



Site Baseline Report

Sully Moors Road, Penarth, Wales

Hexion UK Ltd.

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Contents

1.0	Introduction.....	1
2.0	Stage 1 – Identification of hazardous substances.....	6
3.0	Stage 2 – Identification of Relevant Hazardous Substances.....	23
4.0	Stage 3 - Risk assessment for each relevant hazardous substance	28
5.0	Stage 4 – Site history and background.....	43
6.0	Stage 5 – Environmental setting.....	48
7.0	Stage 6 – Description of site contamination	52
8.0	Stage 7 – Information availability.....	54
9.0	Stage 8 – Baseline site report.....	55
	APPENDICES	64
	Appendix 1 – Data figures	65
	Appendix 2 – Previous correspondence with NRW	71
	Appendix 3 - Drawings	72
	Appendix 4 – Raw data	76
	Appendix 5 – Legal Framework.....	77
	Appendix 6 – Design of Site Protection and Monitoring Programme.....	78

Executive Summary

Enzygo Limited was commissioned by Hexion UK Ltd. (Hexion UK) to provide a baseline survey of their installation at Sully Moors Road, Penarth, South Wales in accordance with Article 22(2) of Directive 2010/75/EU on industrial emissions. Previously-measured concentrations of relevant hazardous substances (RHS), which include monoethylene glycol, diethylene glycol, polyethylene glycol (collectively termed 'glycols'), formaldehyde, and total phenol; were used to determine baseline levels for discrete zones within the installation, as set out in the ASR.

Mean values for each measurement round (March 2008, September 2008, March 2009, September 2009, March 2010 and September 2010) were calculated, where possible, for each zone. Outlier data (which exceeded the 95th percentile for the dataset) were excluded from the mean zonal value. Exclusion of outlier data affected mean total phenol values for BH305 (Zone Q), BH223 (Zone A), BH301 (Zone E) and BH126 (Zone A).

The proposed baseline concentration values for RHS in all zones mainly did not exceed the Environmental Quality Standard (EQS) for glycols and formaldehyde. The exception to this was levels of total phenol in Zone A. However, the last 2 measurement rounds showed dramatically reduced total phenol concentrations in Zone A, so it can be argued that a much lower baseline value is applicable (see section 9.2.10).

Baseline values for formaldehyde could not be accurately determined, given the data available. Measurements were assumed to be the highest concentration possible reported by the analytical method, in reality they are probably much lower (see section 9.3.3 for further information).

It was not considered appropriate to calculate baseline values for Total Aromatic Hydrocarbons (TAH) or Total Petroleum Hydrocarbons (PTH) as they are composed of a number of species, none of which appear on the RHS list.

1.0 Introduction

1.1 Background

- 1.1.1 Enzygo Limited (Enzygo) was commissioned by Hexion UK to produce a site baseline report on groundwater quality at its operational facility at Sully Moors Road, Sully, Penarth, Cardiff, CF64 5YU (hereafter referred to as the 'Site').
- 1.1.2 The installation within the Site manufactures speciality organic chemicals with a primary focus on Epoxy, Phenolic and Coating Resins.
- 1.1.3 An Integrated Pollution Prevention and Control (IPPC) Permit Application for the Site was made to the former Environment Agency Wales (EAW) now Natural Resources Wales (NRW) in 2006, and an Application Site Report (ASR) was submitted.
- 1.1.4 A Site baseline report was submitted to NRW in 2014 by ExCAL Limited (Report No: 84-01-09). Concerns about the report were raised by NRW in a letter to Ian Beatty (Hexion UK Environmental Health and Safety Manager) dated 5th January 2016, Ref: NRW/SE OPS/Taff & Ely I&WR/AK/Site Baseline Report letter/051216 (included in Appendix 2):
- The statistical approach used by ExCAL presented a 'mean of means', which smooths out parameter concentrations over the whole site. NRW recommended presenting the data according to each of the identified zones within the site as defined by the ASR (see Figure 5).
 - Data outliers were included in the statistical analysis without any justification.
 - Water quality datasets from site monitoring boreholes together with surface water quality data for the adjacent Sully Brook surface watercourse were used to generate baseline (or 'reference' groundwater quality data). However, the data used include that obtained during several years of the operational phase of the Site.
 - Reference data establishes the baseline conditions at a specific time before operations commenced or when the baseline report was first produced. During the operational phase, ongoing groundwater quality monitoring allows action to be taken if evidence of deterioration is found, rather than waiting until site closure.
 - Borehole-specific baselines – NRW could not understand the derivation of proposed borehole-specific baselines. For example, sulphate concentrations in one borehole ranged from 240.3 mg/l to 718 mg/l, but the proposed baseline concentration was higher at 942.2 mg/l.
 - NRW could not understand how the site-wide baseline values were calculated.
- 1.1.5 Soil data would have been obtained during the original site investigations when groundwater monitoring boreholes were installed. However, a review of soils data is not included in this baseline assessment as no information was provided and soils were not included in the 2014 site baseline report. Moreover, it is likely that groundwater quality is more indicative of RHS emissions from the installation as each borehole is interrogating leachate from a larger volume of soils and ground than a one off soil measurement could do.

1.2 Objectives

1.2.1 This report addresses NRW's concerns as follows:

- Only data from March 2008 to September 2010 coincidental with the issue of the Site Environmental Permit is used to generate the reference data.
- Data outliers (>95%ile concentrations) were removed, and justification for the removal is provided.
- Mean and standard deviation values from the 'cleaned' outlier free data set were calculated for each monitoring borehole, and also aggregated for boreholes located in each of the site zones as designated in the ASR to calculate mean and standard deviation values for each zone.
- The zonal values are compared to the site-wide values.

1.3 Legislation, regulation and guidance

1.3.1 The baseline report was produced in accordance with the appropriate law, regulations and guidance as reviewed below (see also Appendix 5).

EU IED Directive

1.3.2 The Environmental Permitting (England and Wales) (Amendment) Regulations 2013 brought the Industrial Emissions Directive (2010/75/EU) (IED) into force on the 27th February 2013. The IED brought in requirements for operators to tackle potential soil and groundwater contamination from relevant hazardous substances. As part of this process, EU Guidance on baseline reports and sampling was published on the 6th May 2014.

EU Guidance

1.3.3 Article 22(1) of the IED provides that, 'Without prejudice to Directive 2000/60/EC, Directive 2004/35/EC, Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration (1) and to relevant Union law on soil protection, the competent authority shall set permit conditions to ensure compliance with paragraphs 3 and 4 of this Article upon definitive cessation of activities'.

1.3.4 Article 22, paragraphs 2 to 4 of the IED, contains provisions for the definitive cessation of activities involving the use, production or release of relevant hazardous substances in order to prevent and tackle potential soil and ground water contamination from such substances. A key tool in this respect is the establishment of a 'baseline report'.

1.3.5 Where an activity involves the use, production or release of relevant hazardous substances and having regard to the possibility of soil and groundwater contamination, a baseline report is to be drawn up before starting the operation of the installation or before a permit for the installation is updated for the first time after 7 January 2013. The report will form the basis for a comparison with the state of contamination upon definitive cessation of activities. Where information produced pursuant to other national or Union law reflects the state at the time the report is drawn up, that information may be included in, or attached to, the baseline report.

- 1.3.6 Article 3(19) of the IED clarifies that the baseline report needs to provide information on the state of soil and groundwater contamination by relevant hazardous substances. Article 22(2) specifies that a baseline report should contain at least the following information:
- (a) information on the present use and, where available, on past uses of the site; and
 - (b) where available, existing information on soil and groundwater measurements that reflect the state at the time the report is drawn up or; alternatively, new soil and groundwater measurements having regard to the possibility of soil and groundwater contamination by those hazardous substances to be used, produced or released by the installation concerned.

UK Regulation

- 1.3.7 The Site is regulated by Natural Resources Wales (NRW).
- 1.3.8 NRW was formed on the 1 April 2013 from Environment Agency Wales, the Countryside Council for Wales and the Forestry Commission Wales. The Environment Agency then embarked on a revision of the H5 guidance for Applicants Site Condition Report – guidance and templates. NRW adopted this guidance when it was issued and so it seemed sensible to wait for the publication of both documents before giving further advice to operators, including Hexion UK. However, the H5 guidance has still not been published by the Environment Agency.
- 1.3.9 On 5 January 2016 NRW advised Hexion UK (correspondence included in Appendix 2) that the Installation Permit is likely to require updating following publication of the relevant Best Available Techniques (BAT) reference documents (BREF) and Best Available Techniques conclusions (BATc).
- 1.3.10 For the Speciality Organics sector the latest timetable suggests BATc are likely to be issued in 2019, and compliance with IED (by way of permit reviews) will need to be completed by 2023. However, the final timetable is subject to an ongoing review of the EU Chemical Strategy, which may alter the order, timing and number of chemical sector BREFs and is likely to include a condition to implement the “protecting soil and groundwater” requirements of the IED Directive.
- 1.3.11 In the absence of available BREF and BATc documentation NRW advised that the baseline report should be produced in line with the EU Commission guidance.
- 1.3.12 NRW require Hexion UK to submit a new site condition report (SCR) containing a baseline report. They advised that much, if not all of the information required by a baseline report may already have been submitted in an original SCR submitted to NRW, but that a review of that document might be required. NRW also advised that any substantial change in operations before the permit review may also trigger the need for a baseline report.

