediation to mitigate the associated environmental risks and liabilities, is presented on Figure 9.

4 ENGINEERING CONSIDERATIONS

The remediation technologies selected are considered to represent the best available remediation technologies for the identified CVOC impacts and the ground conditions encountered to date beneath the Site.

The selected remediation approach may not be appropriate to address new contamination resulting from on-going operations at the Site, however there are no known on-going sources.

4.1 Access and Security

A planning application (reference Application Number 11/P/00101) has been submitted to the Local Planning Authority, TCBC, for the redevelopment of the northern zones at the Site (Zones 1 & 2) and for the refurbishment of the southern zone (Zone 3). Detailed redevelopment plans which have been provided to ARCADIS, and are presented in the planning application, indicated that three main commercial developments will be carried out on Site, as follows:

- **Zone 1** – Employee car park to the north of the main production plant, to be redeveloped with a new supermarket, associated petrol filling station and two smaller retail units (as well as a pedestrian bridge from the Site into Cwmbran town centre).

- **Zone 2** – Central portion of the Meritor Site including the HGV entrance, loading bay and the northern third of the existing production building to be redeveloped as commercial offices with a hotel (and associated bar/ restaurant) and car parking areas.

- **Zone 3** – The reminder of the production building (south of building column row M) and the southern yard area and visitors car park to be retained as a heavy vehicle braking systems production building with associated employee and visitor car parking areas; an engineering centre; and Meritor's offices.

The proposed redevelopment areas are presented on Figure 3. A more detailed plan of the proposed redevelopment of Zone 3 is presented on Figure 10.

Zone 3 will continue to operate as a braking system manufacturing/assembly facility throughout the duration of the remediation works, with production equipment temporarily relocated to the northern end of the production building.

4.1.1 Access

Current Access
Access to Zone 3, the land to be retained by Meritor and the focus of the remediation works, is currently *via* Security Gate 1 from Grange Road. Access to the current visitors car park is *via* a more southerly security gate from Grange Road. Access can also be gained to the Meritor facility *via* Security Gate 2 from Grange Road. Gate 2 is located to the north of Zone 3.

Current access arrangements are presented on Figure 11.

Future Access
Access can currently be gained to the Meritor facility *via* Security Gate 2 from Grange Road. Gate 2 is located to the north of Zone 3 and therefore access will be restricted and no longer possible through this route following the sale of Zones 1 and 2. Following the refurbishment of Zone 3, vehicles will enter the Site *via* Gate 1 from Grange Road and will be directed around Site in a counter-clockwise direction, until reaching a turning head in the north of Zone 3. Vehicles will reverse direction at the turning head, retrace their route in a clockwise direction, and exit the Site *via* Gate 1.

Future access arrangements are presented on Figure 12.

Access for Remediation Engineers
The remediation strategy requires and assumes relatively unrestricted access to Zone 3 and the main production building by ARCADIS to enable installation of the remediation infrastructure and to install, operate and monitor the remediation system at the Site. Where structures and Site boundaries are present, factors such as stability and access may place limitations on the extent of remediation achievable in these areas.

The scope of remediation activities at the Site may be constrained by the presence of potential underground structures (building footings, *etc*), and the requirement to minimise disruption to the Site. Additionally, access near the eastern boundary is limited by consideration for the railway line.

4.1.2 Zone 3 Refurbishment

During the refurbishment of Zone 3, the current production building will be reduced in size at the northern portion of the building, eliminating roughly a third of the building area. The warehouse building to the immediate south of the main production building will be demolished, however the electrical sub-station present at the eastern end will remain *in-situ*. The southern portion of the production building is currently undergoing clearance and decommissioning of areas such as the paint line (Recognised Environmental Condition [REC] 5, see the *Phase I ESA* previously referenced). ARCADIS understands that on completion of the clearance and decommissioning works, the southern portion of the production building will be vacant for approximately 12 months, allowing access for the installation of remediation infrastructure, although certain operations will be re-installed in the southern portion of the building as early as May 2012. However, it is understood that after 12 months the southern portion of the production building will utilised for the assembly and production of braking systems and access will be restricted in this area of the Site.

During the refurbishment of Zone 3, the current southern yard area will be redeveloped as a car parking area for Meritor employees and visitors to the Site. The southern car park works will occur between February and April 2012. It is understood that employees and visitors will require access to the southern yard area throughout the duration of the proposed remediation works.

The remediation technologies selected are considered to be appropriate for the identified CVOC impacts and the geology identified beneath the Site given the Site-specific constraints.

4.1.3 Security

24 hour a day security is present at the Site. The security areas will be relocated from Security Gates 1 and 2 to a central area as indicated on Figure 12. Fencing and closed circuit television (CCTV) cameras currently in place will be retained for Zone 3 following the refurbishment.

In order to prevent unauthorised access to the system and minimise the effects of potential vandalism, all critical above ground components of the system should be housed within secure locked steel shipping containers. The permanent components of the remediation infrastructure will be installed below ground with access *via* inspection chamber covers.

4.2 Ground Conditions

The remediation area of the Site is currently comprised of a yard area used for the unloading and loading of HGVs and for storage, and of the southern portion of the main production building.

Formerly the off-highway vehicle braking systems production building, the boiler and compressor houses, and a series of stores including chemical and paint stores, were located in the South yard area and were subsequently demolished. There is the potential for the footings of these buildings to remain *in-situ*. The scope of remediation activities at the Site may be constrained by the presence of potential underground structures (building footings, *etc*), and the requirement to minimise disruption to the Site.

Following the refurbishment of Zone 3, the external area will be utilised as a car park for Site employees and visitors. The selected remediation technologies must be compatible with the future Site infrastructure to ensure the continued operation of the Site.

4.3 Utilities

The implementation of the proposed CVOC remediation scheme requires the service of utilities to the Site.

Power
Operation of the remediation equipment at the Site would require a suitable 100Amp, three-phase, 415V power supply to be available.

Electricity consumption would be dependant on final equipment specification and the load under which the ERD and SVE are running (dependant on Site-specific conditions).

Water Supply
A substantial water supply will be required for the proposed remediation works in Zone 3 and it is considered that the existing water supply at the Site will be sufficient and available to use during the operation of proposed remediation systems.

4.4 Specific Notable Items

ARCADIS understands that the southern portion of the main production building is undergoing a programme of refurbishment, including the removal of steel from the structure that supported the original roof (the roof was replaced but the original structure remained redundant but *in situ*), painting, installation of sky lighting and laying of new flooring.

During this time ARCADIS understands that Meritor will be utilising a Permit-to-Work system for these areas of the Site. A permit from Meritor may be required to access the southern yard and the factory areas on a daily basis whilst the remediation infrastructure is being installed and groundwater monitoring is being undertaken.

4.5 Timescale Considerations

Meritor requires a cost-effective remediation approach to mitigate the potential risks associated with the intended industrial end-use of Zone 3.

The proposed remediation approach was designed assuming that Meritor will remain on Site for the foreseeable future, therefore a lower priority was given to the remediation timeframe as cost effectiveness is considered to be the most important factor.

Alternative technologies may offer quicker remediation solution, but are likely to entail much greater costs.

4.6 Stakeholder Considerations

Meritor
ARCADIS understands that Meritor owns the wider Site and will retain Zone 3 and that it is to remain a braking systems manufacturing plant. Therefore, remediation technologies installed on Site should be designed to minimise disruption to the Site operations.

Elements of the infrastructure for the proposed *in situ* remediation system will need to be installed below ground to allow continued use of the Site. Risk management options have been assessed giving an equal priority to remediation technologies that would cause significant disruption to Site operations.

Regulators
Remediation should be carried out in a manner acceptable to the Regulators. The works should be designed to minimise the potential for harm to human health and pollution of the environment. In addition, the works should not have a serious detriment to the local amenity.

Neighbouring Businesses
The Site is located in close proximity to neighbouring commercial properties; this places considerations on control of noise and prevention of vapour migration that may arise from the application of potential remediation technologies.

4.7 Health and Safety Considerations

In order to prevent unauthorised access to the remediation system and minimise the effects of potential vandalism, all critical above ground components of the system should be housed within the secure locked compounds. Additional fencing will be maintained throughout the remediation infrastructure installation works to minimise the potential for unauthorised access.

4.8 Areas of Uncertainty

The Laser Induced Fluorescence and Membrane Interface Probe holes, boreholes and monitoring wells progressed to date have been primarily located to target Recognised Environmental Conditions (RECs)at the Site and to identify significant areas of concern with regard to soil and groundwater impacts. However, there is potential for higher concentrations of CoC, as hotspots, to be present in areas of Zone 3 that have not been investigated due to current structures, or equipment.

5 REMEDIATION OBJECTIVES

The aim of the risk management work in Zone 3 described within this document is to reduce the potential environmental risks associated with CVOC in soil and groundwater to the identified receptors and environmental liabilities associated with the future use of the Site, and to minimise the potential for remediation works to cause contamination of previously uncontaminated areas of the Site.

ARCADIS considered the following objectives to be appropriate for the risk management work in Zone 3:

- Reduction of the concentrations of CoC in soil and groundwater beneath Zone 3 at the Site; and
- Minimisation of the potential future migration of identified on-site CVOC impacts beneath Zone 3 to off-site receptors.

5.1 Remediation Criteria

The remediation criteria will be considered to have been met when either of the following criteria has been achieved:

- Comparison of site conditions with the updated risk assessment or a revision of the risk assessment, justified by changes in the plume geometry or the conceptual understanding of the Site, indicates that the reduced mass of contaminants does not present an unacceptable risk to the identified receptors;

- Until the improving effect of continued reagent injections has diminished to low or asymptotic levels;

The benefits of continued remediation should be considered against the costs throughout the works. It is anticipated that one of more of the above criteria can be achieved with the proposed design, which has been developed with relative benefits for the cost of the works in mind. If one of the above criteria is not achieved within the scope of the design, cost-benefit analysis will be considered as a justification that additional remediation works should not be undertaken considering likely improvement to the Site condition that could be achieved, versus environmental and financial costs.

6 REMEDIATION DESIGN

6.1 Outline Strategy

ERD and In Situ Chemical oxidation (ISCO) have been identified as viable remediation technologies to address the identified CVOC impacts in groundwater beneath Zone 3 during previous remediation option appraisal. Following the decision making process outlined by the Construction Industry Research and Information Association (CIRIA), and incorporating issues raised by the EA for the selection of remedial strategies and ARCADIS' professional judgement, the selection procedure identified the most appropriate technology to address the identified CVOC impacts in groundwater due to the following reasons:

- There is potential for higher matrix demand at the site with ISCO, hence the required volume of oxidant would be high, resulting in significantly higher remediation costs for the Site;
- The risk management options have been assessed giving a lower priority to remediation timescale and higher priority to the remediation costs. It is understood that the Site will be operated for the foreseeable future, therefore there is no demand for expensive rapid remediation at the Site. ARCADIS estimated that the remediation cost associated with ISCO would be 2 to 3 times higher than the cost of ERD;
- Site conditions and results from pilot testing indicated that ERD can be applied at the Site to successfully transform CVOC, and hence cost effectively mitigate the environmental risk associated with CVOC in groundwater;
- The proposed ERD will cause less disturbance to Site operations compared to ISCO due to the lower required frequency of applications and the lower number of required application locations;
- ERD is a biological approach, which is not subject to restrictions with respect to physical contact of reagent with contaminants;
- ISCO requires the handling of large quantities of hazardous oxidising chemicals on Site;
- There is potential for evolution of heat and gas during ISCO, which may create hazardous conditions and health and safety issues for the operation of the Site; and
- It is considered that ERD is a more sustainable approach due to the less refined and cheaper reagent (molasses).

Considering the all above factors and incorporating the design decisions along with principles such as practicability, effectiveness, durability and efficiency, the operation of ERD for 5 to 6 years is considered the most appropriate remediation strategy for Zone 3 to successfully and cost effectively mitigate risks associated with CVOC dissolved in groundwater.

6.2 Outline Design

6.2.1 Enhanced Reductive Dechlorination

Reductive dechlorination is a biologically mediated reaction which enables the transfer of electrons to chlorinated contaminants from electron donors. In the reduction process, chlorinated solvent molecules replace their chlorine atoms with hydrogen, leading to the sequential dechlorinated pattern as follows:

Tetrachloroethene (PCE) → TCE → *cis*-DCE → Vinyl Chloride → Ethene → Ethane

ERD involves enhancing or inducing the biological transformation of chlorinated compounds through periodic injection of a soluble electron donor solution into the *In situ* Reactive Zone (IRZ). The injections of electron donors at a sufficient rate to exceed the recharge of electron acceptors naturally present within the aquifer such as oxygen and nitrate will drive the aquifer conditions anaerobic, which promotes aquifer microbial communities into sulphate reduction and methanogenesis, stimulating reductive dechlorination of CVOC dissolved in groundwater.

Therefore, periodic injections of an electron donor solution (a carbohydrate solution) will be undertaken at the Site to achieve the biological transformation of TCE into non harmful ethane to meet the remediation objectives in Zone 3. ARCADIS proposes to use molasses as the carbohydrate solution.

The ERD system will comprise the following components:

- Injection wells;
- Molasses distribution lines; and
- Molasses mixing and injection units.
- SVE system

6.2.2 ERD Pilot Trial

An ERD pilot trial was undertaken at the Zone 3 in the Site to determine the effectiveness of the ERD as viable remediation technology to mitigate the identified CVOC impacts beneath the Zone 3 area. The results of the pilot trial collected so far are reported in Interim Enhanced Reductive Dechlorination Pilot Trial Report (ARCADIS Ref: 909363415, in press).

The results collected so far from the ERD pilot trial indicate that anaerobic conditions can be achieved beneath the Site by periodic injection of molasses and reductive dechlorination of TCE can be achieved.

The estimated migratory porosity for the Alluvium was 1.65% while it varied from 0.4% to 1.6% in the Raglan Mudstone Formation.

The results of the pilot trial have been used to estimate design parameters described in Appendix B.

6.2.3 Soil Vapour Mitigation Plan

The potential for generation of dissolved methane during ERD requires consideration of health and safety factors during implementation of the IRZ system beneath Zone 3. Considering the Site activities, the building layout, and the anticipated footprint of the IRZ beneath Zone 3, there is potential for methane generation, therefore control measures are proposed, as follows:

- Forced air extraction to create negative vacuum beneath the building in the unsaturated zone via soil vapour extraction
- Passive venting systems within the car park area
- Regular monitoring of methane and VOC gas concentrations within SVE off-gas via landfill gas analyzer and photoionisation detector to establish typical gas generation rates (based on number of pore volume exchanges and measured concentrations)

In SVE, air flow is induced in the subsurface with an applied vacuum to capture the potential vapour generated during IRZ implementation, and vapours will be treated on Site as appropriate. In addition, the SVE system will assist to reduce concentrations of CVOC within the unsaturated zone beneath the Site.

The SVE system will comprise the following components:

- Extraction wells;
- Vapour Extraction pipework;
- SVE system; and
- Vapour treatment unit.

The SVE extraction wells will be situated every 20 m along ERD injection lines (horizontally) which in turn are spaced at 40 m intervals perpendicular to groundwater flow throughout the main production building footprint to be retained by Meritor. The SVE extraction wells for the second SVE system, located along the southern boundary of the Site (Zone 3), are situated every 10 m along the SVE extraction line.

No conclusive data was found during SVE pilot testing, however, considering the purpose of the system is to prevent build up of hazardous gas concentrations rather than physically strip Volatile Organic Compounds (VOC) from soil a 20 m spacing along the proposed ERD injection lines internally and every 10 m externally is considered to be sufficient for vapour control based on ARCADIS' previous experience. In addition, vapour extraction from Light Non-Aqueous Phase Liquid (LNAPL) extraction wells is proposed. This provides additional vapour control capability at the eastern and southern boundary of the Site and the southern portion of the factory building.

The SVE system will have the following design features to ensure appropriate vapour control:

- SVE system extraction capacity is based on design assumptions, detailed in Appendix B, to provide at 1-2 pore volume air exchanges per day.
- The SVE system blowers will have a flow rate of 1000 m^3/hr.
- SVE systems to be linked to telemetry and alarm systems in order to identify malfunction of equipment immediately and minimise potential for extended system downtime.
- Design of SVE systems where necessary to include multiple air extraction blowers to minimise potential for complete system failure.
- Two SVE systems are proposed to be installed at the Site (one in the south yard and one within the building) – this again provides contingency against complete system failure.

In the event of complete system failure, if repair is not possible within 5 days, methane/ VOC concentration within ground gas monitoring points will be conducted. If concentrations above 5,000 ppm (10% of the lower explosive limit (LEL) for methane, 20% of the LEL for vinyl chloride) are measured weekly soil gas monitoring will be conducted until the SVE system is operational or until it is determined that methane/ VOC concentrations are stable at non-explosive levels.

If ground gas concentrations exceed 50% of the LEL and/ or concentrations of VOC in air within the building exceed 3 ppm in the soil gas samples (3 ppm the vinyl chloride workplace exposure limit protective of human health), indoor air monitoring will be conducted and temporary extraction equipment will be mobilised to Site and will be operated until the SVE units have been repaired and are reactivated.

6.3 Infrastructure Requirements

An above-ground remediation container will be used to house the equipment for the mixing and injection of molasses and the SVE plant. Pipe work will connect the injection and SVE unit to the injection and extraction wells *via* sub-surface ducting installed in shallow utility trenches. Each remediation well will be accessed *via* an inspection chamber. By linking the remediation wells and the container *via* a network of underground ducts, the Site will be able to operate with minimum disturbance from the remediation system.

The specification for the remediation infrastructure is given below.

6.3.1 Internal Remediation Infrastructure Installation

The provisional layout of molasses injection wells, SVE wells and additional monitoring wells in internal areas is presented on Figure 13. It should be noted that it is anticipated that the layout as described in this section and presented on Figure 13 will be subject to modifications over the course of the infrastructure installation due to the future layout of machines within the production building following refurbishment activities. The anticipated specifications of injection, SVE extraction and additional monitoring wells together with inspection chambers and trenching specifications, are given below:

Molasses Injection Wells

- Installation: Dual Installation
- Provisional Number of Injection Wells: 25
- Diameter of Injection Wells: Minimum 50 mm
- Injection Well Screen: 3 mbgl to 6 mbgl in the Alluvium
  10 mbgl to 13 mbgl in the Raglan Mudstone Formation
- Well Screen Slot Size: 0.5 mm
- Filter Pack Grain Diameter: 0.75 – 1.25 mm

CVOC impacts were identified both in the Alluvium and the Raglan Mudstone Formation Aquifers. Therefore, dual installation injection wells as proposed above is considered appropriate for delivering molasses solution into the Alluvium and Raglan Mudstone Formation to enhance the reductive dechlorination process beneath Zone 3.

Concentrations of CVOC have been measured exceeding the SSAC protective of water resources in the Raglan Mudstone Formation in wells screening the upper section of the Raglan Mudstone Formation (approximately 10 to 15 mbgl), as well as deeper sections (approximately 25 to 33 mbgl). The molasses injections in the Raglan Mudstone Formation Aquifer are proposed within the upper section of Raglan Mudstone Formation aquifer only (to maximum depth of 13 mbgl). It is considered that the remediation of CVOC in upper zone will enhance the natural attenuation of impacts identified in the lower zone of Raglan Mudstone Formation aquifer as it is anticipated that the molasses will sink within the Raglan Mudstone Formation aquifer, encouraging reductive dechlorination of CVOC within the lower zone of Raglan Mudstone Formation. The sinking of molasses with the Raglan Mudstone Formation was observed during the tracer test carried out as part of the ERD pilot trial, where changes in colour in BH301D, screened from 25 to 30 mbgl during injection of a 5% molasses solution to 11 mbgl. A decrease in concentrations of TCE in BH301D, along with an increase in *cis*-DCE concentrations was observed, supporting the expectation that molasses injections in the shallow section of the Raglan Mudstone Formation will encourage reductive dechlorination processes within deeper sections of the aquifer, Therefore, it is considered that the injection of molasses solution into the Alluvium aquifer and the upper part of Raglan Mudstone Formation aquifer is sufficient to achieve the remediation objectives in Zone 3.

In addition, in the southern area of Zone 3 triple installation wells have been installed thus enabling molasses introduction at greater depth and allowing future enhancement of the ERD process if necessary (see Section 6.3.2 for details of installation).

Vapour Extraction Wells

- Installation: Single Installation
- Provisional Number of Extraction Wells: 15
- Diameter of Extraction Wells: Minimum 50 mm
- Extraction Well Screen: 0.5 mbgl to water table
- Well Screen Slot Size: 0.5 mm
- Filter Pack Grain Diameter: 0.75 – 1.25 mm

Monitoring Wells

- Installation: Triple Installation
- Number of Additional Monitoring Wells: 4
- Diameter of Injection Wells: Minimum 50 mm
- Monitoring Well Screen: 1 mbgl to 6 mbgl in the Alluvium
  10 mbgl to 15 mbgl in the Raglan Mudstone Formation (Upper section)
  20 mbgl to 25 mbgl in the Raglan Mudstone Formation (Lower section)
- Well Screen Slot Size: 0.5 mm
- Filter Pack Grain Diameter: 0.75 – 1.25 mm

The provisional layout of the internal injection and SVE well system is presented on Figure 13. The injection wells are to be located within inspection chambers, the specification of which is presented below:

Inspection Chambers

- Minimum Depth: 750 mm
- Minimum Length: 600 mm
- Minimum Width: 450 mm
- Inspection Cover: Composite Flush to Proposed Floor Level
- Inspection Cover Rating: Heavy Duty

Remediation System Ducting

Wells are connected by three 110 mm diameter sub-surface ducting and one 50mm HDPE pipe installed in shallow trenches. Draw-cords should be installed within all ducts.

6.3.2 External Remediation Infrastructure Installation

The molasses injection and SVE wells have been installed externally in the South yard. An as-built layout plan is presented on Figure 14. The specifications of injection, SVE extraction and additional monitoring wells together with inspection chambers and trenching are given below:

Injection Wells

- Installation: Triple installation
- Number of Injection Wells: 19
- Diameter of Injection Wells: 50 mm
- Injection Well Screen: 3 mbgl to 6 mbgl in the Alluvium
  10 mbgl to 13 mbgl in the Raglan Mudstone Formation (Upper section)
  17 mbgl to 20 mbgl in Raglan Mudstone Formation (Lower section)
- Well Screen Slot Size: 0.5 mm
- Filter Pack Grain Diameter: 0.75 – 1.25 mm

Monitoring Wells

- Installation: Triple installation
- Number of Injection Wells: 7
- Diameter of Injection Wells: 50 mm
- Injection Well Screen: 2 mbgl to 6 mbgl in the Alluvium
  10 mbgl to 15 mbgl in the Raglan Mudstone Formation (Upper section)
  20 mbgl to 25 mbgl in Raglan Mudstone Formation (Lower section)

- Well Screen Slot Size: 0.5 mm
- Filter Pack Grain Diameter: 0.75 – 1.25 mm

Triple installation injection wells were installed externally in the South yard in Zone 3 in order to enable the molasses injections into the Alluvium and the Raglan Mudstone Formation. This installation is designed to allow treatment of CVOC in groundwater in the Alluvium, and the shallow and deeper sections of the Raglan Mudstone Formation close to site boundary prior to groundwater flowing off Site.

Vapour Extraction Wells

- Installation: Single Installation
- Number of Extraction Wells: 6
- Diameter of Extraction Wells: Minimum 50 mm
- Extraction Well Screen: 0.5 mbgl to water table
- Well Screen Slot Size: 0.5 mm
- Filter Pack Grain Diameter: 0.75 – 1.25 mm

Inspection Chambers

- Minimum Depth: 750 mm
- Minimum Length: 600 mm
- Minimum Width: 450 mm
- Inspection Cover: Composite Flush to Proposed Hardstanding Level
- Inspection Cover Rating: Traffic Rated/ Heavy Duty (up to 40 tonnes)

Remediation System Ducting

Wells were connected by three 110 mm diameter sub-surface ducting and one 50mm HDPE pipe installed in shallow trenches. Draw-cords were installed within all ducts.

6.3.3 Utility Requirements

The implementation of the proposed remediation scheme requires the service of utilities to the Site as detailed in Section 4.3.

7 REMEDIATION METHODOLOGY

7.1 Scope of Works

The proposed remediation for Zone 3 comprises the following tasks:

Task 1: Planning, Regulatory Interface, and Power Connection
Task 2: Installation of Remediation Infrastructure
Task 3: Baseline Monitoring
Task 4: ERD injection and SVE operation
Task 5: Process and Performance Monitoring
Task 6: Remediation Verification

The programme assumes a three month period of planning and Regulatory liaison. Installation of external remediation infrastructure was carried out between October 2011 and Febuary 2012. Installation of internal remediation infrastructure is scheduled to be finished by the end of May 2012. It is considered that injection of molasses for 5 to 6 years will be required to achieve the remediation objectives at the Site. Remediation verification monitoring will be carried out for 12 months following the completion of molasses injection at the Site.

7.2 Project Team

It is considered that the overall project team should comprise the following components:

ARCADIS Delivery Team	ARCADIS Peer Review	Meritor	
Project Director Project Manager Dedicated Field Staff Appointed Sub-Contractors	Account Manager Technical Support Health and Safety Officer Purchasing Officer	Environmental Manager	Refurbishment Programme Manager

7.3 Health and Safety Requirements

Risk assessments will be undertaken for the phases of work and, safety method statements will be developed for relevant tasks.

7.4 Remediation Tasks

Task 1: Regulatory Interface

The programme assumes a three month period of planning and regulatory liaison. However, the lead-in period for planning and Regulatory liaison will be subject to the responses received. The following issues should be addressed during this period:

- Remediation licensing;
- Health and safety plans, method statement development *etc*.; and,
- Equipment and service procurement.

Task 2: Installation of Remediation Infrastructure

The installation of external remediation infrastructure including molasses injection wells, SVE wells, inspection chambers and associated ducting in the southern yard was previously carried out in Zone 3 and the layout of injection and extraction wells across the South yard at the Site is presented on Figure 14.

The internal molasses injection wells, SVE wells, inspection chambers and associated sub surface ducting will be installed as per the proposed layout presented on Figure 13, however it should be noted that modifications to the layout are anticipated due to constraints relating to the positioning of machines within the building following refurbishment activities,

It is anticipated that the internal infrastructure installation works would take in the order of 10 to 12 weeks to complete.

Following completion of the infrastructure installation, molasses mixing and injection units and SVE systems will be mobilised to Site and will be connected to the remediation well network and power supply to enable the proposed remediation works at the Site. Delivery of these remediation units to the Site is most likely to be *via* lorry mounted crane to enable the remediation units to be positioned in the locations indicated on Figures 13 and 14.

Task 4: Baseline Monitoring

In order to obtain comprehensive and consistent groundwater quality information beneath the Site, and to provide a baseline to measure the performance of the remediation system, a baseline groundwater monitoring visit is proposed comprising the inspection of selected on-Site monitoring and extraction wells for the presence of groundwater and LNAPL, measurement of depths to groundwater and thickness of LNAPL, if present, using an interface probe, and groundwater sampling using low flow methodology.

Monitoring wells to be sampled and analyses to be undertaken are listed in the table below:

<table>
<tr><th colspan="2">Monitoring Wells</th><th>Laboratory Analyses</th></tr>
<tr><td>Alluvium Aquifer</td><td>Raglan Mudstone Formation</td><td rowspan="4">Total Organic Carbon (TOC)
VOC
pH
Methane
Ethane
Ethene
Carbon dioxide
Sulphate
Nitrate
Electrical Conductivity (EC)</td></tr>
<tr><td>Internal:
BH103, BH107, BH108, BH115, BH122, BH909, BH912, BH919, BH922, BH925, BH926 BH928 and RSW7001S-RSW7004S</td><td>Internal:
BH301S, BH301D, BH303S, BH303D and RSW7001D-RSW7004D</td></tr>
<tr><td>External:
BH114A, BH204S, BH400, BH402 BH923 and RSW2006S-RSW2012S,</td><td>External:
BH204D, BH205D, BH304D and RSW2006D-RSW2012D</td></tr>
<tr><td colspan="2">Off Site Wells:
BHOS307, BHOS409, BHOS410, BHOS412 and BHOS414.</td></tr>
</table>

Task 5: ERD Injection and SVE operation

<u>ERD Injection</u>

In the internal remediation area in Zone 3, it is proposed that 329 m^3 of 5% molasses solution are delivered per injection event into the Alluvium and the Raglan Mudstone Formation aquifers using the proposed injection well network.

In the external remediation area in Zone 3, it is proposed 363 m^3 of 5% molasses solution are delivered per injection event into the Alluvium and the Raglan Mudstone Formation aquifers using the recently installed injection well network.

It is proposed four injections are undertaken quarterly over a five to six year period. It is considered that the proposed molasses injection schedule will create anaerobic conditions in the aquifers beneath the Site and effectively increase the biological transformation of TCE to ethane. Injection frequency and timescales will be reviewed and adjusted where necessary to optimize the process.

SVE Operation

The SVE system will be operated in Zone 3 together with the ERD injection system in order to manage the potential for methane generation during the implementation of the IRZ beneath Zone 3. It is estimated that extraction at an air flow rate of 1,000 m^3 per hour will be appropriate to manage the potential for methane generation beneath the Site.

Vapour extracted *via* the SVE system will be treated appropriately by absorbent media or other necessary means before discharging into the atmosphere.

Task 6: Process and Performance Monitoring

Process monitoring will be carried out to observe the establishment of the IRZ due the injection of molasses solution across Zone 3. The establishment of the IRZ can be evaluated based on data collected during the process monitoring and necessary adjustment to the proposed injection schedule can be made accordingly.

It is proposed process monitoring is carried out two months after each injection. Monitoring wells to be sampled and analyses to be undertaken are listed in the table below:

Monitoring Wells		Laboratory Analyses
Alluvium Aquifer	Raglan Mudstone Formation	TOC pH, EC, dissolved oxygen and oxidation reduction potential via probe on site.
Internal: RSW7001S-RSW7004S, BH103, BH107, BH108, BH115, BH122, BH909, BH912, BH919, BH922, BH925, BH926 and BH928.	Internal: RSW7001D-RSW7004D, BH301S, BH301D, BH303S and BH303D.	
External: RSW2006S-RSW2012S	External: RSW2006D-RSW2012D	

Performance monitoring will be carried out to evaluate the biological transformation of TCE beneath Zone 3 and hence to determine the effectiveness of remediation work at the Site.

It is proposed performance monitoring is carried out every six months. It should be noted that the proposed monitoring programme may be altered based on the data collected during these monitoring events. Selected monitoring wells representing groundwater quality beneath Zone 3 will be sampled using low flow methodology and will be submitted to an accredited laboratory for analyses. Monitoring wells to be sampled and analyses to be undertaken during performance monitoring are listed in the table below:

Monitoring Wells		Laboratory Analyses
Alluvium Aquifer	Raglan Mudstone Formation	Total Organic Carbon (TOC)

Monitoring Wells		Laboratory Analyses
Internal: RSW7001S-RSW7004S, BH103, BH107, BH108, BH115, BH122, BH909, BH912, BH919, BH922, BH925, BH926 and BH928.	Internal: RSW7001D-RSW7004D, BH301S, BH301D, BH303S and BH303D.	VOC pH Methane Ethane Ethene Carbon dioxide Sulphate Nitrate Electrical Conductivity (EC) Fermentation products
External: RSW2006S-RSW2012S, BH114, BH204S, BH400, BH402 and BH923.	External: RSW2006D-RSW2012D, BH204D, BH205D and BH304	
Off Site Wells: BHOS307, BHOS409, BHOS410, BHOS412 and BHOS414.		

In addition, it is proposed groundwater samples collected from selected monitoring wells across Zone 3 are submitted for analyses of TPH bi-annually. The rationale behind the analysis of TPH is to assess the degree of dissolution of LNAPL that may potentially occur across Zone 3, due to the potential for generation of biosurfactant during the ERD process, potentially causing an increase in TPH concentrations in groundwater. The proposed monitoring will provide the data to assess variations in TPH concentrations in groundwater, and hence to determine the requirement for potential additional remediation work for management of risks associated with TPH in groundwater.