1.4 Scope of report

- 1.4.1 This report responds to the NRW comments, the H5 guidance from the Environment Agency and discussions with Hexion UK.
- 1.4.2 European Commission guidance on the stages and the activities and objectives involved in production of an acceptable baseline report is summarised in Table 1 on the following page.
- 1.4.3 This baseline report is structured in line with the required activities and objectives in section 1.2 and Table 1.

1.4.4

Table 1) European Commission guidance on the main stages of baseline report preparation

Stage	Activity	Objective
1.	Identify which hazardous substances are used, produced or released at the installation and produce a list of these hazardous substances.	Determine whether or not hazardous substances are used, produced or released in view of deciding on the need to prepare and submit a baseline report.
2.	Identify which of the hazardous substances from Stage 1 are 'relevant hazardous substances' (see Section 3.13). Discard those hazardous substances that are incapable of contaminating soil or groundwater. Justify and record the decisions taken to exclude certain hazardous substances.	To restrict further consideration to only the relevant hazardous substances in view of deciding on the need to prepare and submit a baseline report.
3.	For each relevant hazardous substance brought forward from Stage 2, identify the actual possibility for soil or groundwater contamination at the site of the installation, including the probability of releases and their consequences, and taking particular account of: -the quantities of each hazardous substance or groups of similar hazardous substances concerned; -how and where hazardous substances are stored, used and to be transported around the installation; -where they pose a risk to be released; In case of existing installations also the measures that have been adopted to ensure that it is impossible in practice that contamination of soil or groundwater takes place.	To identify which of the relevant hazardous substances represent a potential pollution risk at the site based on the likelihood of releases of such substances occurring. For these substances, information must be included in the baseline report
4	Provide a site history. Consider available data and information: - In relation to the present use of the site, and on emissions of hazardous substances which have occurred and which may give rise to pollution. In particular, consider accidents or incidents, drips or spills from routine operations, changes in operational practice, site surfacing, changes in the hazardous substances used.	Identify potential sources which may have resulted in the hazardous substances identified in Stage 3 being already present in the site of the installation.

	<p>-Previous uses of the site that may have resulted in the release of hazardous substances, be they the same as those used, produced or released by the existing installation, or different ones.</p> <p>Review of previous investigation reports may assist in compiling this data.</p>	
5	<p>Identify the site's environmental setting including:</p> <ul style="list-style-type: none"> - Topography; - Geology; - Direction of groundwater flow; - Other potential migration pathways such as drains and service channels; - Environmental aspects (e.g. particular habitats, species, protected areas, etc.); and - Surrounding land use. 	<p>Determine where hazardous substances may go if released and where to look for them. Also identify the environmental media and receptors that are potentially at risk and where there are other activities in the area which released the same hazardous substances and may cause them to migrate onto the site.</p>
6	<p>Use the results of Stages 3 to 5 to describe the site, in particular demonstrating the location, type, extent and quantity of historic pollution and potential future emissions sources noting the strata and groundwater likely to be affected by those emissions - making links between sources of emissions, the pathways by which pollution may move and the receptors likely to be affected.</p>	<p>Identify the location, nature and extent of existing pollution on the site and to determine which strata and groundwater might be affected by such pollution. Compare with potential future emissions to see if areas are coincident.</p>
7	<p>If there is sufficient information to quantify the state of soil and groundwater pollution by relevant hazardous substances on the basis of Stages (1) to (6) then go directly to Stage 8. If insufficient information exists then intrusive investigation of the site will be required in order to gather such information. The details of such investigation should be clarified with the competent authority.</p>	<p>Collect additional information as necessary to allow a quantified assessment of soil and groundwater pollution by relevant hazardous substances.</p>
8	<p>Produce a baseline report for the installation that quantifies the state of soil and groundwater pollution by relevant hazardous substances.</p>	<p>Provide a baseline report in line with the IED.</p>

2.0 Stage 1 – Identification of hazardous substances

2.1 Baseline Reporting Stage 1 list of hazardous substances

- 2.1.1 Table 2 lists the materials inventory compiled for the IPPC Permit Application for the Site as included in the 2006 Application Site Report, when the IPPC Permit was issued. Table 2 includes the quantities of all the substances used and locations in which they are stored.

Table 2) Materials inventory – taken from the 2006 PPC Application

Material	Chemical Composition	Handling Location	Annual Usage/Production tonnes	Toxicity / Environmental Harm (risk phrases from MSDS and other information)	Risk of Environmental Harm (from 2006 ASR)
1,3-Butylene glycol diacetate	C ₈ H ₁₄ O ₄	Ace and Furan Production Area	48	No information found, assume worst case.	MODERATE
Ace hardeners	Blend of esters (organic compounds with OGH group)	Ace and Furan Production Area	2166	No information found, assume worst case.	MODERATE
Acetic acid 80%	CH ₃ COOH	Used in reactor area	14.5	Harmful. Corrosive. Flammable. Causes severe burns.	MODERATE
Acetic anhydride	(CH ₃ CO) ₂ O	Used in Reactor Area, S49 Warehouse	6.6	Toxic. Corrosive. Harmful to inhalation or if swallowed. Causes severe burns. Irritating to respiratory system. Risk of serious damage to eyes. This material is not expected to significantly bio-accumulate.	MODERATE
Acetone	CH ₃ COCH ₃	QA Laboratory, raw materials flammables store.	1.4	Harmful when inhaled, ingested and when in contact with eyes. Good biodegradability, large octanol/water partition value (<3), non-toxic aquatics.	MODERATE
Adipic acid	C ₆ H ₁₀ O ₄	Grinding and blending area, S49 warehouse	17.6	Practically non-toxic, readily biodegradable.	LOW

Material	Chemical Composition	Handling Location	Annual Usage/Production tonnes	Toxicity / Environmental Harm (risk phrases from MSDS and other information)	Risk of Environmental Harm (from 2006 ASR)
Ammonia	NH ₃	Ammonia station within reactor area, S49 warehouse	58	Harmful. Corrosive. Irritant. Causes burns. Risk of serious damage to eyes. Very toxic to aquatics, R50 .	MODERATE
Antifoam C100N	Dimethyl siloxanes and silicones, 90%; Silica, 10%	Used in Reactor Area, S49 Warehouse	1.4	The components of Antifoam C100N have a very low order of toxicity, although prolonged contact with the skin or contact with the eyes may cause some irritation.	LOW
Bakelite PF0210DF03/FL09				No information found, assume worst case.	MODERATE
Barytes	Barium sulphate, BaSO ₄	Grinding and Blending Area, S49 warehouse	130	Respiratory and eye irritant. May bio-accumulate.	MODERATE
Bisphenol A	HO(C ₆ H ₅)C(CH ₃) ₂ (C ₆ H ₅)OH	Ace and Furane Production Area, S49 warehouse	103	Harmful. Irritating to eyes, respiratory system and skin. May cause sensitization by skin contact.	MODERATE
Butyl carbitol	C ₈ H ₁₈ O ₃	Used in Reactor Area, S49 Warehouse	1.6	Irritating to eyes and skin contact. Risk of serious damage to eyes. This material is not expected to be toxic to aquatic life. LC ₅₀ goldfish 2700mg/l, LC ₅₀ daphnia magna 48hrs > 1000mg/l.	MODERATE
Butyl di-glycol acetate	C ₁₀ H ₂₀ O ₄	Used in Reactor Area, S49 Warehouse	14.6	Harmful by inhalation or by contact with skin.	LOW

Material	Chemical Composition	Handling Location	Annual Usage/Production tonnes	Toxicity / Environmental Harm (risk phrases from MSDS and other information)	Risk of Environmental Harm (from 2006 ASR)
Cabosil TS610	Silica	Used in Reactor Area, S49 Warehouse	2.3	No information found, probably inert.	LOW
Calcium oxide	CaO	Used in Reactor Area, S49 Warehouse	1.7	Extremely flammable. Corrosive, irritating to eyes and skin. High pH.	LOW
Calcium stearate	Ca(C ₁₈ H ₃₅ O ₂) ₂	Grinding and Blending Area, S49 warehouse	0.03	Irritant. Biodegradable, no detectable toxicity.	LOW
Calmete C500	Calcium carbonate	Grinding and Blending Area, S49 warehouse	5.5	Irritating to eyes, respiratory system and skin. LC ₅₀ algae 72hrs>200mg/l, LC ₅₀ daphnia 49Hrs>1000mg/l, LC ₅₀ fish 96Hrs>10000mg/l.	LOW
Calmete H2LT	Calcium carbonate	Grinding and Blending Area, S49 warehouse	143	Irritating to eyes, respiratory system and skin. Non-volatile, biodegradable.	LOW
Cashew Nut Shell Liquor (CNSL)	Aromatic hydrocarbon	V707 in A60 tank farm, used in reactor area	698	German Water Hazard Class/German Water Endangerment Class (WGK): Class 1.	MODERATE
Desmophen TP-PU 1907	Polyether polyol	S49 warehouse	21.1	No information found, assume worst case.	MODERATE
Diesel	Various hydrocarbons	Tanks 101 and 102	Not quantified	Potentially harmful if released to the environment.	MODERATE