The existing total fluid pumping system installed for recovery of LNAPL may be altered to extract groundwater contaminated with TPH, if required.

SVE System Monitoring

During the period of *in-situ* remediation, SVE system will be operated automatically and will be visited on a monthly basis to conduct system monitoring and maintenance tasks.

The operating, monitoring and maintenance schedule is designed to meet three key requirements for the operation of the remediation system as follows:

1) To provide data for tracking of system performance and allow necessary adjustments to be made to optimize the system;
2) To ensure reliable operation of the remediation system to minimise downtime, and
3) To meet regulatory requirements for the waste discharge streams.

The SVE system monitoring and maintenance tasks will comprise visual inspection and system operation optimization, as well as the collection of the following data:

- Depth to groundwater and LNAPL, if present, in monitoring well network in Zone 3;
- Power consumption;
- Total SVE air flow rates;
- Applied vacuum in SVE system;
- Pre and post treatment VOC concentrations in extracted vapour;
- Methane, CO_2 and O_2 concentrations in extracted vapour;
- SVE system operation runtime;
- Any other measurement imposed by regulators (*e.g.* noise, background VOC, *etc*).

Task 7: Remediation Verification

It is proposed that injections of molasses should be continued until the result of groundwater monitoring visits show that the remediation criteria have been consistently met in Zone 3, or until the improving effect of continued reagent injections has diminished to low or asymptotic levels. This will be defined on consideration of the following lines of evidence:

- Biological transformation of contaminants; and
- Contaminant Concentration trends in groundwater.

Following completion of the molasses injection, the Site should continue to be monitored in order to verify that the remediation objectives have been successfully met at the Site. Lines of evidence will be collected to verify the success of remediation in managing the potential risks associated with the identified CVOC impacts beneath Zone 3.

The proposed remediation works in Zone 3 area have been designed to effectively manage the potentially active relevant pollutant linkages as far as reasonably practicable using best available technologies and considering costs and benefits. Therefore, following completion of verification monitoring and depending on the results obtained, revision of the DQRA will be undertaken to reassess the potential risks associated with the residual contamination following completion of remediation work at the Site. Cost benefit analyses would also be undertaken.

A detailed Remediation Verification Plan (RVP) for CVOC remediation will be provided separately (ARCADIS Ref: 909363806, January 2012).

Remediation System Decommissioning

The remediation system should be decommissioned and remediation equipment, electricity and system control units should be removed from Site.

Injection, extraction and monitoring wells on the Site should be capped, and if no longer required, decommissioned in accordance with best practice guidance.

7.5 Pollution Prevention and Control

It is anticipated that the proposed remedial strategy will produce only limited quantities of waste. The identified potential waste streams and controls to prevent pollution are summarised below. System monitoring will be carried out in accordance with the requirements of the Environmental Permit for the works.

7.5.1 Volatile Organic Compound Monitoring

The background total VOC level will be measured during the system commissioning using a Photo Ionisation Detector (PID). The trigger level of total VOC for Site boundary is considered as the measured background total VOC plus 5 ppm. Should the operation of the remediation system exceed the trigger level, the operation of the remediation system will be ceased immediately and necessary action will be taken to reduce the VOC level as appropriate.

7.5.2 Dusts, Fibres, Particulates and Aerosols

It is considered that the proposed remediation system at the Site will not generate dust, fibres, particulates and aerosols during operation at the Site.

7.5.3 Waste

Operation of the remediation systems will produce waste streams. The relevant waste streams and proposed controls to prevent pollution are summarised below.

Solid Waste

Solid waste generated by the remediation programme should be disposed of off-Site in accordance with the applicable waste management regulations under Duty of Care documentation.

Liquid Waste

The proposed remediation work at the Site will not generate liquid waste at the Site.

Gaseous Waste

Extracted soil vapour will be passed through an absorbent media to reduce contaminant concentrations and odour prior to discharge to the atmosphere. The air discharge will be monitored during the monthly system monitoring visits and absorbent media renewed as required.

7.5.4 Noise Pollution

Where necessary, noise generated during the remediation operations on-Site will be controlled to prevent excessive noise levels beyond the Site boundary. It is proposed that major works involving heavy plant movement and operation should be undertaken during typical day working hours.

7.5.5 Vehicle Movements

The proposed remediation works will generate a number of vehicle movements associated with the removal of solid waste (soil excavated from trenching *etc*) for disposal as a result of the remediation infrastructure installation, as well as any delivery to the Site of imported material to backfill the trenching. Consideration should be given to the route and the timing of these vehicle movements, to minimise risk and disturbance to sensitive locations (such as schools, residential areas).

Risks associated with the transport of soils that potentially contain CoC, such as dust emission, should be appropriately managed.

The works could create mud debris from vehicle movements and subsequent tracking off-Site on vehicle tyres. Wheel washing should be managed during the works to prevent off-Site mud debris transfer.

8 REGULATORY ISSUES

In developing a remediation strategy for the Site, there are a number of regulatory issues that need to be considered. These include the acceptability of a remediation technique within the UK regulatory framework, and the requirement for a remediation technique to be licensed.

8.1 Abstraction Licence and Discharge Consent

The proposed remediation work will not involve extraction of groundwater from beneath the Site, therefore neither abstraction license nor discharge consent will be required for the remediation works in Zone 3.

8.2 Environmental Permitting

In the UK, contaminated soil and groundwater are considered to be waste. In April 2008, the Environmental Permitting Regulations (EPR) came into effect, replacing the Waste Management Licensing and Pollution Prevention Control regimes. Therefore, the need for a waste management licence, such as a Mobile Treatment Licence (MTL), is now assessed below in terms of the requirement for an Environmental Permit. Exceptions to this are soil excavation and installation of barriers, which are currently considered to lie outside the waste management regime.

At present, an EA enforcement position exists whereby, enforcement action will not normally be pursued where treatment of a volume of less than 1,000 m^3 of contaminated soil or groundwater is carried out, without an Environmental Permit in place, subject to certain criteria, as detailed in the EA Licensing/Permitting Position Statements, Licensing/Permitting Position 1.1 – Trials and small scale remediation schemes:

"Where a small scale remediation scheme or a trial is to be undertaken to determine whether or not a particular remediation technique is suitable to ensure the remediation of contaminated materials, then provided that:

(1) for any Site the total quantity of contaminated material, substances or products treated as part of the trial remediation project does not exceed 1000 m^3; and,

(2) the name, contact address (home or business), and contact telephone numbers of any landowner, developer or contractor involved in the remediation project, details of the technique and dates on Site, are supplied to the Environment Agency area office at least five working days before that project begins, then the Environment Agency will not expect a waste management licence to be obtained to cover these works."

It is considered likely that an Environmental Permit will be required to undertake remediation works for Zone 3.

9 STUDY LIMITATIONS

IMPORANT. This section should be read before reliance is placed on any of the information, opinions, advice, recommendations or conclusions contained in this report.

1 This report has been prepared by ARCADIS(UK) Limited (ARCADIS), with all reasonable skill, care and diligence within the terms of the Appointment and with the resources and manpower agreed with Meritor Heavy Vehicle Braking Systems (UK) Limited (the 'Client') and Meritor, Inc. ARCADIS does not accept responsibility for any matters outside the agreed scope.

2 This report has been prepared for the sole benefit of the Client unless agreed otherwise in writing.

3 Unless stated otherwise, no consultations with authorities or funders or other interested third parties have been carried out. ARCADIS are unable to give categorical assurance that the findings will be accepted by these third parties as such bodies may have unpublished, more stringent objectives. Further work may be required by these parties.

4 All work carried out in preparing this report has used, and is based on, ARCADIS' professional knowledge and understanding of current relevant legislation. Changes in legislation or regulatory guidance may cause the opinion or advice contained in this report to become inappropriate or incorrect. In giving opinions and advice, pending changes in legislation, of which ARCADIS is aware, have been considered. Following delivery of the report, ARCADIS have no obligation to advise the Client or any other party of such changes or their repercussions.

5 This report is only valid when used in its entirety. Any information or advice included in the report should not be relied upon until considered in the context of the whole report.

6 Whilst this report and the opinions made are correct to the best of ARCADIS' belief, ARCADIS cannot guarantee the accuracy or completeness of any information provided by third parties.

7 This report has been prepared based on the information reasonably available during the project programme. All information relevant to the scope may not have been received.

8 This report refers, within the limitations stated, to the condition of the Site at the time of the inspections. No warranty is given as to the possibility of changes in the condition of the Site since the time of the investigation.

9 The content of this report represents the professional opinion of experienced environmental consultants. ARCADIS does not provide specialist legal or other professional advice. The advice of other professionals may be required.

10 Where intrusive investigation techniques have been employed they have been designed to provide a reasonable level of assurance on the conditions. Given the discrete nature of sampling, no investigation technique is capable of identifying all conditions present in all areas. In some cases the investigation is further limited by Site operations, underground obstructions and above ground structures. Unless otherwise stated, areas beyond the boundary of the Site have not been investigated.

11 If below ground intrusive investigations have been conducted as part of the scope, service tracing for safe location of exploratory holes has been carried out. The location of underground services shown on any drawing in this report has been determined by visual observations and electromagnetic techniques. No guarantee can be given that all services have been identified. Additional services, structures or other below ground obstructions, not indicated on the drawing, may be present on Site.

12 Unless otherwise stated the report provides no comment on the nature of building materials, operational integrity of the facility or on any regulatory compliance issues.

13 Unless otherwise stated, samples from the Site (soil, groundwater, building fabric or other samples) have NOT been analysed or assessed for waste classification purposes.

10 REFERENCES

Construction Industry Research and Information Association (CIRIA), 1995. Remedial Treatment for Contaminated Land Volume 4: Classification and Selection of Remedial Methods. CIRIA, London.

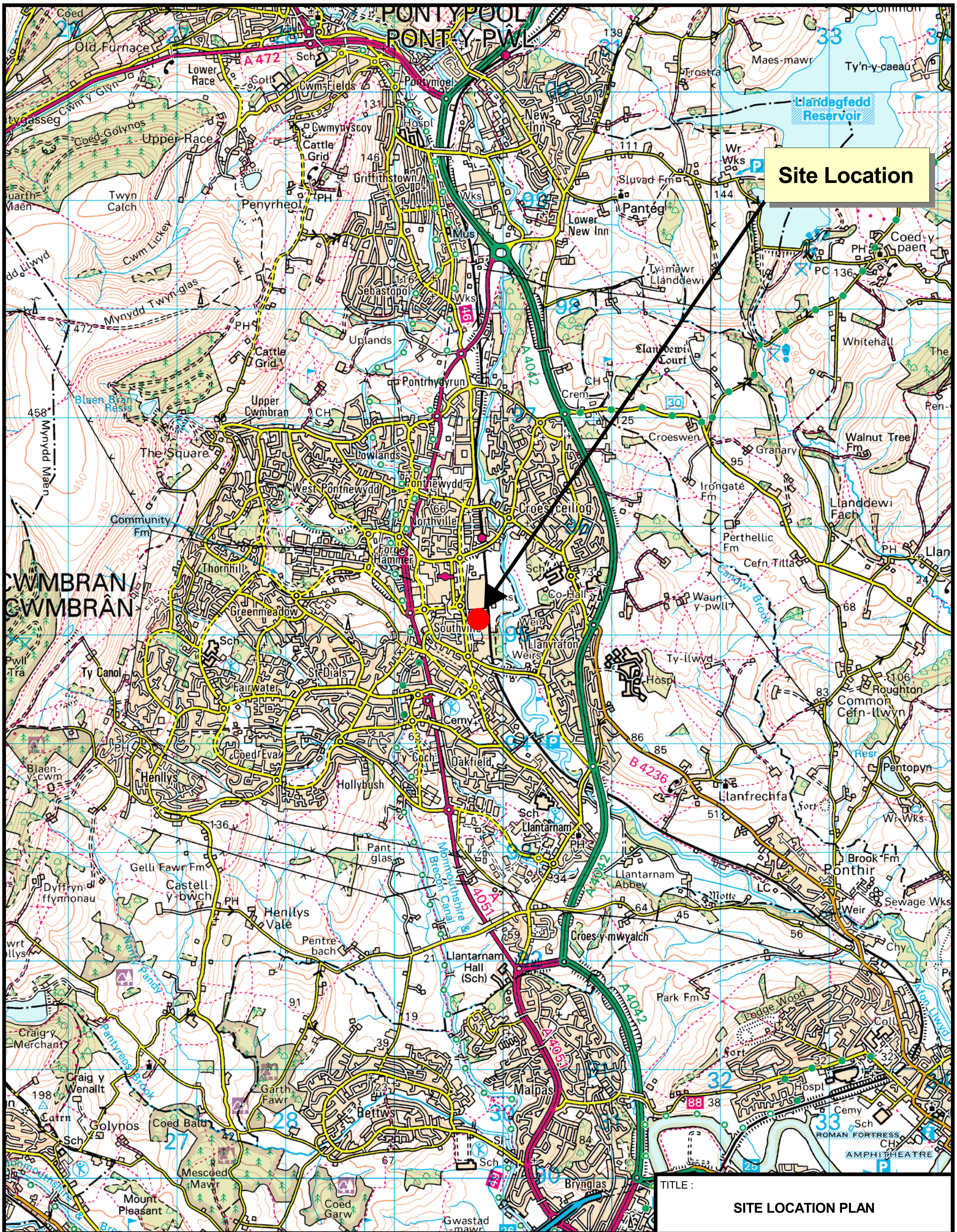
Department for Environment, Food and Rural Affairs (DEFRA) & Environment Agency (EA), 2004. Model Procedures for the Management of Land Contamination (R&D Publication CLR 11).

Environment Agency, 2001. Issues for the Selection of Remedial Strategies. www.environment-agency.gov.uk

Environment Agency 2001. Process Based Remediation of Land Contamination. www.environment-agency.gov.uk

Environment Agency 2001. Remedial Methods for Contaminated Groundwater. www.environment-agency.gov.uk

FIGURES



LEGEND	NOTES
● SITE LOCATION	

TITLE :	SITE LOCATION PLAN
SITE :	CWMBRAN
CLIENT :	MERITOR HVBS (UK) LTD
PROJECT : 90936.38	FIGURE 1
DATE : 26/01/12	DRAWN BY : RJM
DRG No : 909363815.apr / SLP	
SCALE : 1 : 50,000	PRINT : A4

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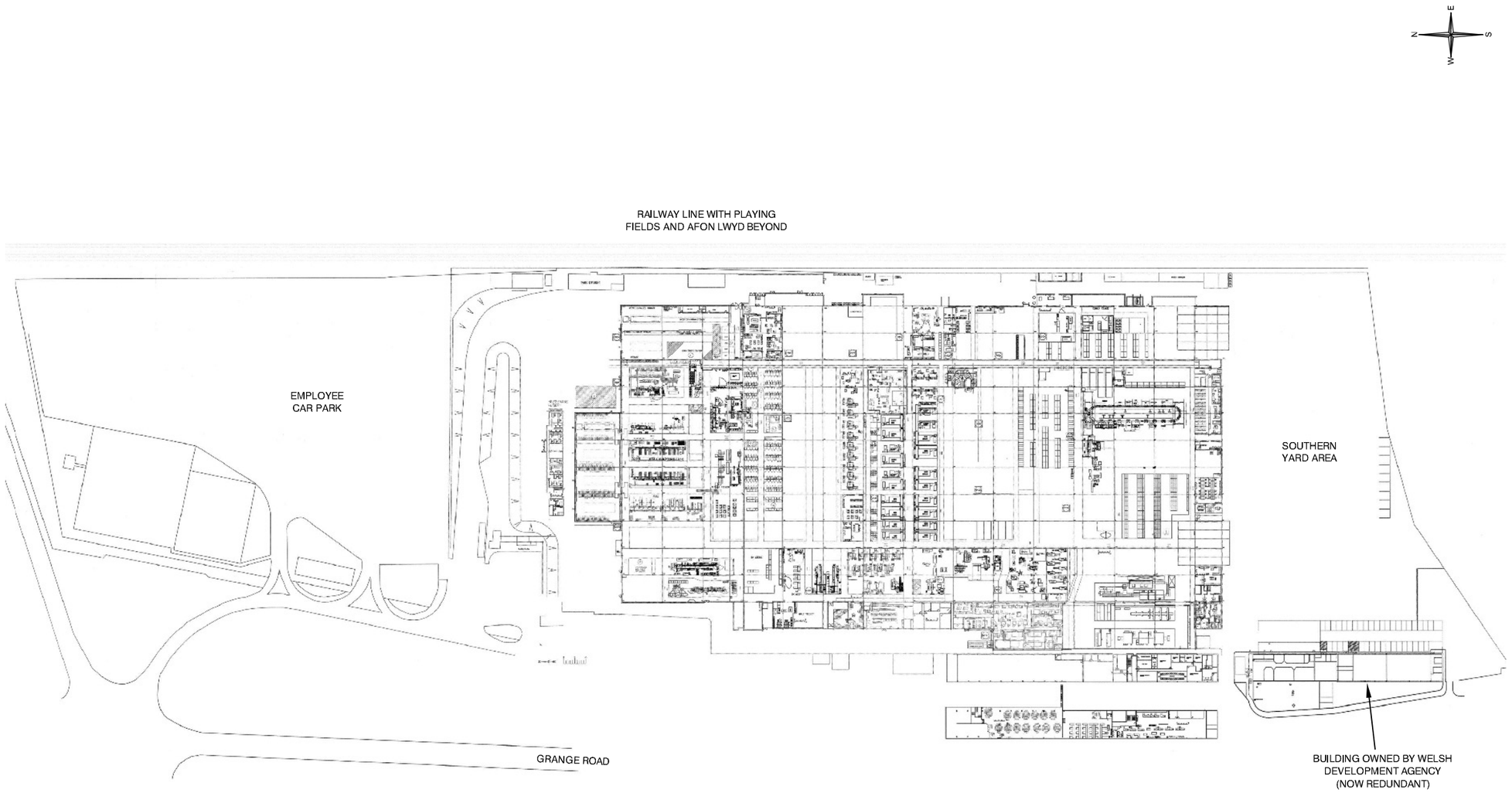

KEY

NOTES

NOT TO SCALE

INTERIOR OF PRODUCTION BUILDING HAS BEED ALTERED RECENTLY

REV	DATE	COMMENT	CAD

TITLE: SITE LAYOUT PLAN 2010

SITE: CWMBRAN

CLIENT: MERITOR HVBS (UK) LTD

PROJECT: 90936.38 | FIGURE 2

DATE: 01/11/11 | DRAWN: ASZ | REV: -

DRG.No.: 909363817-CAD | PRINT: A3

NOTE: ALL ENTITIES SHOWN ON THIS DRAWING ARE TO BE REGARDED AS APPROXIMATE AND ARE INDICATIVE ONLY. NO MEASUREMENTS TAKEN FROM THIS DRAWING SHOULD BE USED FOR THE LOCATION OF INTRUSIVE INVESTIGATION WORKS ON SITE. SYMBOLS FOR BOREHOLES, TRIAL PITS AND OTHER SPECIFIC FEATURES ARE REPRESENTATIONS OF LOCATION ONLY AND UNLESS OTHERWISE SPECIFIED, DO NOT REPRESENT THE TRUE SIZE OF THE FEATURE. - CONTACT ARCADIS UK IN CASE OF ANY QUERY

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LEGEND

- SITE BOUNDARY
- ZONE 1: REDEVELOPMENT FOR SUPERMARKET AND PETROL FILLING STATION
- ZONE 2: REDEVELOPMENT FOR MIXED COMMERCIAL END-USE
- ZONE 3: REFURBISHMENT OF MERITOR FACILITY (REDUCED FOOTPRINT)

NOTES

SYMBOLS FOR BOREHOLES, TRIAL PITS AND OTHER SPECIFIC FEATURES ARE REPRESENTATIONS OF LOCATION ONLY AND UNLESS OTHERWISE SPECIFIED, DO NOT REPRESENT THE TRUE SIZE OF THE FEATURE.

0 10 20 40 60 80 100 Metres

N

TITLE:

FUTURE REDEVELOPMENT ZONES

SITE : **CWMBRAN**

CLIENT : **MERITOR HVBS (UK) LIMITED**

PROJECT :	**90936.38**	**FIGURE 3**	
DATE :	26/01/12	DRAWN BY :	RJM
DRG No. :	909363807 GIS		
SCALE :	**1 : 2,250**	PRINT :	**A3**

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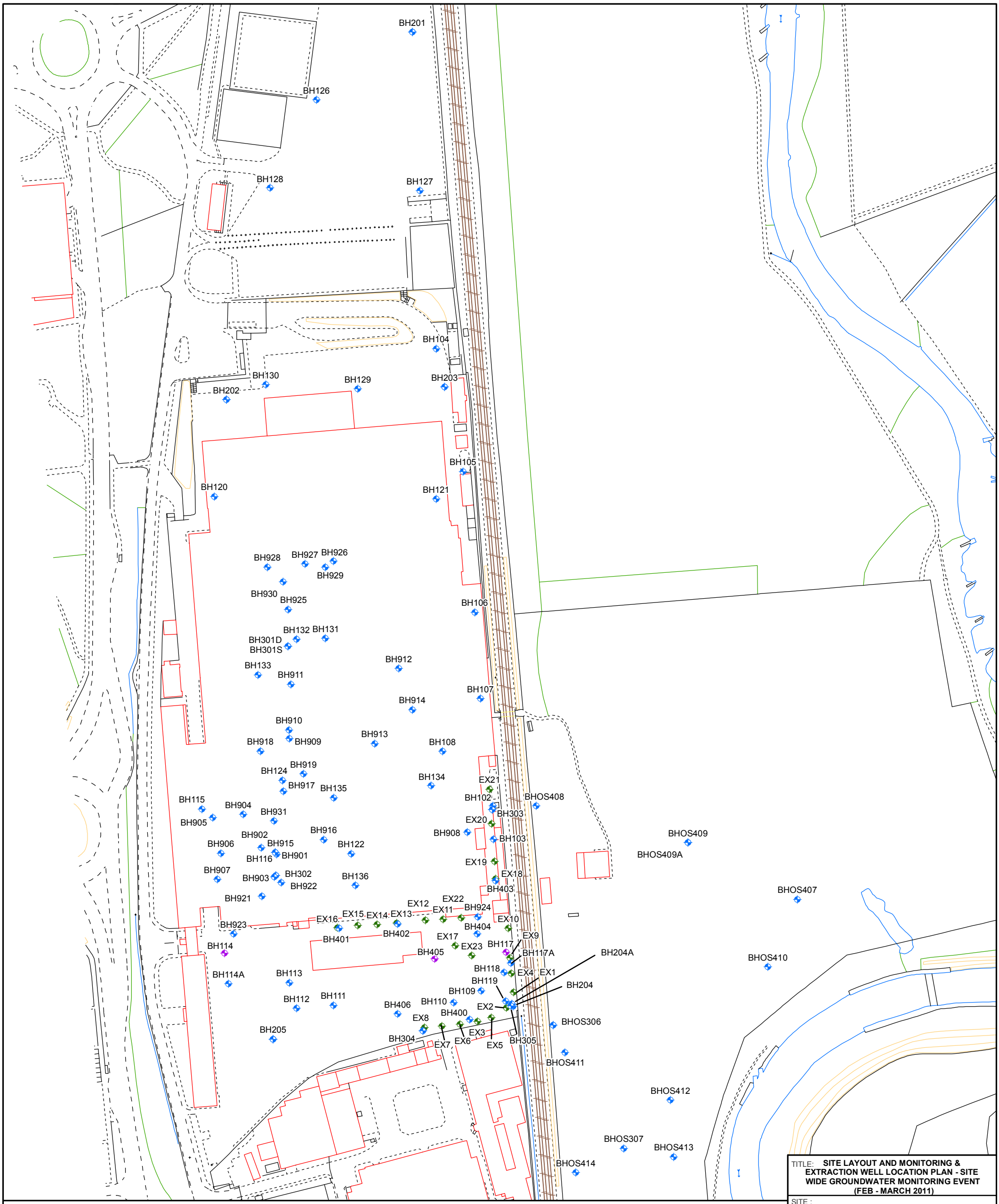

LEGEND

- BOREHOLE, NO MONITORING WELL INSTALLED
- MONITORING WELL
- EXTRACTION WELL

NOTES

SYMBOLS FOR BOREHOLES, TRIAL PITS AND OTHER SPECIFIC FEATURES ARE REPRESENTATIONS OF LOCATION ONLY AND UNLESS OTHERWISE SPECIFIED, DO NOT REPRESENT THE TRUE SIZE OF THE FEATURE.

0 10 20 40 60 80 100 Metres

N

TITLE: **SITE LAYOUT AND MONITORING & EXTRACTION WELL LOCATION PLAN - SITE WIDE GROUNDWATER MONITORING EVENT (FEB - MARCH 2011)**

SITE : **CWMBRAN**

CLIENT : **MERITOR HVBS (UK) LIMITED**

PROJECT :	**90936.38**	**FIGURE 4**	
DATE :	26/01/12	DRAWN BY :	RJM
DRG No. :	909363808 GIS		
SCALE :	**1 : 2,000**	PRINT :	**A3**

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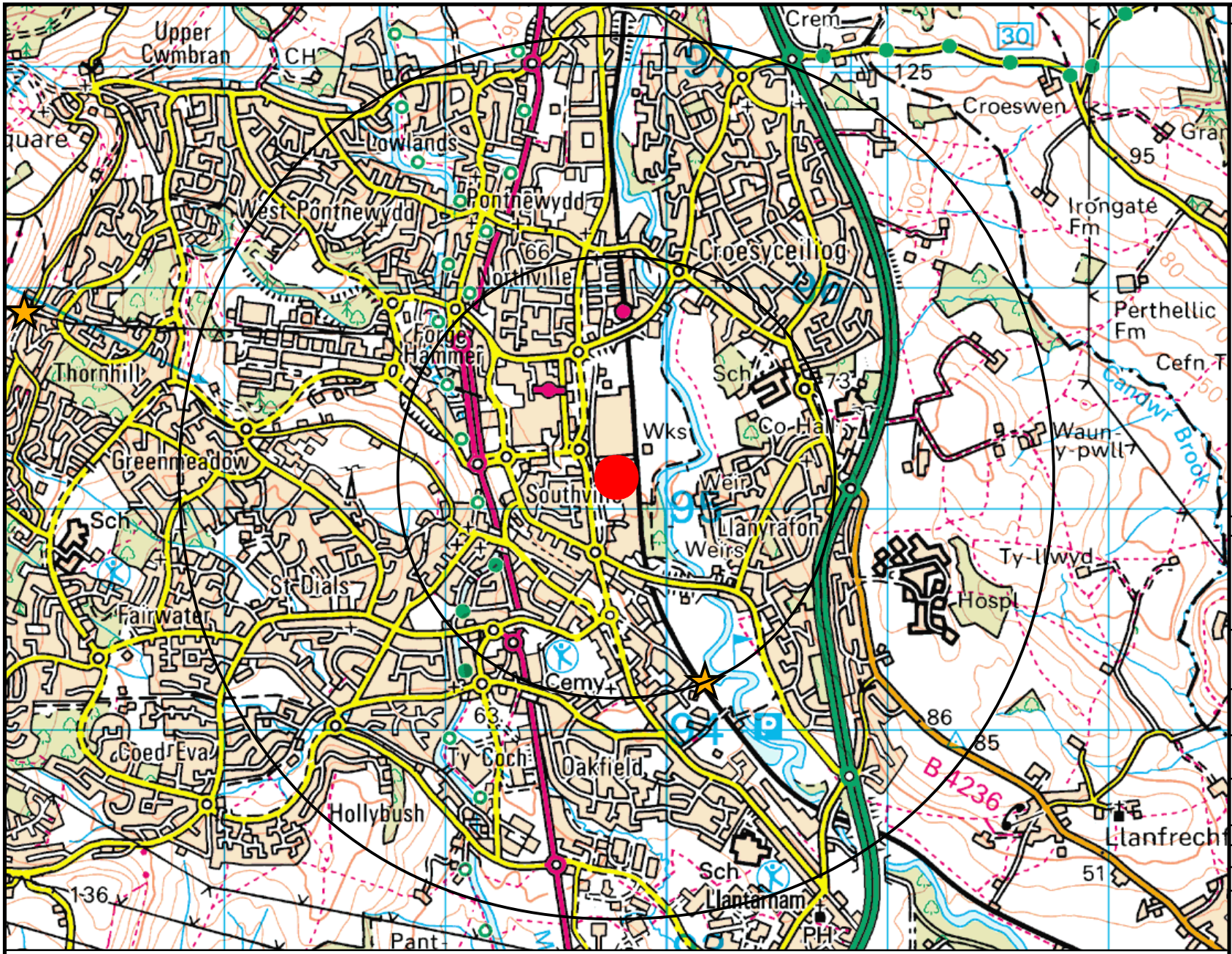

WARNING: THE INFORMATION SHOWN IS DERIVED FROM PUBLICLY AVAILABLE DATA OF REGIONAL SCALE AND IS SUITABLE FOR INITIAL RESPONSE AND PLANNING PURPOSES, BUT IS NOT A SUBSTITUTE FOR INFORMATION FROM SITE. (UPDATED 04/2007)

LEGEND

- SITE LOCATION

SOURCE PROTECTION ZONES

- SPZ 1
- SPZ 2
- SPZ 3

GROUNDWATER ABSTRACTIONS

- WATER SUPPLY
- AGRICULTURAL
- OTHER ABSTRACTIONS (E.G. INDUSTRIAL)
- SURFACE WATER ABSTRACTION

NOTES

CIRCLES ARE AT A RADIUS OF 1km AND 2km FROM THE SITE LOCATION

TITLE :
SOURCE PROTECTION ZONES AND ABSTRACTION MAP

SITE :
CWMBRAN

CLIENT :
MERITOR HVBS (UK) LTD

PROJECT :	90936.38	FIGURE	5
DATE :	26/01/12	DRAWN BY :	RJM
DRG No :	909363815.apr / SPZ		
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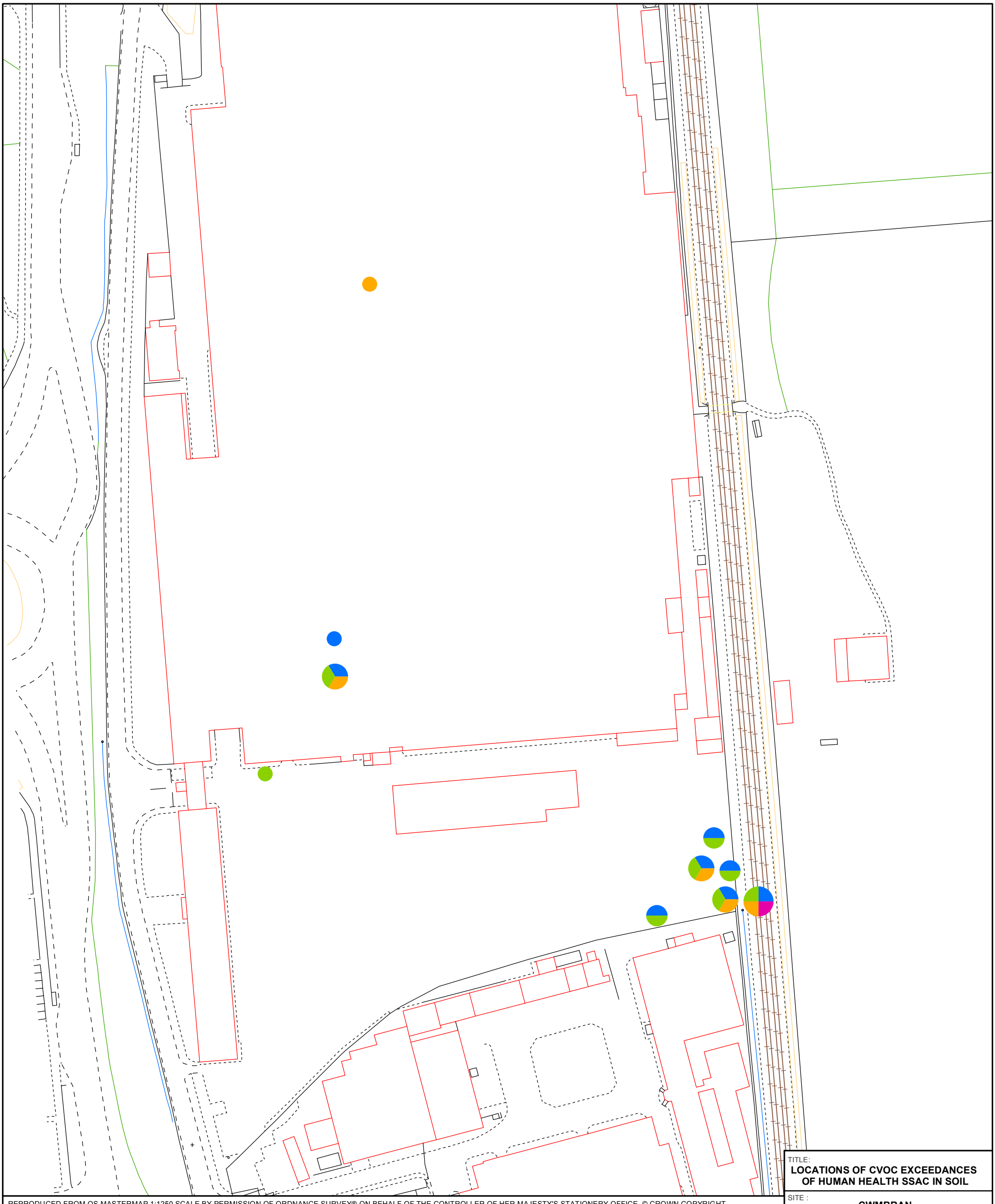

LEGEND

- Vinyl Chloride
- Cis 1,2 Dichloroethene
- Trichloroethene
- Bezno (a) pyrene

NOTES

SYMBOLS FOR BOREHOLES, TRIAL PITS AND OTHER SPECIFIC FEATURES ARE REPRESENTATIONS OF LOCATION ONLY AND UNLESS OTHERWISE SPECIFIED, DO NOT REPRESENT THE TRUE SIZE OF THE FEATURE.