Material	Chemical Composition	Handling Location	Annual Usage/Production tonnes	Toxicity / Environmental Harm (risk phrases from MSDS and other information)	Risk of Environmental Harm (from 2006 ASR)
Di-basic ester bulk	Mixture of dimethyl esters. Dimethyl succinate, dimethyl adipate, dimethyl gluturate	15-V1538 in A15 tank farm.	157	Irritating to eyes and skin. Overexposure by inhalation or skin contact may cause irritation of the upper respiratory system. EC _{24 hr} 180ppm, biodegradable.	MODERATE
Diethylene glycol	(CH ₂ CH ₂ OH) ₂ O	V304 in A10 tank farm, S49 warehouse, used in reactor area	301	Harmful if swallowed. Slight irritant. Practically non-toxic to aquatic organisms. LC _{50 96hrs fathead minnow} >10000mg/l EC _{50 48hrs daphnia} >10000mg/l, IC _{50 bacterial inhibition} >10000mg/l, slowly degrades.	LOW
Dipentene	C ₁₀ H ₁₆	Used in Reactor Area, S49 Warehouse	0.048	Harmful if swallowed. Skin, eye and respiratory irritant. Flammable. Very toxic to aquatic organisms. May cause long-term adverse effects within the aquatic environment. LD/C ₅₀ (rabbit) - route: skin, dose: 1370 µl/kg.	MODERATE
Dipropylene glycol	HOC ₃ H ₆ OC ₃ H ₆ OH	Used in Reactor Area, S49 Warehouse	76	Designated non-hazardous in PPC Application. LC _{50 goldfish 24hrs} >5000mg/l, LC _{50 fathead minnow} >100mg/l, partially degradable in water.	LOW
Dri-sil 55	Silsesquioxanes, 3-[(2-aminoethyl)amino]propyl Me, methoxy-terminated, 98%, Methanol, 2%	Used in Reactor Area, S49 Warehouse	3.5	Hydrolyses / no adverse aquatic effects / no bio accumulation.	LOW

Material	Chemical Composition	Handling Location	Annual Usage/Production tonnes	Toxicity / Environmental Harm (risk phrases from MSDS and other information)	Risk of Environmental Harm (from 2006 ASR)
Effluent	Potentially contains any raw materials	3-V108 in A30 tank farm, 300-V1660 and 300-V1665 at bio plant, Effluent Lagoons	Not quantified	Has the potential to be harmful to the environment due to the possible presence of phenol, formaldehyde and other raw materials.	MODERATE
Effluent Sludge	Bio-sludge	300-V1663 at Bio Plant	1300	Has the potential to be harmful to the environment due to the possible presence of phenol, formaldehyde and other raw materials.	MODERATE
Ekaland 100 GCP	1,4-Benzenediamine, N,N'-mixed Phenyl and Toly Derivs., 98%; Benzenamine, N-phenyl-, 2%	Used in Reactor Area, S49 Warehouse	2.6	R50/53 - very toxic to aquatics, may cause long term effects in the aquatic environment.	HIGH
Energol CS68	Paraffin oil	Used in Reactor Area, S49 Warehouse	1.07	No information found, assume worst case.	MODERATE
Epoxy resins and derivatives	Aromatic hydrocarbon chain	S49 warehouse storage	30	No information found, assume worst case.	MODERATE
Epoxy silane	(Generic name)	Not known	5	No information found, assume worst case.	MODERATE
Esterified resole	Aromatic hydrocarbon	Reactor area	Not quantified	No information found, assume worst case.	MODERATE

Material	Chemical Composition	Handling Location	Annual Usage/Production tonnes	Toxicity / Environmental Harm (risk phrases from MSDS and other information)	Risk of Environmental Harm (from 2006 ASR)
Ethylene glycol	C ₂ H ₆ O ₂	V306 tank in A10 farm, used in reactor area	196	Harmful if swallowed, irritating to eyes. LC ₅₀ goldfish 24hrs >5000mg/l, COD 1.29gO ₂ /g, BOD/COD 54-64%.	MODERATE
Ethylene glycol diacetate	CH ₃ CO ₂ CH ₂ CH ₂ CCH ₃	15-V1537 in A15 tank farm, used in reactor area	29	Harmful to aquatics, readily biodegradable.	MODERATE
Formaldehyde	CH ₂ O	V303 and 2-V608 tanks in A10 and A20 tank farms, used in reactor area	18,959	Potentially harmful to the environment. May cause harm through pH alteration. Flammable. Very toxic. Causes burns. Limited evidence of carcinogenic effects. Risk of serious damage to eyes. May cause sensitization by skin contact. Freshwater EQS = 0.005 mg/l.	HIGH
Formic acid 85%	CH ₂ O ₂	Used in Reactor Area, S49 Warehouse	0.9	Harmful. Corrosive. Causes severe burns. Practically non-toxic to aquatics.	MODERATE
Furane	Colourless, toxic flammable liquid used in the synthesis of nylon.	A15 and S49 Warehouse	(No data)	No information found, assume worst case.	MODERATE

Material	Chemical Composition	Handling Location	Annual Usage/Production tonnes	Toxicity / Environmental Harm (risk phrases from MSDS and other information)	Risk of Environmental Harm (from 2006 ASR)
Furans	C ₄ H ₄ O	15-V1528, 15-V1529 and 15-V1530 in A15 tank farm, used in ace and furan production area	50	Toxic. Highly flammable. May cause cancer.	MODERATE
Furfural alcohol	C ₅ H ₆ O ₂	1-V1531 tank in A10 tank farm, used in reactor area	351	Toxic. LC ₅₀ pimephalespromelas 96hrs 32mg/l, EC ₅₀ 24hrs daphnia 115mg/l.	MODERATE
Gamma-butyrolactone	C ₄ H ₆ O ₂	15-V1540 in A15 tank farm, used in mixing vessel	244	Harmful. Irritating to eyes. LC ₅₀ 96hrs fish <460mg/l, LC ₅₀ 48hrs daphnia >500mg/l.	MODERATE
Hazardous general waste	Mixed	Waste compound	30	Potential to be harmful to the environment if released.	MODERATE
Heavy layer distillate	Approx. 68% phenol, remainder water.	2V-1571 in A20 tank farm, used in reactor	200	Toxic. Corrosive. Irritant.	MODERATE
Hexamine (and hexamine lubricated)	C ₆ H ₁₂ N ₄	Grinding and Blending Area, S49 warehouse storage	877	May be harmful by ingestion or inhalation. Skin irritant. May cause allergic skin reaction. A high potential to affect aquatic life.	MODERATE
IMS 358	80% Sulphuric acid, 20% Isopropanol.	V218 in A30 tank farm, S49 warehouse, used in reactor area	14.3	Highly toxic. Corrosive. Causes severe burns. Irritant. Highly flammable.	MODERATE

Material	Chemical Composition	Handling Location	Annual Usage/Production tonnes	Toxicity / Environmental Harm (risk phrases from MSDS and other information)	Risk of Environmental Harm (from 2006 ASR)
IMS 94	90% Ethanol, 4% Methanol, 6% Water	V307 in A20 tank farm, used in reactor area	13.8	Harmful. Toxic. Danger of very serious irreversible effects. Highly flammable. Probably biodegradable and non-toxic to aquatic organisms.	MODERATE
Isopropanol	CH ₃ CHOHCH ₃	Used in reactor area, raw materials and flammables storage.	23.8	Highly flammable. Irritating to eyes and respiratory system.	MODERATE
Jeffsol EC50	Ethylene carbonate, 50%; Propylene carbonate, 50%	Used in Reactor Area, S49 Warehouse	4.2	No information found, assume worst case.	MODERATE
Lactic acid 80%	CH ₃ CHOHCOOH	Used in Reactor Area, S49 Warehouse	12.9	Causes burns.	LOW
Latex 115	Chloroprene-Methacrylic Acid Copolymer, 48%; Diethanolamine, 2%; Water, 59%	Used in Reactor Area, S49 Warehouse	0.575	No information found, assume worst case.	MODERATE
Latex aquastik 1120	Chloroprene-Methacrylic Acid Copolymer, 48%; Water, 52%	Used in Reactor Area, S49 Warehouse	20.4	No information found, assume worst case.	MODERATE
Latex Breon 1562	Acrylonitrile-1,3-Butadiene Copolymer, 40%; Water, 60%	Used in Reactor Area, S49 Warehouse	177	No information found, assume worst case.	MODERATE