0 4 8 16 24 32 40 Metres

N

TITLE:
LOCATIONS OF CVOC EXCEEDANCES OF HUMAN HEALTH SSAC IN SOIL

SITE : **CWMBRAN**

CLIENT : **MERITOR HVBS (UK) LIMITED**

PROJECT :	**90936.38**	**FIGURE 6**	
DATE :	26/01/12	DRAWN BY :	RJM
DRG No. :	909363814 GIS		
SCALE :	**1 : 1,200**	PRINT :	**A3**

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LEGEND

- TRICHLOROETHENE
- VINYL CHLORIDE
- CIS-1,2-DICHLOROETHENE
- TETRACHLOROETHENE
- TRANS-1,2-DICHLOROETHENE

NOTES

SYMBOLS FOR BOREHOLES, TRIAL PITS AND OTHER SPECIFIC FEATURES ARE REPRESENTATIONS OF LOCATION ONLY AND UNLESS OTHERWISE SPECIFIED, DO NOT REPRESENT THE TRUE SIZE OF THE FEATURE.

0 10 20 40 60 80 100 Metres

N

TITLE: **LOCATIONS OF CVOC EXCEEDANCES OF WR SSAC IN SOIL**

SITE : **CWMBRAN**

CLIENT : **MERITOR HVBS (UK) LTD**

PROJECT :	**90936.38**	**FIGURE 7**	
DATE :	26/01/12	DRAWN BY :	RJM
DRG No. :	909363813 GIS		
SCALE :	**1 : 2,000**	PRINT :	**A3**

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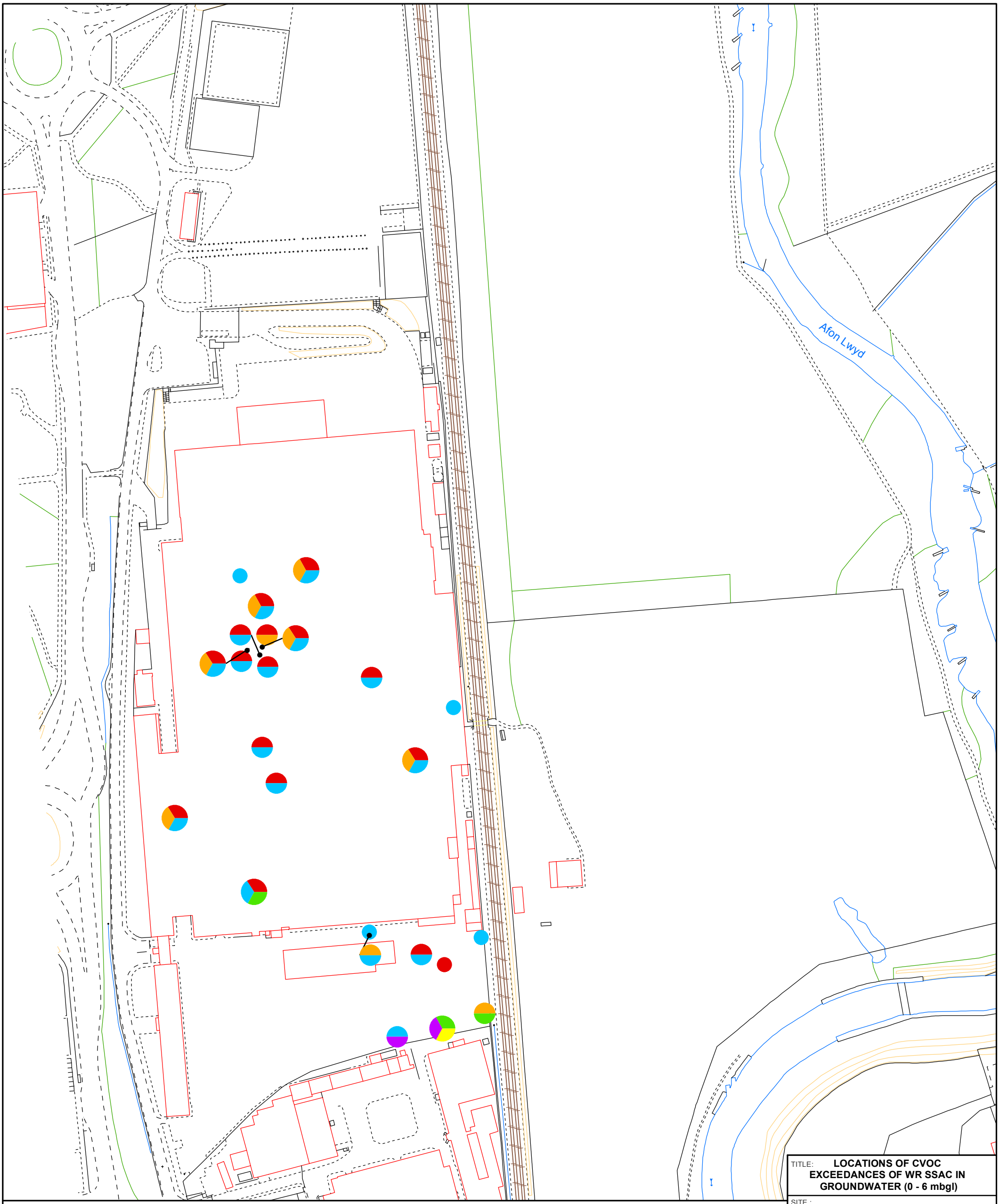

LEGEND

- TRICHLOROETHENE
- VINYL CHLORIDE
- CIS-1,2-DICHLOROETHENE
- TETRACHLOROETHENE
- TRANS-1,2-DICHLOROETHENE
- 1,1,2-TRICHLOROETHANE

NOTES

SYMBOLS FOR BOREHOLES, TRIAL PITS AND OTHER SPECIFIC FEATURES ARE REPRESENTATIONS OF LOCATION ONLY AND UNLESS OTHERWISE SPECIFIED, DO NOT REPRESENT THE TRUE SIZE OF THE FEATURE.

BASED ON MOST RECENT DATA COLLECTED IN NOVEMBER 2011

0 10 20 40 60 80 100 Metres

N

TITLE: **LOCATIONS OF CVOC EXCEEDANCES OF WR SSAC IN GROUNDWATER (0 - 6 mbgl)**

SITE : **CWMBRAN**

CLIENT : **MERITOR HVBS (UK) LTD**

PROJECT :	**90936.39**	**FIGURE 8a**	
DATE :	26/01/12	DRAWN BY :	AP
DRG No. :	909363809 GIS		
SCALE :	**1 : 2,000**	PRINT :	**A3**

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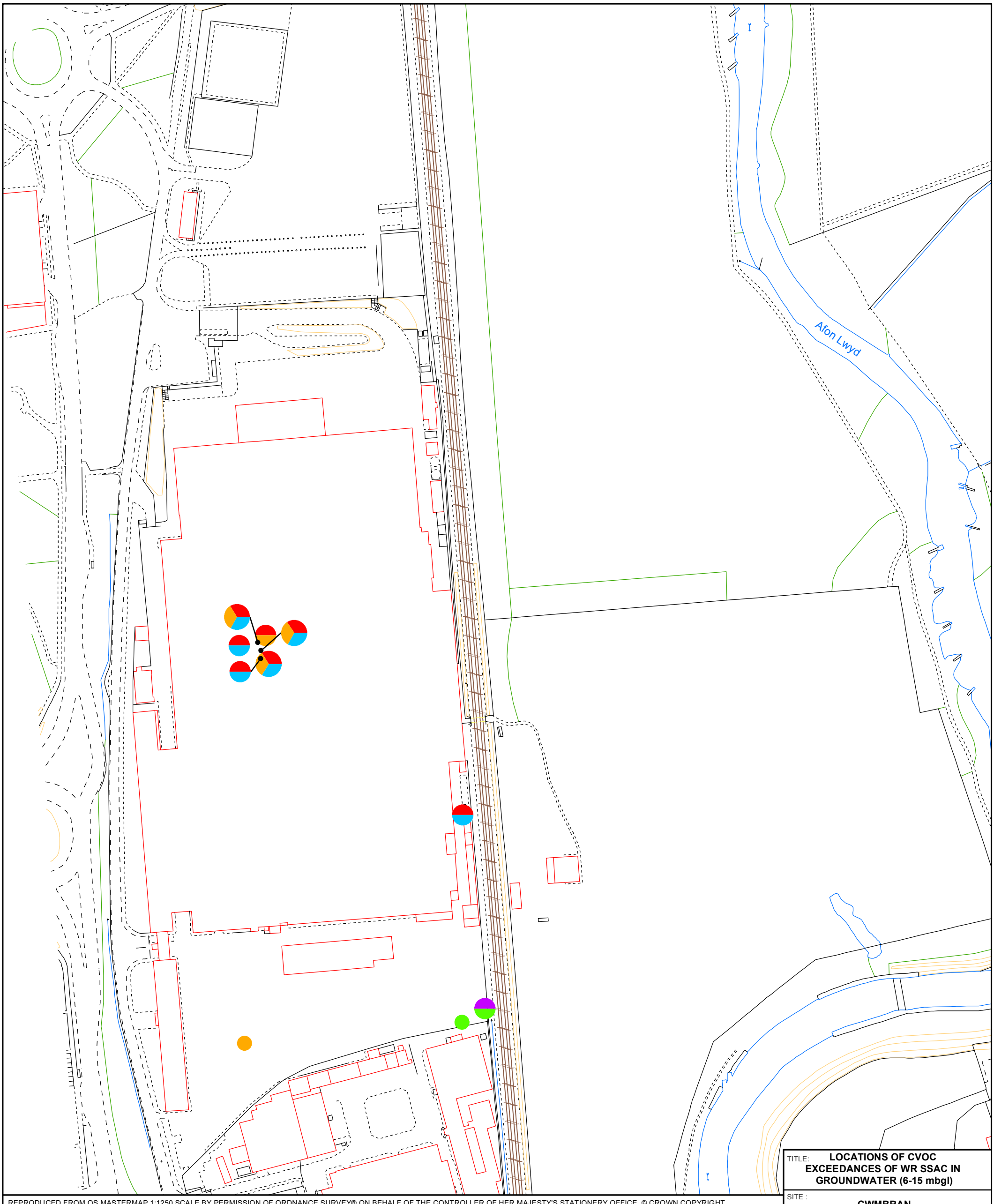

LEGEND

- TRICHLOROETHENE
- VINYL CHLORIDE
- CIS-1,2-DICHLOROETHENE
- TETRACHLOROETHENE
- TRANS-1,2-DICHLOROETHENE

NOTES

SYMBOLS FOR BOREHOLES, TRIAL PITS AND OTHER SPECIFIC FEATURES ARE REPRESENTATIONS OF LOCATION ONLY AND UNLESS OTHERWISE SPECIFIED, DO NOT REPRESENT THE TRUE SIZE OF THE FEATURE.

BASED ON MOST RECENT DATA COLLECTED IN NOVEMBER 2011

0 10 20 40 60 80 100 Metres

N

TITLE: **LOCATIONS OF CVOC EXCEEDANCES OF WR SSAC IN GROUNDWATER (6-15 mbgl)**

SITE : **CWMBRAN**

CLIENT : **MERITOR HVBS (UK) LTD**

PROJECT :	**90936.38**	**FIGURE 8b**	
DATE :	26/01/12	DRAWN BY :	AP
DRG No. :	909363810 GIS		
SCALE :	**1 : 2,000**	PRINT :	**A3**

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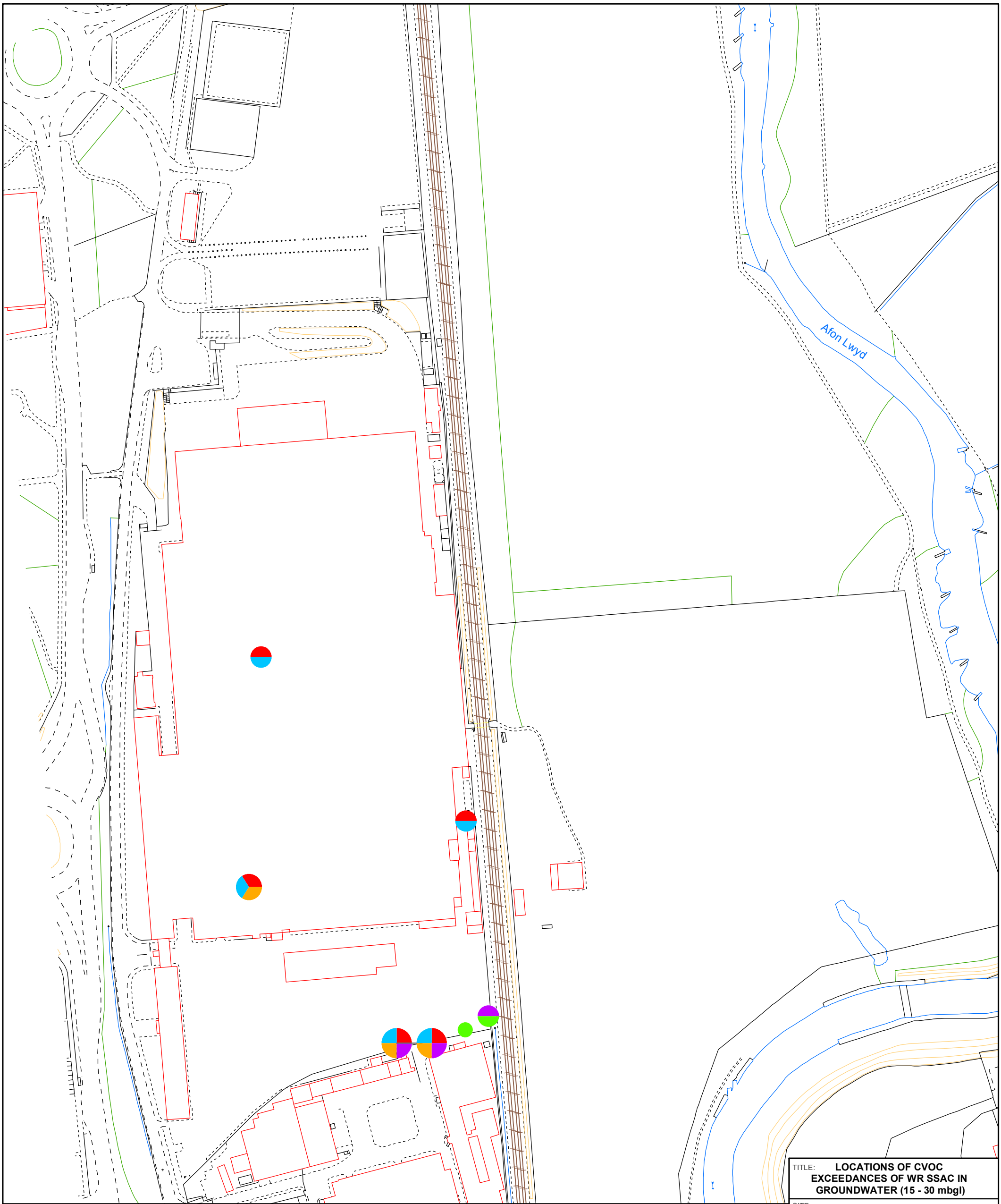

LEGEND

- TRICHLOROETHENE
- VINYL CHLORIDE
- CIS-1,2-DICHLOROETHENE
- TETRACHLOROETHENE
- TRANS-1,2-DICHLOROETHENE

NOTES

SYMBOLS FOR BOREHOLES, TRIAL PITS AND OTHER SPECIFIC FEATURES ARE REPRESENTATIONS OF LOCATION ONLY AND UNLESS OTHERWISE SPECIFIED, DO NOT REPRESENT THE TRUE SIZE OF THE FEATURE.