Material	Chemical Composition	Handling Location	Annual Usage/Production tonnes	Toxicity / Environmental Harm (risk phrases from MSDS and other information)	Risk of Environmental Harm (from 2006 ASR)
Libranone C40	Ethoxylated Castor oil	Tank storage, used in reactor area	350	No information found, assume worst case. LC/EC/IC ₅₀ >10mg/l.	MODERATE
Light layer distillate	8% phenol, 2.5% formalin, remainder water	2-V1572 in A20 tank farm, used in reactor area and PRU	4000	Toxic in contact with skin or if swallowed.	MODERATE
Lignin MNRP-2H (58)	Wood lignin	Used in Reactor Area, S49 Warehouse	9.1	No information found, assume worst case. Probably inert.	MODERATE
Liquid lab waste	Mixed	Waste compound	Not quantified	Potential to be harmful to the environment if released.	MODERATE
Liquid novolac resins	(Generic name)	3-V619 and 3-V620 in A30 tank farm.	11,000	Potential to be harmful to the environment if released due to presence of phenol and formaldehyde.	MODERATE
Mangalox M75	Manganese dioxide	Grinding and Blending Area, S49 warehouse	9.1	Harmful.	MODERATE
Methanol	CH ₄ O	V313 tank in A20 tank farm, used in reactor area	52.5	Dangerous to aquatic life in high concentrations. May be dangerous if it enters water intakes. Highly flammable. Toxic.	MODERATE
Methylformate	C ₂ H ₄ O ₂	S49 warehouse	64	Extremely flammable.	MODERATE
Methylene Diisocyanate	OCN(C ₆ H ₅)CH ₂ (C ₆ H ₅)NCO	S49 warehouse	30	Toxic, severe irritant. May cause sensitization by inhalation or skin contact.	MODERATE

Material	Chemical Composition	Handling Location	Annual Usage/Production tonnes	Toxicity / Environmental Harm (risk phrases from MSDS and other information)	Risk of Environmental Harm (from 2006 ASR)
Microcal ET	Calcium silicate	Grinding and blending area	15.8	Skin, eye and respiratory irritant.	LOW
Mono Ammonium Phosphate	NH ₄ H ₂ PO ₄	S49 warehouse	47.3	Irritating. Harmful if swallowed. Soluble, TL _m 96hr 100-1000ppm, orthophosphate may precipitate heavy metals.	MODERATE
Monoethylene glycol	HOCH ₂ CH ₂ OH	V304 in A10 tank farm, S49 warehouse, used in reactor area	?	May cause irritation to the respiratory system if inhaled. Harmful or fatal if swallowed. May cause nausea, vomiting and diarrhea. Slightly irritating in contact with skin. Irritating to eyes. Not regarded as dangerous for the environment.	MODERATE
Monophenyl Glycol	C ₈ H ₁₀ O ₂	Used in Reactor Area, S49 Warehouse	15.3	Harmful.	MODERATE
Mowilith DM 132	Ethylene-vinyl acetate copolymer, 60%; polyvinyl alcohol, 5%; water, 35%	S49 warehouse	40.5	No information found, assume worst case.	MODERATE
Non-hazardous general waste	Mixed	Waste compound	Not quantified	Non-hazardous.	LOW
Novalac powdered resins	Phenolic resins	Silos within A80 tank farm	309	Potential to be harmful to the environment if released.	MODERATE

Material	Chemical Composition	Handling Location	Annual Usage/Production tonnes	Toxicity / Environmental Harm (risk phrases from MSDS and other information)	Risk of Environmental Harm (from 2006 ASR)
Oxalic acid	H ₂ C ₂ O ₄	3-V1562 in A30 tank farm, used in reactor area	53.8	Harmful. Corrosive. Causes burns.	MODERATE
Paraform 91LP	Paraformaldehyde, 91%; water, 8.5%; formaldehyde, 0.5%	Used in Reactor Area, S49 Warehouse	16.7	Harmful. Toxic. Corrosive. May cause sensitization by skin contact or inhalation. May cause cancer. May cause inheritable genetic damage. LC ₅₀ 96hr 50mg/l, LC ₅₀ 2 days daphnia 2ppm.	MODERATE
Pel rig 9238	Poly[oxy(methyl-1,2-ethanediyl)],(a)-hydro-(o)-hydroxy-ether with, (be)-D-fructofuraneosyl (a)-D-glucopyranoside	S49 warehouse	0	No information found, assume worst case.	MODERATE
Phenol (total)	C ₆ H ₅ OH	V301 and V302 tanks in A10 tank farm, V603 and V604 tanks in A20 tank farm. Used in reactor area.	20,785	Persistent in water. Not expected to concentrate or bio-concentrate in aquatic organisms to a significant extent. Biodegradable. Freshwater & Saltwater EQS = 0.03 mg/l. Residential soil EQS = 120-380 mg/kg.	MODERATE
Poly-ethylene glycol	C _{2n} H _{4n+2} O _{n+1}	V305 in A10 tank farm	(No data)	Slightly hazardous in case of skin contact (irritant, permeator), of eye contact (irritant), of ingestion and inhalation. Oral LD ₅₀ [Rabbit]: 26,800 mg/kg. Ecotoxicity in water (LC50): >5000 mg/l 24 hours [Goldfish].	LOW

Material	Chemical Composition	Handling Location	Annual Usage/Production tonnes	Toxicity / Environmental Harm (risk phrases from MSDS and other information)	Risk of Environmental Harm (from 2006 ASR)
Portachrome C38	Chromite (Cr_2FeO_4)	Grinding and Blending Area, S49 warehouse	5.4	No information found, assume worst case.	MODERATE
Potassium hydroxide (50%)	KOH	1-V1534 in A10 tank farm, used in reactor area	1714	Harmful. Corrosive. Causes severe burns. Risk of serious damage to eyes. Strong alkaline.	MODERATE
Propylene carbonate	$\text{C}_4\text{H}_6\text{O}_3$	15-V1539 in A15 tank farm	422	Irritating to eyes. LC_{50} 5300mg/l, EC_{50} >500mg/l, biodegradable.	LOW
Rapeseed oil butyl ester	(Various)	Used in Reactor Area, S49 Warehouse	4.7	No information found, assume worst case.	MODERATE
Recovered Phenol (80%)	Approx. 80% phenol, 20% water	Bulk storage tank, used in reactor area	837	Flammable. Toxic in contact with skin or if swallowed.	MODERATE
Resin liquid waste	Aromatic hydrocarbon chain	Waste store	324	Potential to be harmful to the environment if released.	MODERATE
Resin powder waste	Aromatic hydrocarbon chain	Waste store	163	Potential to be harmful to the environment if released.	MODERATE
Resole distillate (also referred to as product distillate)	Approx. 2.5% phenol, 2% formaldehyde, remainder water.	1-V1001 in A10 tank farm	1,066	Potential to be harmful to the environment if released.	MODERATE

Material	Chemical Composition	Handling Location	Annual Usage/Production tonnes	Toxicity / Environmental Harm (risk phrases from MSDS and other information)	Risk of Environmental Harm (from 2006 ASR)
Resole resins	Aromatic hydrocarbon chain	Tanks V401 to V416, 5-V1508a/b, V1509 to V1521, V1581a/b and V1582a/b all in A50 tank farm, used in reactor area	31,786	Harmful by inhalation or if swallowed.	MODERATE
Resorcinol	m-Dihydroxybenzene C ₆ H ₆ O ₂	Used in Reactor Area, S49 Warehouse	28.6	Toxic. Irritant. Risk of serious damage to eyes. This material is very toxic to aquatics.	HIGH
Resorcinol fraction RFK	Phenols, Ammonia Liquor Ext., Resorcinol Fraction, 93%; resorcinol, 7%	Used in Reactor Area, S49 Warehouse	255	Toxic to aquatic organisms. May cause long-term adverse effects in the aquatic environment.	HIGH
Rubble	Stone waste	Waste compound	Not quantified	No harmful characteristics.	LOW
Salicylic acid	C ₇ H ₆ O ₃	Used in Reactor Area, S49 Warehouse	27	Highly flammable. Harmful by inhalation, ingestion and through skin absorption. Irritant. Risk of serious damage to eyes. May cause harm to the unborn child.	MODERATE
Scrap metal	Metals	Waste compound	15	No harmful characteristics.	LOW
Silane 1506	Gamma-Aminopropylmethyldiethoxysilane	Used in Reactor Area, S49 Warehouse	2.6	Potential to be harmful to the environment if released.	MODERATE

Material	Chemical Composition	Handling Location	Annual Usage/Production tonnes	Toxicity / Environmental Harm (risk phrases from MSDS and other information)	Risk of Environmental Harm (from 2006 ASR)
Silane ameo/a1101/a1100	(3-Aminopropyl)triethoxysilane	Used in Reactor Area, S49 Warehouse	31	Harmful. Causes burns. LC ₅₀ 96hrs 2208mg/l, EC ₅₀ algae 72hrs 603mg/l, EC ₅₀ daphnia 48hrs 331mg/l.	MODERATE
Sodium ethyl hexyl sulphate (40%)	C ₈ H ₁₇ NaSO ₄	Used in Reactor Area, S49 Warehouse	80	Irritating to eyes and respiratory system.	MODERATE
Sodium Hydroxide (also referred to as 'caustic rewash' or 'caustic solution' in the 2006 IPPC Application)	NaOH	1-V1533 in A10 tank farm, external to S49 warehouse, used in reactor area	114	Harmful. Corrosive. Causes severe burns. Toxic to aquatic life. Levels of >10ppm or pH10.5 may be fatal to fish and other aquatics.	MODERATE
Solid lab waste	Mixed	Waste compound	Negligible	Potential to be harmful to the environment if released.	MODERATE
Solvent waste	Mixed organic solvents	Waste compound	Not quantified	Potential to be harmful to the environment if released.	MODERATE
Styrenated phenol	Aromatic hydrocarbon	Produced in reactor area, transferred to road transport	Not quantified	No information found, assume worst case.	MODERATE
Styrene	C ₈ H ₈	Used in reactor area	Not quantified	Harmful. Corrosive. Flammable. Causes burns. Risk of serious damage to the eyes. Irritant.	MODERATE

Material	Chemical Composition	Handling Location	Annual Usage/Production tonnes	Toxicity / Environmental Harm (risk phrases from MSDS and other information)	Risk of Environmental Harm (from 2006 ASR)
Sulphuric Acid	H ₂ SO ₄	3-V1573 in A30 tank farm, external to S49 warehouse, used in reactor area	58	Toxic. Causes severe burns. Irritating to eyes, respiratory system or skin. May cause cancer by inhalation.	MODERATE
'Surfactant' listed in Table 3	(Varied - generic name)	(No data)	(No data)	No information found, assume worst case.	MODERATE
Sulphamic Acid	H ₃ NSO ₃	(No data)	(No data)	No information found, assume worst case.	MODERATE
Triacetin	C ₉ H ₁₄ O ₆	15-V1536 in A15 tank farm, used in mixing vessel	1,116	Non-hazardous. WGK1, LC ₅₀ carp 48hr 174mg/l.	LOW
Triethanolamine	C ₆ H ₁₅ NO ₃	Used in Reactor Area, S49 Warehouse	3.5	Irritant. BOD ₂₀ =66% of ThOD, COD=1.52mg/mg, LC ₅₀ daphnia 48hr 947mg/l.	LOW
Urea Fomaldehyde Concentrate	Urea-formaldehyde copolymer, 55%; free formaldehyde, 25%, water, 20%	15-V1541 in A15 tank farm, 1-V1532 tank in A10 tank farm, used in reactor area.	12.2	Potential to the harmful to the environment if released due to the presence of formaldehyde.	MODERATE
Wooden Pallets	Wood	Various locations	Not quantified	Non-hazardous.	LOW
Zinc Acetate	(CH ₃ COO) ₂ Zn	Used in Reactor Area, S49 Warehouse	1	Irritating to eyes, respiratory system and skin.	LOW

Material	Chemical Composition	Handling Location	Annual Usage/Production tonnes	Toxicity / Environmental Harm (risk phrases from MSDS and other information)	Risk of Environmental Harm (from 2006 ASR)
Zinc Stearate	$\text{ZnC}_{18}\text{H}_{35}\text{O}_2$	Grinding and Blending area, S49 Warehouse	3.6	Irritating to respiratory system.	MODERATE

3.0 Stage 2 – Identification of Relevant Hazardous Substances

3.1 Baseline Reporting Stage 2: List of relevant hazardous substances

- 3.1.1 Stage 2 considers which of the substances identified in Stage 1 and listed in the materials inventory (Table 2) is a relevant hazardous substance (RHS).
- 3.1.2 ‘Relevant hazardous substances’ (Article 3(18) and Article 22(2), first subparagraph) *are those substances or mixtures defined within Article 3 of Regulation (EC) No 1272/2008 on the classification, labelling and packaging of substances and mixtures (CLP Regulation) which, as a result of their hazardousness, mobility, persistence and biodegradability (as well as other characteristics), are capable of contaminating soil or groundwater, and are used, produced and/or released by the installation.*
- 3.1.3 Where a group of substances display similar characteristics they may be considered together provided that justification for the grouping is given.
- 3.1.4 Sources of information may include the classification and labelling inventory of substances notified under Regulation (EC) No 1272/2008 (the CLP Regulation) and chemical information on substances registered under Regulation (EC) No 1907/2006 (the REACH Regulation). Other sources of information can also include the risk assessment reports for 141 chemicals under Council Regulation (EEC) No 793/93 (Existing Substances Regulation). All these sources can be found on the European Chemical Agency (ECHA) website¹.

RHS Screening and justification

- 3.1.5 The substances used at site as listed in Table 2 were screened for whether or not they are RHS (i.e. referenced in the ECHA database). The substances that are greyed out in Table 3 are not considered RHS as they are not listed on the ECHA database.

¹ <http://echa.europa.eu/information-on-chemicals/>

Table 3) List of 'Relevant Hazardous Substances' (RHS)

Material	Justification for inclusion/exclusion of Relevant Hazardous Substances
1,3-Butylene glycol diacetate	Not in ECHA database.
Ace hardeners	In ECHA database.
Acetic acid 80%	In ECHA database.
Acetic anhydride	Not in ECHA database.
Acetone	In ECHA database.
Adipic acid	In ECHA database.
Ammonia	In ECHA database.
Antifoam C100N	Not in ECHA database.
Bakelite PF0210DF03/FL09	Not in ECHA database.
Barytes	Not in ECHA database.
Bisphenol A	In ECHA database.
Butyl carbitol	In ECHA database.
Butyl di-glycol acetate	In ECHA database.
Cabosil TS610	Not in ECHA database.
Calcium oxide	In ECHA database.
Calcium stearate	Not in ECHA database.
Calmete C500	Not in ECHA database.
Calmete H2LT	Not in ECHA database.
Cashew Nut Shell Liquor (CNSL)	Not in ECHA database.
Desmophen TP-PU 1907	In ECHA database.
Diesel	In ECHA database.
Di-basic ester bulk	In ECHA database.
Diethylene glycol	In ECHA database.
Dipentene	In ECHA database.
Dipropylene glycol	In ECHA database.

Material	Justification for inclusion/exclusion of Relevant Hazardous Substances
Dri-sil 55	Not in ECHA database.
Effluent	In ECHA database.
Effluent Sludge	In ECHA database.
Ekaland 100 GCP	In ECHA database.
Energol CS68	In ECHA database.
Epoxy resins and derivatives	In ECHA database.
Epoxy silane	In ECHA database.
Esterified resole	In ECHA database.
Ethylene glycol (Mono Ethylene Glycol)	In ECHA database.
Ethylene glycol diacetate	In ECHA database.
Formaldehyde	In ECHA database.
Formic acid 85%	In ECHA database.
Furans	In ECHA database.
Furane	In ECHA database.
Furfural alcohol	In ECHA database.
Gamma-butyrolactone	In ECHA database.
Hazardous general waste	In ECHA database.
Heavy layer distillate	In ECHA database.
Hexamine (and hexamine lubricated)	In ECHA database.
IMS 358	In ECHA database.
IMS 94	Not in ECHA database.
Isopropanol	In ECHA database.
Jeffsol EC50	In ECHA database.
Lactic acid 80%	In ECHA database.
Latex 115	In ECHA database.
Latex aquastik 1120	In ECHA database.
Latex Breon 1562	In ECHA database.

Material	Justification for inclusion/exclusion of Relevant Hazardous Substances
Libranone C40	In ECHA database.
Light layer distillate	In ECHA database.
Lignin MNRP-2H (58)	Not in ECHA database.
Liquid lab waste	In ECHA database.
Liquid novolac resins	Not in ECHA database.
Mangalox M75	In ECHA database.
Methanol	In ECHA database.
Methylformate	In ECHA database.
Methylene Diisocyanate	In ECHA database.
Microcal ET	In ECHA database.
Mono Ammonium Phosphate	In ECHA database.
Monoethylene glycol	In ECHA database.
Monophenyl Glycol	Not in ECHA database.
Mowilith DM 132	In ECHA database.
Non-hazardous general waste	Not in ECHA database.
Novalac powdered resins	In ECHA database.
Oxalic acid	In ECHA database.
Paraform 91LP	In ECHA database.
Pel rig 9238	Not in ECHA database.
Phenol (total)	In ECHA database.
Poly-ethylene glycol	In ECHA database.
Portachrome C38	In ECHA database.
Potassium hydroxide (50%)	In ECHA database.
Propylene carbonate	In ECHA database.
PTSA (65%) TUX8	In ECHA database.
Rapeseed oil butyl ester	Not in ECHA database.
Recovered Phenol (80%)	In ECHA database.
Resin liquid waste	In ECHA database.