BASED ON MOST RECENT DATA COLLECTED IN NOVEMBER 2011

0 10 20 40 60 80 100 Metres

N

TITLE: **LOCATIONS OF CVOC EXCEEDANCES OF WR SSAC IN GROUNDWATER (15 - 30 mbgl)**

SITE : **CWMBRAN**

CLIENT : **MERITOR HVBS (UK) LTD**

PROJECT :	**90936.38**	**FIGURE 8c**	
DATE :	26/01/12	DRAWN BY :	AP
DRG No. :	909363811 GIS		
SCALE :	**1 : 2,000**	PRINT :	**A3**

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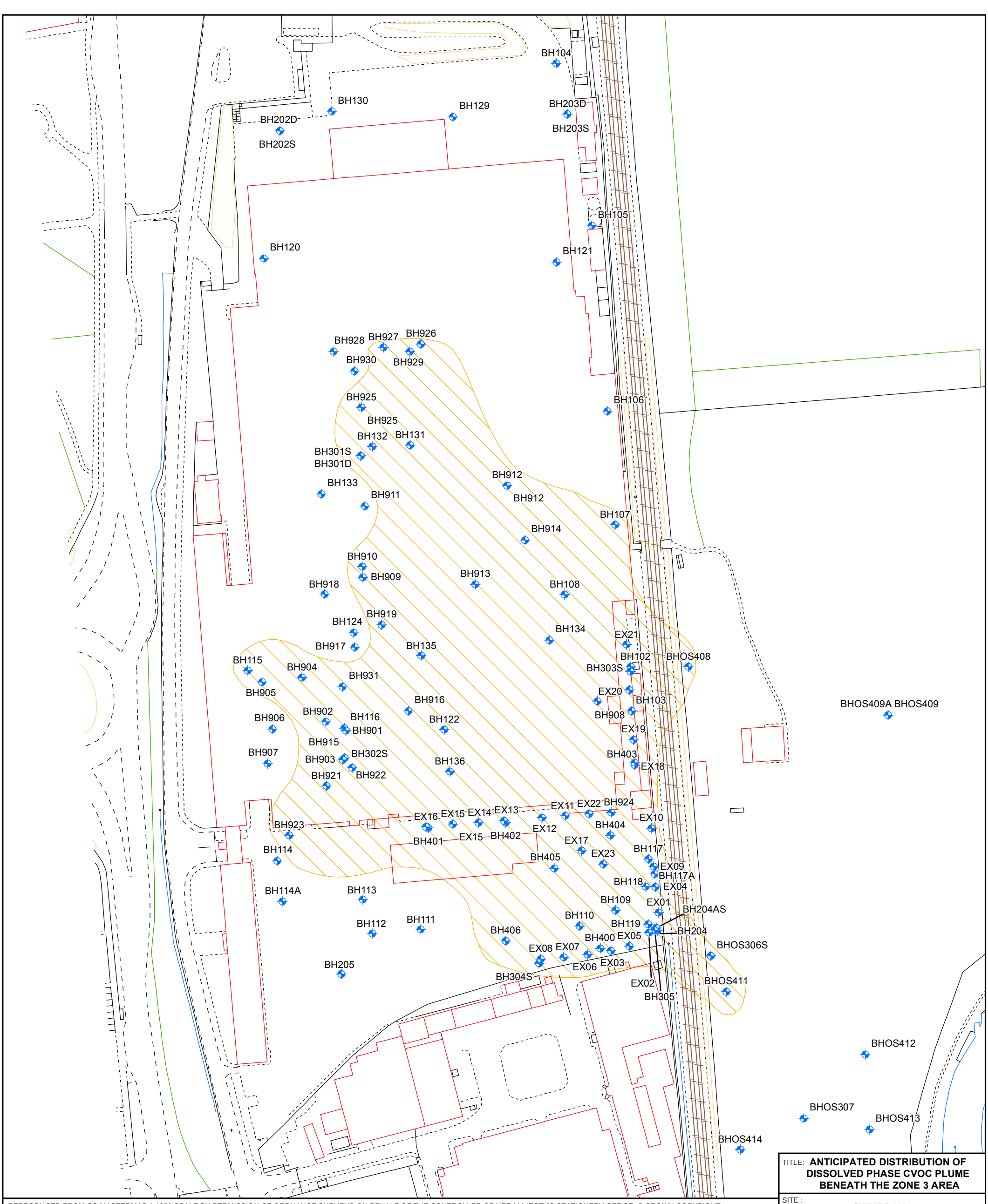

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LEGEND

- BOREHOLE LOCATIONS
- CVOC CONCENTRATION IN GROUNDWATER > SSAC

NOTES

SYMBOLS FOR BOREHOLES, TRIAL PITS AND OTHER SPECIFIC FEATURES ARE REPRESENTATIONS OF LOCATION ONLY AND UNLESS OTHERWISE SPECIFIED, DO NOT REPRESENT THE TRUE SIZE OF THE FEATURE.

0 10 20 40 60 80 100 Metres

N

TITLE: **ANTICIPATED DISTRIBUTION OF DISSOLVED PHASE CVOC PLUME BENEATH THE ZONE 3 AREA**

SITE : **CWMBRAN**

CLIENT : **MERITOR HVBS (UK) LTD**

PROJECT :	**90936.38**	**FIGURE 9**	
DATE :	26/01/12	DRAWN BY :	RJM
DRG No. :	909363812 GIS		
SCALE :	**1 : 1,500**	PRINT :	**A3**

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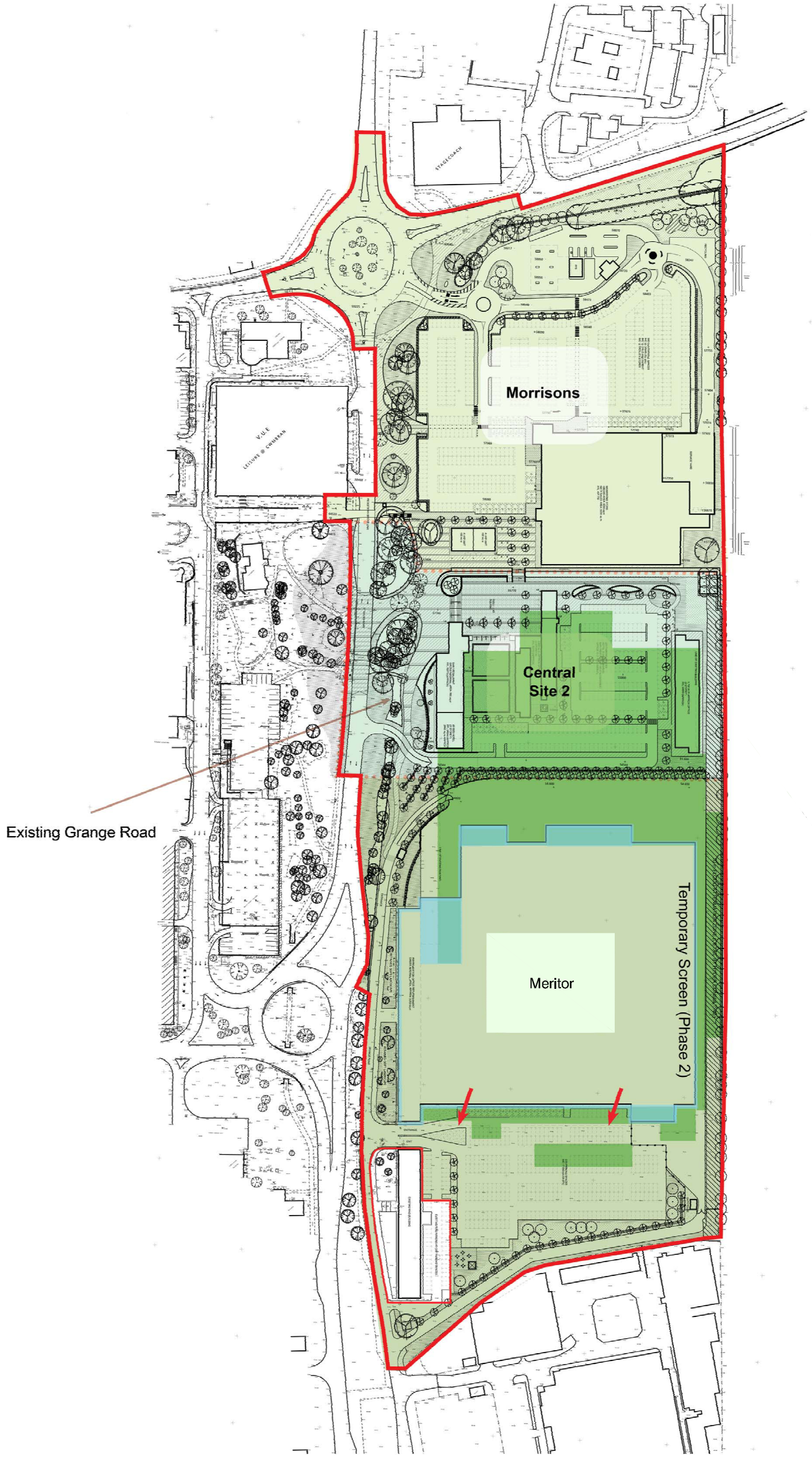

DISCLAIMER	NOTES	KEY
NOTE: ALL ENTITIES SHOWN ON THIS DRAWING ARE TO BE REGARDED AS APPROXIMATE AND ARE INDICATIVE ONLY. NO MEASUREMENTS TAKEN FROM THIS DRAWING SHOULD BE USED FOR THE LOCATION OF INTRUSIVE INVESTIGATION WORKS ON SITE. SYMBOLS FOR BOREHOLES, TRIAL PITS AND OTHER SPECIFIC FEATURES ARE REPRESENTATIONS OF LOCATION ONLY AND UNLESS OTHERWISE SPECIFIED, DO NOT REPRESENT THE TRUE SIZE OF THE FEATURE. - CONTACT ARCADIS UK IN CASE OF ANY QUERY	BASED ON DRAWING BY DLA ARCHITECTURE. DRAWING No:2000-027/503 DATE:JAN 2011 NOT TO SCALE	MORRISONS SITE DEMOLITIONS TO EXISTING MERITOR FACTORY EXISTING AND RECLADDING TO THE MERITOR FACTORY

TITLE: PROPOSED REDEVELOPMENT PLAN		SITE: CWMBRAN	
PROJECT: 90936.38		CLIENT: MERITOR HVBS (UK) LTD	FIGURE 10
DATE: 01/11/11	PRINT: A3		
DRAWN BY: ASZ	REV: -		
DRG.No.: 909363818-CAD			

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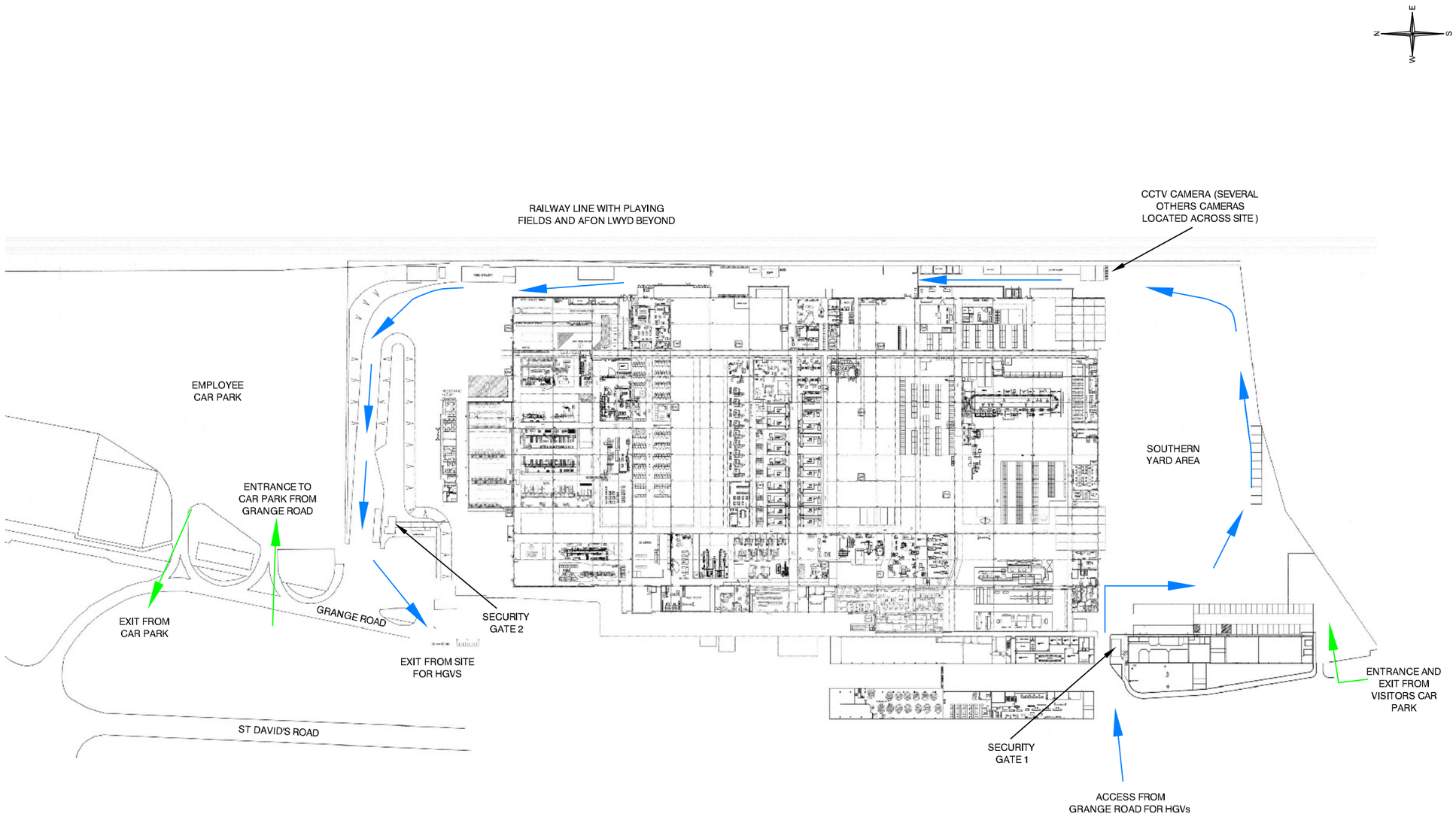