Material	Justification for inclusion/exclusion of Relevant Hazardous Substances
Resin powder waste	In ECHA database.
Resole distillate	In ECHA database.
Resole resins	In ECHA database.
Resorcinol	In ECHA database.
Resorcinol fraction RFK	In ECHA database.
Rubble	Not in ECHA database.
Salicylic acid	Not in ECHA database.
Scrap metal	Not in ECHA database.
Silane 1506	Not in ECHA database.
Silane ameo/a1101/a1100	Not in ECHA database.
Sodium ethyl hexyl sulphate (40%)	In ECHA database.
Sodium Hydroxide	In ECHA database.
Solid lab waste	In ECHA database.
Solvent waste	In ECHA database.
Styrenated phenol	In ECHA database.
Styrene	In ECHA database.
Sulphuric Acid	In ECHA database.
Sulphamic Acid	In ECHA database.
Triacetin	In ECHA database.
Triethanolamine	In ECHA database.
Urea Fomaldehyde Concentrate	In ECHA database.
Wooden Pallets	Not in ECHA database.
Zinc Acetate	In ECHA database.
Zinc Stearate	Not in ECHA database.

4.0 Stage 3 - Risk assessment for each relevant hazardous substance

4.1 Baseline Reporting Stage 3 – possibility of soil or groundwater contamination by relevant hazardous substances released from the site of the installation.

- 4.1.1 Table 4 summarises the quantities and storage locations of RHS on the Site. The table also describes the measures that are in place to adequately contain the substance when it is not in use, and to prevent leakage to natural ground or water.
- 4.1.2 The locations of all potential contaminant sources are shown in Figures 8 and 9 in Appendix 3.

Table 4) Storage and handling locations for all relevant hazardous substances, taken from the 2006 IPPC application (Application Site Report).

Tank No.	Location	Contents	Design Capacity (m ³)	Description (construction, use and condition)	Age (Est. date)	Nature and mode of fill and draw lines and points	Secondary Containment (impervious?)	Tertiary Containment (impervious?)	Integrity Testing	Evidence of Potential Releases
V211	A30	25% Caustic (refers to sodium hydroxide, NaOH)	0.1	Carbon steel tank of apparent good condition	1990	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V301	A10	Phenol	104	Stainless steel tank of apparent good condition	1990	Dip pipe and diffuser. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V302	A10	Phenol	59.7	Stainless steel tank of apparent good condition	1990	Dip pipe and diffuser. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V303	A10	Formalin (Formaldehyde aqueous solution)	198,313 litres	Stainless steel tank of apparent good condition	1990	Dip pipe and diffuser. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V304	A10	Diethylene glycol		Carbon steel tank of apparent good condition	1990	Bottom filling and draining	No secondary containment in place	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed

V305	A10	Polyethylene glycol		Carbon steel tank of apparent good condition	1990	Bottom filling and draining	No secondary containment in place	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V306	A10	Monoethylene glycol	V304, V305 and V306 combine to 103m ³	Carbon steel tank of apparent good condition	1990	Bottom filling and draining	No secondary containment in place	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V307	A20	IMS 94	30	Carbon steel tank of apparent good condition	1990	Dip pipe. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V313	A20	Methanol	30	Carbon steel tank of apparent good condition	1990	Dip pipe. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V603	A20	Phenol Recovered	33	Stainless steel tank of apparent good condition	1990	Dip pipe and diffuser. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V604	A20	Phenol Recovered	33	Stainless steel tank of apparent good condition	1990	Dip pipe and diffuser. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
2-V608	A20	Formalin Formaldehyde aqueous solution	33	Stainless steel tank of apparent good condition	1990	Dip pipe and diffuser. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed

3-V619	A30	Phenol/product	10.12	Carbon steel tank of apparent good condition	1990	Bottom filling and draining	No secondary containment in place	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
3-V620	A30	Phenol/product	10.12	Carbon steel tank of apparent good condition	1990	Bottom filling and draining	No secondary containment in place	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
1-V1001	A10	Resole distillate	100	Stainless steel tank of apparent good condition	1999	Dip pipe. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
15-V1525	A15	Ace mixing vessel	2.8	Stainless steel tank of apparent good condition	2000	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
15-V1526	A15	Ace storage	15	Stainless steel tank of apparent good condition	2000	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
15-V1527	A15	Ace storage	15	Stainless steel tank of apparent good condition	2000	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
15-V1528	A15	Furane mixing vessel	2.8	Stainless steel tank of apparent good condition	2000	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed

15-V1529	A15	Furane storage	15	Stainless steel tank of apparent good condition	2000	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
15-V1530	A15	Furane storage	15	Stainless steel tank of apparent good condition	2000	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparently good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
1-V1531	A10	Furfuryl alcohol	45.4	Carbon steel tank of apparent good condition	2000	Top filling and side draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding and gravel	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
1-V1532	A10	Resole distillate	45.4	Stainless steel tank of apparent good condition	2000	Top filling and side draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding and gravel	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
1-V1533	A10	Sodium Hydroxide	45.4	Carbon steel tank of apparent good condition	2000	Top filling and side draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding and gravel	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
1-V1534	A10	Potassium Hydroxide	45.4	Carbon steel tank of apparent good condition	2000	Top filling and side draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding and gravel	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
1-V1535	A10	Caustic rewash (NaOH)	56.7	Carbon steel tank of apparent good condition	2000	Top filling and side draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding and gravel	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed

1-V1543	A10	Process water	56.7	Carbon steel tank of apparent good condition	2000	Top filling and side draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding and gravel	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
15-V1562	A30	Oxalic acid	2.8	Stainless steel tank of apparent good condition	2000	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding and gravel	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
2-V1571	A20	Heavy layer distillate	150	Stainless steel tank of apparent good condition	1985	Offloading lines extend beyond the bund and overhang unsurfaced ground.	Tank contained within bund	Concrete hardstanding and gravel	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
2-V1572	A20	Light layer distillate	150	Stainless steel tank of apparent good condition	1985	Dip pipe. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
3-V1573	A30	Sulphuric acid	3	Plastic tank of apparent good condition	2000	Top filling and side draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V401/4 02	A50	Resole product	40.39	Carbon steel tank of apparent good condition	1989	Side filling and bottom draining	A bund kerb is provided, although it is possible that the kerb will not contain 100% of the volume of the tank	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V403/4 04	A50	Resole product	40.39	Carbon steel tank of apparent	1989	Side filling and bottom draining	A bund kerb is provided, although it is	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed

				good condition			possible that the kerb will not contain 100% of the volume of the tank			
V405/406	A50	Resole product	40.39	Carbon steel tank of apparent good condition	1989	Side filling and bottom draining	A bund kerb is provided, although it is possible that the kerb will not contain 100% of the volume of the tank	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V407/408	A50	Resole product	40.39	Carbon steel tank of apparent good condition	1989	Side filling and bottom draining	A bund kerb is provided, although it is possible that the kerb will not contain 100% of the volume of the tank	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V409/410	A50	Resole product	40.39	Carbon steel tank of apparent good condition	1989	Side filling and bottom draining	A bund kerb is provided, although it is possible that the kerb will not contain 100% of the volume of the tank	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V411/412	A50	Resole product	40.39	Carbon steel tank of apparent good condition	1989	Side filling and bottom draining	A bund kerb is provided, although it is possible that the kerb will not contain 100% of	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed

							the volume of the tank			
V413/4 14	A50	Resole product	40.39	Carbon steel tank of apparent good condition	1989	Side filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V415/4 16	A50	Resole product	40.39	Carbon steel tank of apparent good condition	1989	Side filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
5- V1508 a/b	A50	Resole product	91.6	Carbon steel tank of apparent good condition	2000	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V1509	A50	Resole product	63.9	Stainless steel tank of apparent good condition	1996	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V1510	A50	Resole product	63.9	Carbon steel tank of apparent good condition	1996	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V1511 a/b	A50	Resole product	91.6	Carbon steel tank of apparent good condition	2000	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed

V1512	A50	Resole product	63.9	Stainless steel tank of apparent good condition	1996	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V1513	A50	Resole product	63.9	Carbon steel tank of apparent good condition	1996	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V1514	A50	Resole product	45.8	Stainless steel tank of apparent good condition	2000	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V1515	A50	Resole product	45.8	Stainless steel tank of apparent good condition	2000	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V1516	A50	Resole product	45.8	Stainless steel tank of apparent good condition	2000	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V1517	A50	Resole product	63.9	Stainless steel tank of apparent good condition	2000	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V1518	A50	Resole product	63.9	Carbon steel tank of apparent good condition	2000	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed

V1519	A50	Resole product	63.9	Carbon steel tank of apparent good condition	2000	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V1520	A50	Resole product	22.9	Carbon steel tank of apparent good condition	2000	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V1521	A50	Resole product	63.9	Carbon steel tank of apparent good condition	2000	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V1581 a/b	A50	Resole product	110.8	Carbon steel tank of apparent good condition	2003	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V1582 a/b	A50	Resole product	110.8	Carbon steel tank of apparent good condition	2003	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
V1588	A50	Surfactant	39	Stainless steel tank of apparent good condition		Top filling and side draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
15-V1536	A15	Triacetin	45	Carbon steel tank of apparent good condition	1993	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent moderate condition with adjacent natural ground	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed

15-V1537	A15	Ethylene glycol diacetate	45	Carbon steel tank of apparent good condition	1993	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent moderate condition with adjacent natural ground	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
15-V1538	A15	Dibasic ester	45	Carbon steel tank of apparent good condition	1993	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent moderate condition with adjacent natural ground	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
15-V1539	A15	Propylene carbonate	45	Carbon steel tank of apparent good condition	1993	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
15-V1540	A15	Gamma butyrolactone	45	Carbon steel tank of apparent good condition	1993	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
15-V1541	A15	Urea Formaldehyde Concentrate	31.5	Stainless steel tank of apparent good condition	2000	Top filling and side draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
SILOS	A80	Powdered Novolac resin	171.5	Aluminium silos of apparently good condition	1990	Not known	No secondary contain-mint in place	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
3-V108	A30	Liquid Effluent	28	Carbon steel tank of apparent good condition	1990	Top filling and bottom draining. Contained within secondary containment	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed

3-V1555	A30	Product distillate	9.5	Stainless steel tank of apparent good condition	2000	Top filling and bottom draining	No secondary containment in place	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
3-V1556	A30	Phenol formaldehyde resin	20	Stainless steel tank of apparent good condition	1988	Bottom filling and bottom draining	No secondary containment in place	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
TK101	U240	Diesel	26	Stainless steel tank of apparent good condition	1980	Top filling and bottom draining. Contained within secondary containment. However, the hose is not contained and has potential to discharge to a nearby gravelled area.	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	Staining was observed on a gravelled area adjacent to the bund due to spillages that occur during filling operation
TK102	U240	Diesel	26	Stainless steel tank of apparent good condition	1980	Top filling and bottom draining. Contained within secondary containment.	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
Boiler House	U240	Hydrochloric Acid	5	Plastic tank of apparent good condition	2000	Top filling and bottom draining. Contained within secondary containment.	Integrated plastic bund within tank	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed

Cooling Tower		Additive	1	Plastic tank of apparent good condition	?	Top filling and bottom draining.	No secondary containment in place	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
300-V1660	Effluent Treatment Plant	Liquid Process Effluent	15	(No tank details)	2000	Top filling and bottom draining. Contained within secondary containment.	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
300-V1663	Effluent Treatment Plant	Effluent Sludge	50	(No tank details)	2000	Top filling and bottom draining. Contained within secondary containment.	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
300-V1665	Effluent Treatment Plant	Liquid Process Effluent	6	Stainless steel tank of apparent good condition	2000	Top filling and bottom draining. Contained within secondary containment.	Concrete bund of apparently good condition	Concrete hardstanding of apparent good condition	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
Boiler House	Boiler House U240	Caustic (NaOH)	1	Plastic IBC (Intermediate Bulk Carrier)	2000	Top filling and bottom draining	No secondary contain-ment in place	Concrete hardstanding and natural ground	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed
Boiler House	Boiler House U240	Diesel		(No tank details)			No secondary contain-ment in place	Concrete hardstanding and natural ground	Integrity of tank tested through water filling	No spillages or other evidence of potential releases were observed

4.1.3 Based on the information in Table 4, it can be assumed that due to the primary, secondary and tertiary containment there is a negligible possibility of the release of the majority of stored RHS, with the following exceptions:

- 1) Monoethylene glycol, Diethylene glycol and Polyethylene in Location A10 - HIGH chance of pollutant leakage (no secondary containment in place);
- 2) Heavy layer distillate in Location A20 – LOW chance of pollutant leakage (offloading lines overhanging bund);
- 3) Resole product in Location A50 – MODERATE chance of pollutant leakage (bund may have insufficient capacity);
- 4) Triacetin in Location A15 – LOW chance of pollutant leakage (moderate condition of tertiary concrete hardstanding);
- 5) Ethylene glycol diacetate in Location A15 – LOW chance of pollutant leakage (moderate condition of tertiary concrete hardstanding);
- 6) Dibasic ester in Location A15 – LOW chance of pollutant leakage (moderate condition of tertiary concrete hardstanding);
- 7) Powdered Novolac resin in Location A80 – HIGH chance of pollutant leakage (no details of storage tank, and no secondary containment in place);
- 8) Phenol formaldehyde resin in Location A30 – HIGH chance of pollutant leakage (no secondary containment in place);
- 9) Diesel in TK101 in Location U240 – VERY HIGH chance of pollutant leakage (hose is not contained and may discharge to nearby gravel area). Staining has been observed on the gravelled area of the bund due to small diesel spillages;
- 10) Diesel in Boiler House U240 Location – HIGH chance of pollutant leakage (no details of storage tank, no secondary containment in place and natural ground adjacent to hardstanding);
- 11) Additive in Cooling Tower location – HIGH chance of pollutant leakage (no secondary containment in place);
- 12) Liquid Process Effluent and Effluent Sludge in the Effluent Treatment Plant location – MODERATE chance of pollutant leakage (no storage tank details available);
- 13) Caustic product – HIGH chance of pollutant leakage (no secondary containment in place); and

4.1.4 It must be emphasised that these substances represent the most significant risk to groundwater due to the way that they were/are stored. Other RHS listed in Table 3 may conceivably enter groundwater via some of the pathways summarised in Table 10, however the likelihood of this occurring is much lower. The application site report states that the transport mechanism, vehicles, pipelines, etc. are all of sound construction, and are regularly inspected and maintained.

4.1.5 Of the RHS listed in Table 3, only the substances listed below were measured in groundwater samples from the Site groundwater monitoring boreholes by Alcontrol Laboratories; as part of

the original URS baseline report in 2006 (raw data is appended separately). The RHS identified in section 4.1.4 as being at higher risk of leakage to natural ground and/or surface- and groundwater receptors are highlighted in bold. For convenience they are listed in alphabetical order. Some substances may be present as indicated by aggregate parameters such as TPH (Total Petroleum Hydrocarbons) e.g. Diesel; or Total Aromatic Hydrocarbons (TAH) e.g. Di-basic Ester or Esterified resole but petroleum hydrocarbons and aromatic hydrocarbons were not speciated and so it not possible to definitively state whether a particular hydrocarbon was present.

4.1.6 We do not think 'grouping' (Section 3.1.3) into TAH or TPH is appropriate without fully understanding the speciated component mix and its variation over time, which is now not possible.

- Acetone
- **Diethylene glycol**
- Ethylene glycol
- **Formaldehyde (as phenol-formaldehyde resin)**
- **Heavy layer distillate (measured as phenol)**
- Light layer distillate (measured as phenol and formaldehyde)
- Methanol
- **Monoethylene glycol**
- **Phenol (total)**
- **Polyethylene glycol**
- **Resole product (as total phenol and formaldehyde)**
- Resorcinol RFK fraction (as total phenol and ammonia liquor)

4.1.7 Therefore, this baseline report focuses on the following speciated RHS which are at the highest risk of polluting natural ground and/or surface- and groundwater; and for which there is monitoring data available (see Figure 7, Appendix 3):

- Monoethylene glycol – In Location A10; Diethylene glycol – In Location A10;

Polyethylene glycol – In Location A10;

- Formaldehyde – In Locations A30 & A50, offloading in Area 10;
- Phenol – In Location A30 & A50, offloading in Area 10;

4.1.8 For convenience; monoethylene glycol, diethylene glycol and polyethylene glycol will be grouped together and termed 'glycols'. The analytical data for diethylene glycol will be used as an 'indicator substance' representing the concentration of glycols, as little data is available for monoethylene glycol and polyethylene glycol.

5.0 Stage 4 – Site history and background

5.1 Site location and setting

The installation address is Sully Moors Road, Sully, Penarth, CF64 5YU, Wales. The Site is located approximately 4 km east of Barry town centre, and 5 km south-west of Penarth town centre. The grid reference of the centre of the Site is 314620, 168275. The site falls within the County Borough of the Vale of Glamorgan (Welsh: *Bro Morgannwg*). The location of the site is shown in Figure 6 (Appendix 3).

5.2 Site history

- 5.2.1 Site history has been established from client-supplied information and reference to the online resource *Grace's Guide to British Industrial History*.
- 5.2.2 The history of the Site goes back to the post-war period. One of the early occupiers was British Resin Products Ltd. (BRP), which built a plant on the current Site in 1950. The plant made thermo-setting and thermo-plastic mouldings powders, paint, resins and synthetic adhesives.
- 5.2.3 In 1967 BRP was sold to British Petroleum Company (BP) together with Distillers Co's (another company originally purchased by BRP in 1937). BP established a new subsidiary company (BP Chemicals) that year, to hold all of BP's chemical and plastics interests and the chemicals businesses acquired from Distillers Co.
- 5.2.4 In the late 1990's the Site was acquired from BP by Blagden Specialty Chemicals Ltd.
- 5.2.5 In 1999 the Site was sold to Borden Chemical UK Ltd. In 2005, Borden Chemical UK Ltd. became part of Hexion Specialty Chemicals, Inc. In 2010, Hexion LLC (the parent company of Hexion Specialty Chemicals, Inc.) merged with Momentive Performance Materials Holdings, Inc. (the parent company of Momentive Specialty Chemicals UK Ltd.).
- 5.2.6 In January 2015, Hexion LLC and Momentive Performance Materials Holdings Inc. de-merged, and Momentive Specialty Chemicals UK Ltd. became Hexion UK Ltd.