KEY

ONE WAY SYSTEM FOR HGVs AROUND SITE

ENTRANCE AND EXITS FROM SITE CAR PARKS

NOTES

NOT TO SCALE

CCTV = CLOSED CIRCUIT TELEVISION

REV	DATE	COMMENT	CAD

TITLE: CURRENT SITE LAYOUT, ACCESS AND SECURITY PLAN

SITE: CWMBRAN

CLIENT: MERITOR HVBS (UK) LTD

PROJECT: 90936.38 | FIGURE 11

DATE: 01/11/11 | DRAWN: ASZ | REV: -

DRG.No.: 909363819-CAD | PRINT: A3

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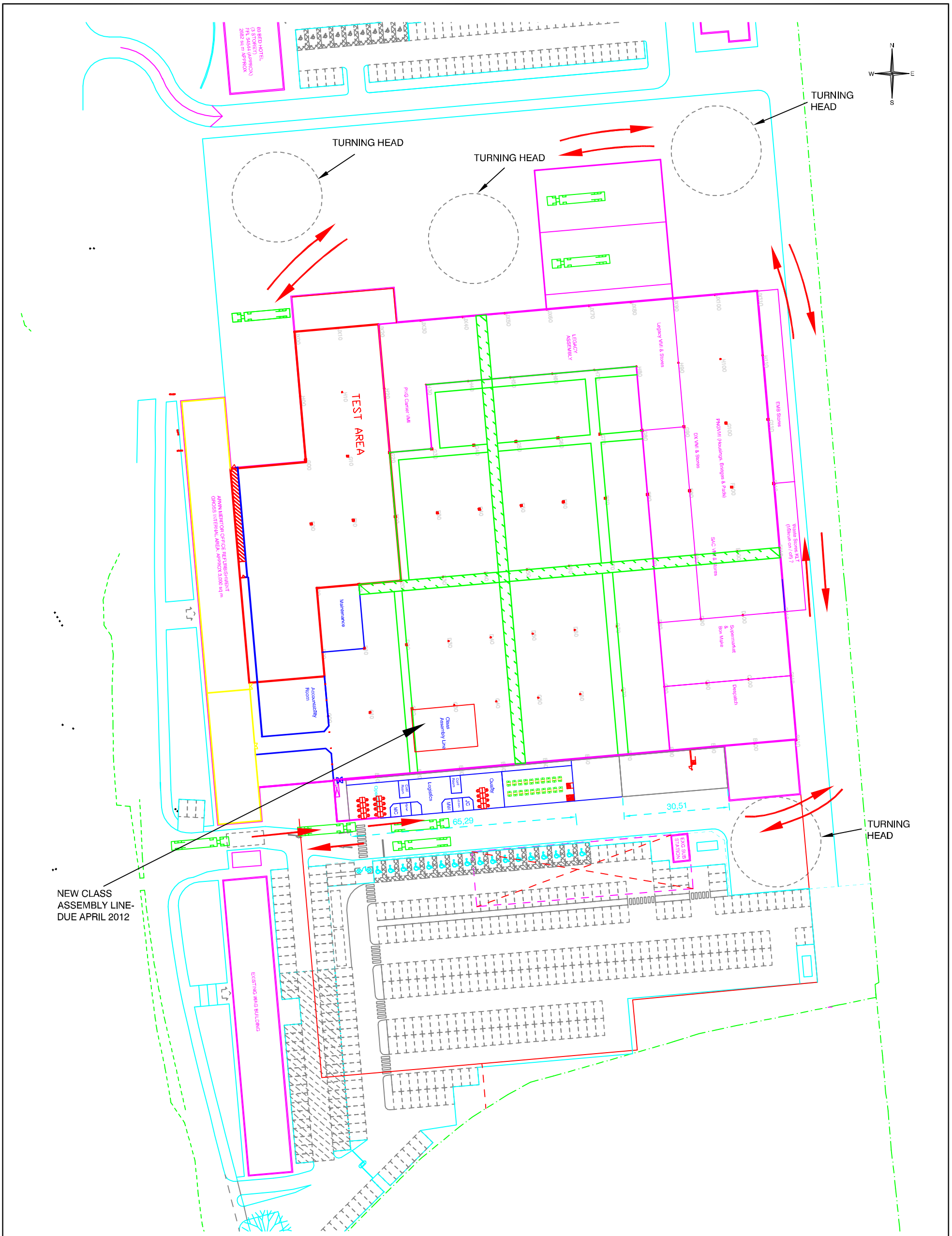

DISCLAIMER	NOTES	KEY
NOTE: ALL ENTITIES SHOWN ON THIS DRAWING ARE TO BE REGARDED AS APPROXIMATE AND ARE INDICATIVE ONLY. NO MEASUREMENTS TAKEN FROM THIS DRAWING SHOULD BE USED FOR THE LOCATION OF INTRUSIVE INVESTIGATION WORKS ON SITE. SYMBOLS FOR BOREHOLES, TRIAL PITS AND OTHER SPECIFIC FEATURES ARE REPRESENTATIONS OF LOCATION ONLY AND UNLESS OTHERWISE SPECIFIED, DO NOT REPRESENT THE TRUE SIZE OF THE FEATURE. - CONTACT ARCADIS UK IN CASE OF ANY QUERY	BASED ON DRAWING BY CLIENT DRAWING No: NLC 17-12 EMPTY V1 ERD ENHANCED REDUCTIVE DECHLORINATION	TRAFFIC

TITLE: PROPOSED ACCESS AND SECURITY ZONE 3 PLAN		SITE: CWMBRAN	
PROJECT: 90936.38		CLIENT: MERITOR HVBS (UK) LIMITED	FIGURE 12
DATE: 01/02/12	PRINT: A3		
DRAWN BY: AP	REV: -		
DRG.No.: 909363823-CAD			

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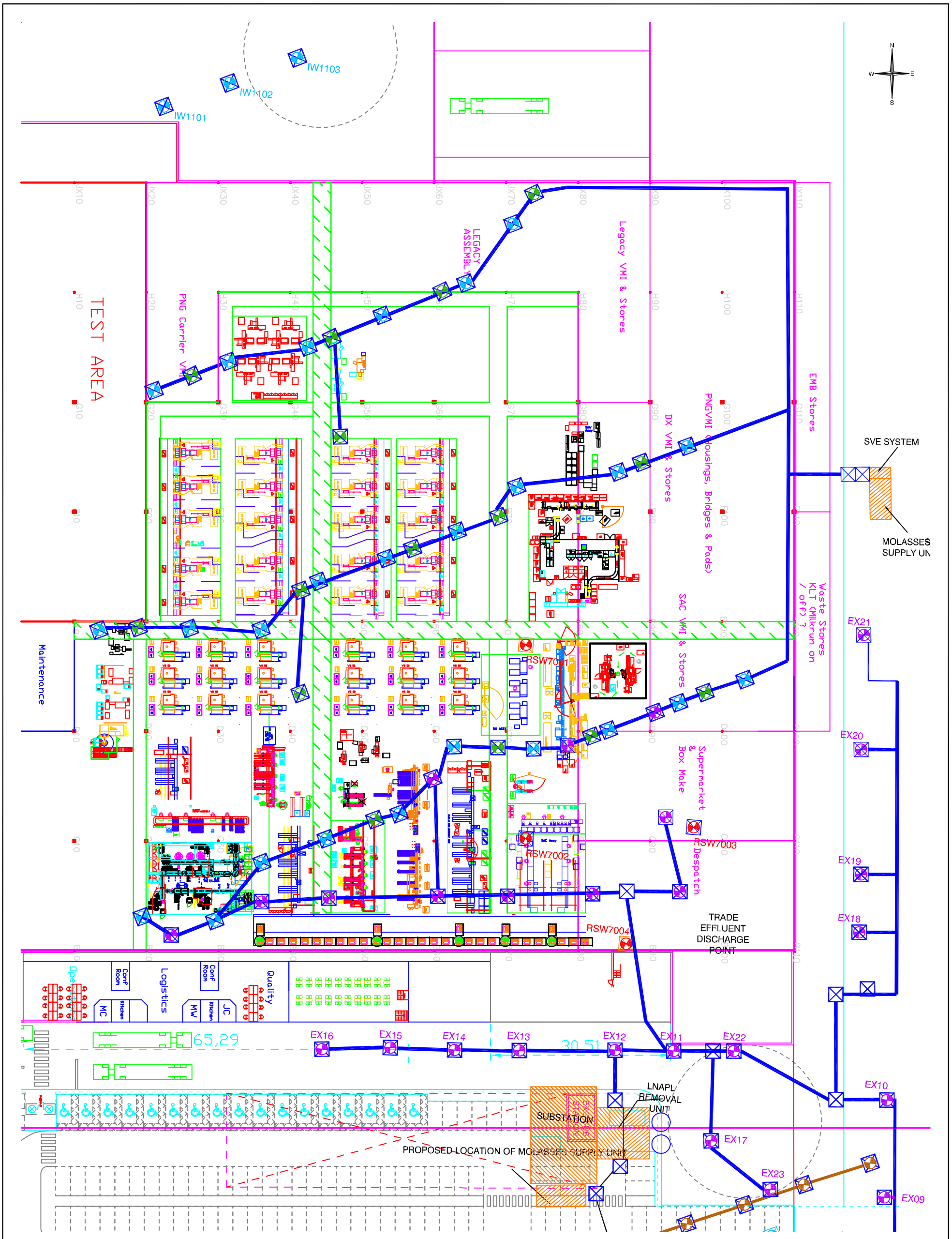

DISCLAIMER	NOTES	KEY
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TITLE: PROPOSED INTERNAL REMEDIATION SYSTEM LAYOUT PLAN		SITE: CWMBRAN	
PROJECT: 90936.38		CLIENT: MERITOR HVBS (UK) LIMITED	FIGURE 13
DATE: 14/02/12	PRINT: A3		
DRAWN BY: AP	REV: -		
DRG.No.: 909363824-CAD			

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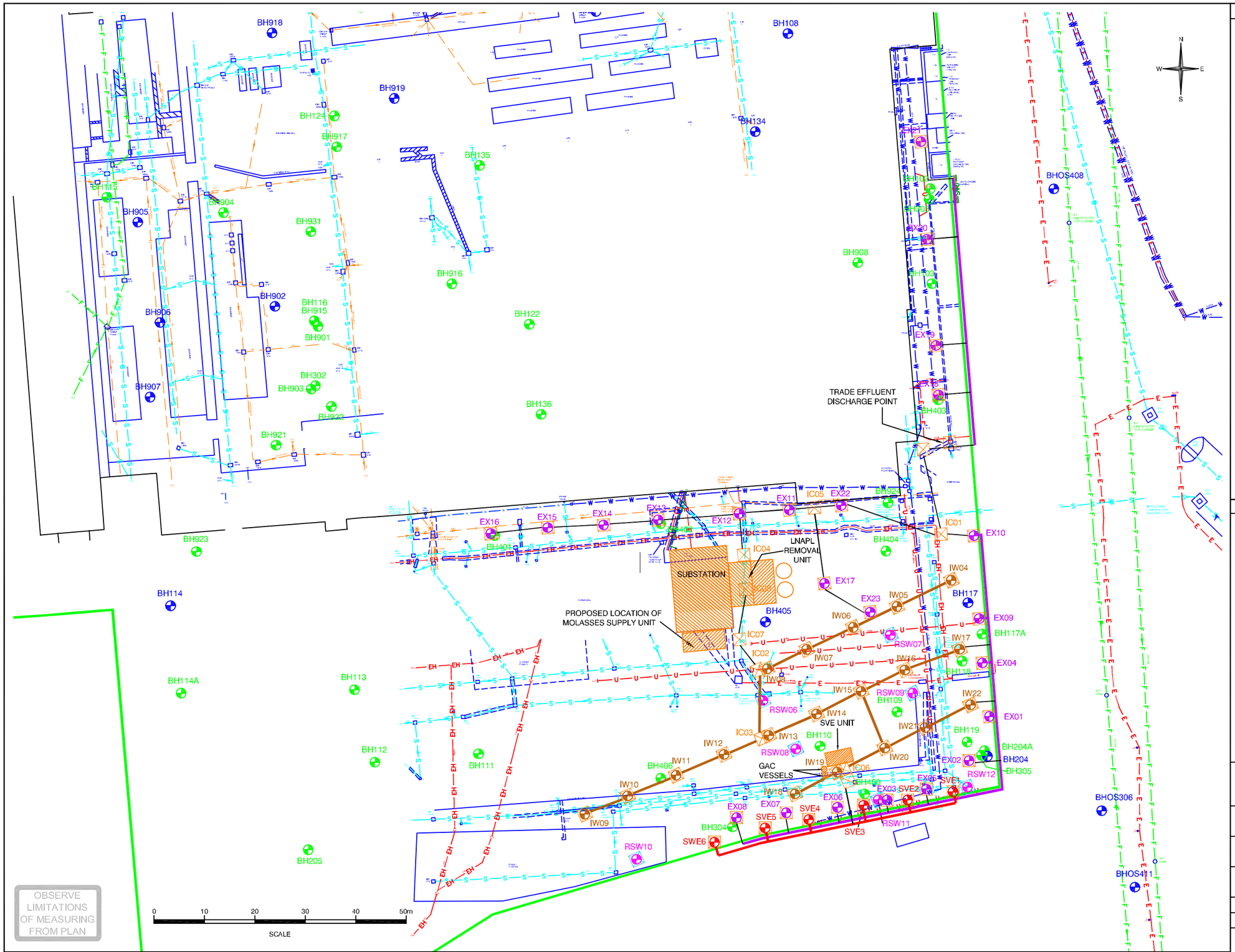

OBSERVE LIMITATIONS OF MEASURING FROM PLAN

KEY

- BOREHOLE LOCATION
- MONITORING WELL LOCATION
- MOLASSES INJECTION WELL LOCATION
- SVE EXTRACTION WELL LOCATION
- INSPECTION CHAMBER
- ADDITIONAL ERD MONITORING WELLS
- PIPEWORK UNDER GROUND
- LNAPL PIPEWORK ABOVE GROUND
- SVE PIPEWORK ABOVE GROUND
- P — FUEL LINE - PETROL
- D — FUEL LINE - DIESEL, KERO OR PARAFFIN
- E — ELECTRICITY CABLE
- HIGH VOLTAGE ELECTRICITY CABLE
- G — TANK GAUGE LINE OR COMMS CABLE
- OFF-SET FILL
- V — VENT PIPE
- OIL PIPE
- T — TELECOM CABLE
- BT CABLE
- CABLE TELEVISION
- GAS
- W — WATER SUPPLY PIPE
- F — FOUL WATER DRAIN
- S — SURFACE WATER DRAIN
- C — COMBINED DRAIN
- U — UNIDENTIFIED - SEE NOTES
- END OF TRACE

NOTES

BASED ON DRAWING BY SITE VISION SURVEYS
DRAWING No: 0911-ARC-5136
DATE: 07/10/2011

ERD ENHANCED REDUCTIVE DECHLORINATION

NOT FOR SITE USE

TITLE: EXTERNAL REMEDIATION SYSTEM LAYOUT PLAN (AS BUILT)

SITE: CWMBRAN

CLIENT: MERITOR HVBS (UK) LIMITED

PROJECT: 90936.38		FIGURE 14
DATE: 07/12/11	DRAWN: AP	REV: -
DRG.No.: 909363820-CAD		PRINT: A3

NOTE: THE LOCATIONS OF ANY UNDERGROUND SERVICES SHOWN ON THIS DRAWING HAVE BEEN DETERMINED USING ELECTRO-MAGNETIC TECHNIQUES AND VISUAL OBSERVATIONS. THIS DRAWING HAS BEEN CREATED FROM AN ELECTRONICALLY SURVEYED BASE PLAN. THE LIMITATIONS OF THIS DRAWING SHOULD BE REALISED AND NO GUARANTEE CAN BE GIVEN THAT ALL SERVICES HAVE BEEN IDENTIFIED. ANY AMENDMENTS TO THE SITE LAYOUT AFTER THE ISSUE OF THIS DRAWING WILL MAKE THIS DRAWING INVALID. THIS DRAWING SHOULD BE CROSS CHECKED AGAINST UTILITY SERVICE PROVIDER PLANS IF USED FOR THE LOCATION OF INTRUSIVE INVESTIGATION WORKS ON SITE. SYMBOLS FOR BOREHOLES, TRIAL PITS AND OTHER SPECIFIC FEATURES ARE REPRESENTATIONS OF LOCATION ONLY AND UNLESS OTHERWISE SPECIFIED, DO NOT REPRESENT THE TRUE SIZE OF THE FEATURE. CONTACT ARCADIS UK IN CASE OF ANY QUERY

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APPENDICES

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Appendix A
Legislative Context and Regulatory Guidance

APPENDIX A
Legislative Context and Regulatory Guidance

Land contamination is generally dealt with by the following types of regulation:

- Acts of Parliament to investigate and remedy harm caused by land contamination;
- Conditions placed upon Planning Permissions for the redevelopment of land; and,
- Acts of Parliament and Regulations for the control of waste.

In Wales land contamination is identified and dealt with through Acts / Regulations including:

- The Contaminated Land (Wales) Regulations (2006);
- Part 2A of the Environmental Protection Act (1990);
- The Environment Act 1995;
- The Town and Country Planning Act (1990);
- The Environmental Permitting (England and Wales) Regulations (2007);
- The Water Resources Act (1991);
- The Water Act (2003);
- The Environmental Damage (Prevention and Remediation) (Wales) Regulations (2009); and,
- The Groundwater (England and Wales) Regulations (2009).

Part 2A of the Environmental Protection Act 1990

Part 2A of the Environmental Protection Act 1990 (which was inserted by Section 57 of the Environment Act 1995) created a regime for the identification and remediation of contaminated land. Section 78A(2) of the Environmental Protection Act 1990 defines contaminated land for the purposes of Part 2A as:

'*any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that;*
(a) significant harm is being caused or there is a significant possibility of such harm being caused; or
(b) pollution of controlled waters is being, or is likely to be caused.'[1]

Harm is defined under section 78A of the Environmental Protection Act as meaning 'harm to the health of living organisms or other interference with the ecological systems of which they form part and, in the case of man, includes harm to his property'. Types of harm are related to specific receptors in order to determine whether they can be regarded as "significant", as defined in Table A of Part 3 of the Welsh Assembly Government (2006)[2] statutory guidance.

Part 2A sets the definition of contaminated land within the context of the 'suitable for use' approach. The legal definition of contaminated land is also discussed within Statutory Guidance released by DEFRA (2008)[3], although this is currently only applicable for England the paper was prepared in consultation with the other UK countries.

The 'suitable for use' approach underlies the assessment process, and is based on the principles of risk assessment, including the concept of the 'pollutant linkage'.

In the event that there are unacceptable levels of risk posed by a Site, a remediation notice can be served under the contaminated land regime introduced under Part 2A of the Environmental Protection Act 1990.

[1] Definition to be amended to "significant pollution of controlled waters is being caused or there is a significant possibility of such pollution being caused" under the Water Act 2003
[2] Part 2A. Statutory Guidance on Contaminated Land. Welsh Assembly Government, December 2006
[3] Guidance on the legal definition of contaminated land. DEFRA July 2008

Regulation of Development on Land Affected by Contamination

Management of risks from contamination in development of land is also regulated in Wales under the Town and Country Planning Act 1990. Land contamination is a material planning consideration within this planning regime. The Local Planning Authority may impose conditions on the development during planning that include preliminary risk assessment, Site investigation, risk assessment and remediation. The Environment Agency may use its role as a statutory consultee to provide the Local Planning Authority with advice.

Assessment of risk is again based on the pollutant linkage concept. The aim of risk management in the development should be to render the land suitable for the proposed use and, therefore, to prevent consideration of the Site under Part 2A.

The Welsh Assembly Government document Planning Policy Wales (March 2002) provides guidance on the relationship between development and the management of risks from land contamination caused by historical use. The Building Regulations 2000, made under the Building Act 1984, also require measures to be taken to protect new buildings and their occupants from the effects of contamination.

Voluntary Remediation Action

Voluntary remediation action on contamination resulting from historical activities can often anticipate future remediation requirements, such as through the Planning regime, and is encouraged, especially where the Site is not being assessed under Part 2A.

Environmental Damage

The Environmental Damage (Prevention and Remediation) Regulations 2009 came into force on 1st March 2009 to implement EC Directive 2004/35 on environmental liability with regard to the prevention and remedying of environmental damage.

These Regulations do not apply retrospectively; environmental damage that took place before the Regulations came into force (1st March 2009), or damage that takes place (or is likely to take place) after that date but is caused by an incident, event or emission that occurred before that date are exempt from the requirements of the Regulations.

The Regulation is concerned with preventing environmental damage. It requires that all operators of activities that cause an imminent threat of environmental damage to take all reasonably practical steps to prevent the damage. Where damage has already been caused, the operator must take all reasonably practical steps to prevent further damage from occurring.

Non-Statutory Regulatory Technical Guidance Documents

The UK non-statutory regulatory technical guidance on the assessment of land contamination, primarily released as part of the Contaminated Land Exposure Assessment (CLEA) methodology (DEFRA and EA) has recently been updated. New guidance has been released by the EA, for use in England and Wales. The following documents currently present guiding principles in investigating and assessing potentially contaminated land, which are generally adopted in considering Sites within any of the legal frameworks discussed above, or when considering voluntary remediation action:

- *Investigation of potentially contaminated Sites – Code of Practice* (British Standard 10175: 2001).
- Contaminated Land Report CLR11 *Model Procedures for the Management of Land Contamination.* (DEFRA and EA, 2004).
- *Human health toxicological assessment of contaminants in soil* Environment Agency Science Report SC050021/SR2 (EA, 2009)
- *Updated technical background to the CLEA model* Environment Agency Science Report SC050021/SR3 (EA, 2009)

- *Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values* Environment Agency Science Report SC050021/SR7 (EA, 2008)
- *An ecological risk assessment framework for contaminants in soil.* Environment Agency Science Report SC070009/SR1 and related reports S2a-e
- *Groundwater Protection: Policy and Practice*, Environment Agency GP3 Parts 1-4
- *Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination* (EA of England and Wales, 2006) developed in consultation with the Scottish Environment Protection Agency (SEPA) and the Northern Ireland Heritage and Environment Service.
- *Assessing risks posed by hazardous ground gases to buildings* Report C665 (CIRIA, 2007)
- *BS 8485:2007 Code of practice for the characterization and remediation from ground gas in affected developments(British Standards Institution, 2007)*
- *Risk Based Corrective Action (RBCA) Methodology* (ASTM designation E1739-95, E2081-00).
- *DoE Industry Profiles*

Appendix B
System Design Assumptions & Methodologies

Appendix B
System Design Assumptions and Methodologies

ERD is considered as the most appropriate remediation technology to achieve the remediation objectives at the Site and the proposed molasses injection was estimated as shown below:

Internal Area:

Parameter	Value	Comment
Screening Length	3 m	Screening of injection wells in Alluvium is from 3 mbgl to 6 mbgl and it is from 10 mbgl to 13 mbgl in Raglan Mudstone Formation (formerly known as the Raglan Marl Group) were decided based on the contamination distribution identified during site investigation works.
Migratory Porosity	1.65%	Migratory porosity was estimated based on the results found during pilot testing and the estimated migratory porosity for alluvium was 1.65%. The estimated migratory porosity varied from 0.4% to 1.6% for Raglan Mudstone Formation. Accordingly, 1.65% was considered for design.
Radius of Influence	6.5 m	Considering the both the results collected during the pilot testing and the cost associated, 6.5 m is considered as the most optimum radius of influence for the site.
Injection Transects	40 m	The length of IRZ is approximately 40 m. This is estimated distance from injection well of 20 ppm Total Organic Carbon (TOC) breakthrough. See Figure A below.
No. of Injection Point	25	The proposed layout of injection wells is presented on Figure 13. As shown in Figure, with radius of influence of 6.5 m, 25 injection wells will be sufficient to cover the impacted area beneath the site.
Injection Volume per Well	6.57 m^3	Injection volume, incorporating migratory porosity, was estimated considering the cylinder volume for 6.5m radius of influence as shown in Figure B below:
Injection Volume per Event	328.5 m^3	6.57 x 25 x 2 (each injection location has dual installation)
Design Injection Volume per Event	342 m^3	Design volume = required volume x 1.04
Injection frequency	3 months	Considering the carbon utilisation, the carbon wash out by the groundwater and cost associated, quarterly injection is proposed for the site. This may be adjusted depending on results.

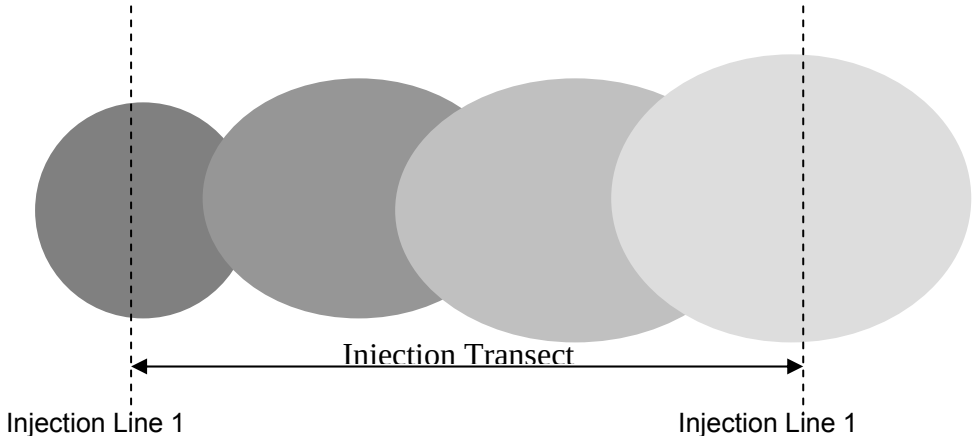
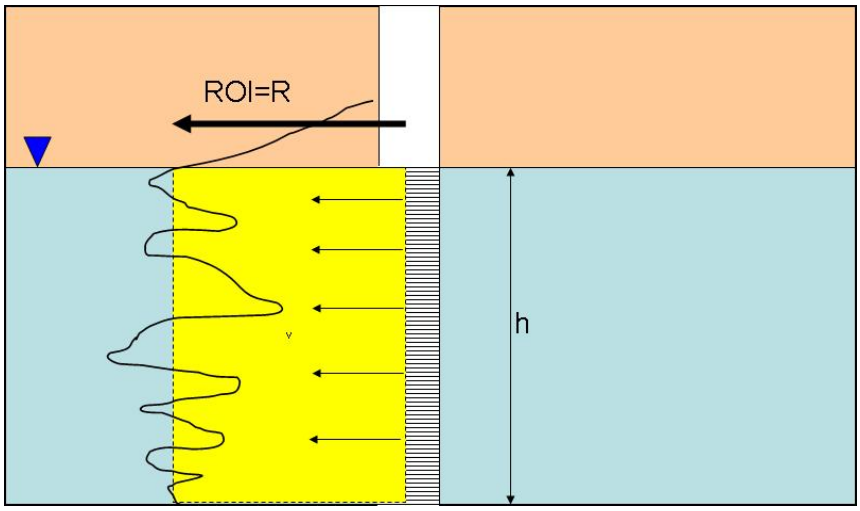


Figure A:
Schematic of Injection Transect



$$V_{inj} = \pi R^2 h \theta_m$$

Figure B:
Simplified Injection Concept and the Volume Estimation Accordingly
Θ_m is migratory porosity estimated for the site.

External Area

Parameter	Value	Comment
Screening Length	3 m	Screening of injection wells in alluvium is from 3 mbgl to 6 mbgl and it is from 10 mbgl to 13 mbgl and 17 mbgl to 20 mbgl in Raglan Mudstone Formation. The screening of injection wells were decided based on the contamination distribution identified during site investigation works.
Migratory Porosity	1.65%	Migratory porosity was estimated based on the results found during pilot testing and the estimated migratory porosity for alluvium was 1.65%. The estimated migratory porosity varied from 0.4% to 1.6% for Raglan Mudstone Formation. Accordingly, 1.65% was considered for design.
Radius of Influence (RoI)	5 m	Pilot test results were not available at time of installation (logistics programme required early installation) hence conservative value of 5 m RoI implemented to ensure satisfactory reagent distribution capability.
Injection Transect	12 m	Pilot test results were not available at time of installation (logistics programme required early installation) hence conservative value of 12 m transect implemented to ensure satisfactory reagent distribution capability.
No. of Injection Point	19	The proposed layout of injection wells is presented on Figure 13. As shown in Figure, with radius of influence of 5 m, 19 injection wells will be sufficient to cover the impacted area beneath the site.
Injection Volume per Well	3.9 m^3	Injection volume, incorporating migratory porosity, was estimated considering the cylinder volume for 5.0m radius of influence as shown in Figure B above:
Injection Volume per Event	362.5 m^3	6.36 x 19 x 3 (each injection location has triple installation)
Design Injection volume per Event	232 m^3	Design volume ~ required volume x 1.04
Injection Frequency	3 months	Considering the carbon utilisation, the carbon wash out by the groundwater and cost associated, quarterly injection was considered as appropriate for the site.

Vapour Mitigation Design for the Site

Soil Vapour Extraction (SVE) and passive venting wells are proposed at the site as a part of the vapour mitigation measures in order to manage the potential for methane and other gas generation during the implementation of *in situ* Reactive Zone (IRZ) beneath the site as a result of molasses injection. The proposed vapour mitigation system design is as follows:

Parameter	Value	Comment
Screening Length	1 m	Based on rest groundwater level found during the previous investigation, a screening length of 1m was estimated for the SVE wells.
Total Porosity	0.5	Based on the literatures, total porosity of 0.5 was estimated for the alluvium beneath the site.
Well Spacing	Every 20 m along ERD injection lines 10 -15 m along LNAPL extraction wells Every 10 m (Southern site boundary SVE wells) Approx. 15 m – 20 m grid (passive venting wells)	No conclusive data was found during SVE pilot testing, however, considering the purpose of the system is to prevent build up of hazardous gas concentrations rather than physically strip Volatile Organic Compounds (VOC) from soil, 20m spacing along the proposed Enhanced Reductive Dechlorination (ERD) injection lines is considered as sufficient based on previous experience. In addition, vapour extraction from Light Non-Aqueous Phase Liquid (LNAPL) extraction wells is proposed. This provides additional vapour control capability at the eastern and southern boundary of the site and the southern portion of the factory building.
Pore Volume Beneath Building **Pore Volume beneath Car Park**	9,576 m^3 4,200 m^3	Based on 144 m x 133 m building footprint and 1.0 m unsaturated zone thickness. Based on 140 m x 60 m car park footprint and 1.0 m unsaturated zone thickness.
No. of Vapour Extraction Wells within Building **No. Vapour Extraction Wells Outside Building**	15 11 7 8 14 6 15	Installed along ERD Lines LNAPL Extraction wells within building LNAPL Extraction Wells along southern building wall LNAPL Extraction wells along southern and eastern site boundaries SVE wells along southern site boundary Passive venting wells within southern car park area

Parameter	Value	Comment
No. of Pore Volume Exchange per Day Beneath Building **No. Pore Volume Exchange beneath External Areas**	1-2 1-2	In line with the guidance given in *"How to evaluate Alternative Cleanup technologies for Underground Storage Tank site- A Guide for Corrective Action Plan Reviewers"* and industrial practice together with ARCADIS experience, it is estimated that two pore volume per day exchange will be sufficient for the site. This is a conservative assumption as the calculation also assumes that extraction of the entire subsurface pore space is required to prevent vapour intrusion into the building. In reality, providing a slight negative pressure beneath the slab should be sufficient to prevent vapour intrusion. In practice this would be achieved at much lower flow rates. The SVE system will be capable of removing 1,000 m^3/hr, hence achieving the required pore volume exchange capacity.
Vapour Treatment	Granular Activated Carbon (GAC) Filter	Low VOC and methane concentrations are anticipated in extracted soil vapour given the volume of air being removed from the subsurface hence GAC filter is considered the most likely treatment medium. The GAC type may be modified during remediation process depending on observed performance and reduction requirements. Soil vapour extraction system vents will be placed to enable further dispersion and additional treatment will be employed if needed to meet environmental permit air emission conditions.