5.3 Previous reports

- 5.3.1 A baseline report for the Site (then operated by Momentive Specialty Chemicals UK Ltd.) was completed by URS in 2006. Water samples from the groundwater monitoring boreholes on the Site were analysed (see Figure 7 in Appendix 3).
- 5.3.2 The most recent baseline report for the Site was by ExCAL Ltd in 2014. ExCAL were commissioned by Momentive Specialty Chemicals UK Ltd (now named Hexion UK Ltd) to undertake a review of groundwater monitoring results obtained between 2007 and 2013 at the Site.

5.4 Previous accidents/incidents on-site resulting in the emission of RHS

5.4.1 The following is a summary of accidents/incidents that have occurred at the facility in the period of the baseline report (2008-2010):

- On the 5th of February 2008 at 19:30, there was a leak from the Reactor 3 hot water pipework. During the heating phase in the manufacture of a resin batch there was a failure of the heating and cooling supply pipe work (Functional location 030). The system was circulating water at a pressure of 13 bar and at a temperature of 112 degrees C. the hole in the pipe was approximately 6mm long by 4mm wide on the outside of an elbow located at high level, 3.2 meters off the ground, and resulted in hot water, some of which was turning into steam, escaping the lagged pipework. The hot water sprayed over an area of 2 to 3 metres. An operator working locally to the area heard the failure and reported it to the control room. The system was put to cool and shut down for investigation/repair. This incident was classified as a serious health and safety incident, but did not have any environmental consequences.
- On the 12th of February at 13:00, approximately 750kg of TCS1200 [SE8B0117] was spilled from the IBC filling point of the Furane mixing vessel (Functional location: 015). One IBC was filled and the filling hose returned to its holster. The operator left the area to take a break. On returning he found that the valve was part open and resin had spilled into the bunded area. He had not closed the other manual valve or either of the actuated valves. The spill was contained and sucked up by the gully sucker for disposal. The state of the work environment at the time of the incident was normal/routine operations. The incident was classified as a minor environmental incident.
- On the 29th of March 2008 at 08:51 there was an overflow of resin from V407 (Functional location 050). When discharging to the tank from R1 and charging the libranone the high level came up on the tank and stopped the pump with approx. 400kg left in the reactor which was dropped to drain. The operator then blew the lines through to the tank, a practice that had been done in the past when making a lot of J6014L and the tanks have been at a high level. It was then noticed that product had come through the vent into the bunded area, approx. 1000kg. The operator informed Richard Sullivan as he was on-Site and started the clean-up process. This incident was classified as a minor environmental incident.
- On the 1st of June 2009 at 04:48 there was a spillage of OS121LA. The logistics operator loaded a tank of OS121LA. The driver had been held on site for a period awaiting product approval and was asleep in his cab during loading. The logistics operator closed the 'loading' manlid and instructed the driver that he had done so. The driver then drove around to the weighbridge. A small quantity (5-10 litres) of resin was noticed on the weighbridge. A second manlid was open, further along the tanker body. The logistics operator was unaware of this when he informed the driver that he had closed up. The driver brought the vehicle back from the weighbridge and closed the second manlid. Security personnel cleaned up the spillage. The haulier has been notified of the incident and a request made for drivers to ensure all tankers are fully sealed whilst driving around site. The state of the work environment at the time of the incident was normal/routine operations. This incident was classified as a minor transportation risk incident (green).

- On the 26th of July 2009 at 08:23 there was an R330UF spillage at tank V1520 (Functional location: 050). The outlet valve from a loading filter on tank V1520 left open following loading IDP140. Operator set up to load R330UF from the same loading point. During loading, the resin backed into the filter through the open value on tank V1520. The resin was then able to drain via the open filter drain line into the collecting IBC below the loading point. Once full, this IBC overflowed; releasing approximately 500kgs of product into the bunded roadway. The operator had checked on the load part way through but as the resin was at this time flowing into the collecting IBC nothing was noticed at this time. The spillage was collected into open top drums on the 26th of July. The surrounding area was caustic-washed on the 27th June. The filter on tank V1520 was left open to drain. A reminder was issued to operators to ensure that they close appropriate valves following loading operations. The state of the work environment at the time of the incident was normal/routine operations. This incident was classified as a minor environmental risk incident (green).
- On the 3rd of November 2009 at 03:43 there was a site spillage of BSR69 (Functional location; 050) following the fall of an IBC from a shunt truck. One IBC of BSR69 fell from the site shunt unit while being transported. The vehicle was turning a corner, the IBC slid off and hit a metal pipe stanchion. The IBC split open and approximately 800kgs of product spilt. The warehouse operator driving the shunt unit stopped the vehicle and transferred to FLT to right the IBC. The operator contacted Steve Hatcher who then worked with him to contain the spill with sand. The absorbent material was collected into open top drums and the area was washed down with water into the bunded area. The stock was written off and the container was sent for disposal. The state of the work environment at the time of the incident was normal/routine operations. This incident was classified as a minor environmental risk incident (green).
- On the 21st of January 2010 at 02:40 there was a caustic leak (Functional location: 030). The Area R10 NaOH/KOH line leaking from above the urea exhauster box onto pipework and cables and dripping down around the area. The leak was taped off. R10 was discharged to tank 1582T and shut down the next morning to inspect the lines. The area was taped off and washed down. The lines were flushed to decontaminate them before they were repaired. The leak in the vicinity of manual valve 1-V2701 Relief valve PRV was inspected, and the outlet was found to be blocked. N.b. previous incident IIS-305-09-00016. The state of the work environment at the time of the incident was normal/routine operations. This incident was classified as a safety low risk incident (yellow).
- On the 26th of April 2010 at 05:05 there was a hose failure on the R1 heating and cooling system (Functional location: 030). The incident was described as a leak on the cooling water/steam inlet at the base of the vessel. The heating and cooling package was isolated, and a maintenance technician was called in. The technician remarked that it appeared that a flange had gone, and that a scaffold would be needed for repair access. Batch (N1205) on the acid cloud point (<5°C). Cooled back to below 40°C. The state of the work environment at the time of the incident was normal/routine operations. This incident was classified as a moderate safety risk incident (orange).
- On the 25th of May 2010 at 07:00 there was a leak of 28% hydrochloric acid from a hose connection (Functional location: Utilities). After changing an IBC of 28% Hydrochloric acid (HCl) it was found that the connection hose was leaking. The IBC had

lost approximately 100 litres of acid. The HCl is used in the softening plant and the IBC is mounted on an IBC bund outside the building. The IBC base valve was closed and the hose disconnected. The area was washed down with water in order to make it safe. The state of the work environment at the time of the incident was normal/routine operations. This incident was classified as a minor environmental risk incident (green).

- On the 23rd of September 2010 at 11.15 there was a resin spill from the R3 sample valve (Functional location: 030). Approximately 1,215kg of resin spilled from the R3 sample valve. The sample valve was closed and effluent diverted to V108. The spill was contained and cleared. The state of the work environment at the time of the incident was normal/routine operations. This incident was classified as a minor environmental risk incident (green).

5.4.2 None of these incidents had a significant environmental impact.

5.5 Site Protection and Monitoring Programme

5.5.1 A Site Protection and Monitoring Programme (SPMP) was prepared for Hexion Specialty Chemicals UK Limited (Hexion UK), Barry Thermosets Plant ('BTP') by URS in February 2007 and submitted to the Environment Agency Wales (EAW) in pursuance of Condition 2.8.1 of the Permit No. PP3238LX (the 'Permit') authorising the operation of Hexion Specialty Chemicals UK Limited, Barry Thermosets Plant (the 'installation').

5.5.2 The SPMP recommended that an intrusive investigation be undertaken to characterise substances identified as being potentially present in, on or under the ground in the Application Site Report (the 'ASR') submitted with the Permit Application. The scope of those investigations was to collect reference data together, to develop an Environmental Monitoring Programme and make recommendations for routine monitoring to be collated into an annual monitoring report. Each monitoring report was also recommended to contain any recommendations for change to the SPMP, subject to agreement with Natural Resources Wales (NRW).

5.5.3 The SPMP recommended:

- That 22 monitoring wells of the larger number previously installed at the site (9 installed in alluvium (superficial deposits) and 13 installed in mudstone bedrock) located in key areas identified by the ASR should be incorporated into an ongoing groundwater monitoring programme for the SPMP. In addition, 10 new boreholes should be installed, 6 to monitor the alluvial aquifer and 4 to monitor groundwater in the bedrock.
- That at each boring, soil samples should be collected at approximately 0.5m intervals for on-site headspace analysis of ionisable volatile organic compounds (VOCs) using a Photo Ionisation Detector (PID).
- Groundwater elevations and subsequent sampling of all monitoring well locations should be carried out following installation and allowing for a suitable time period for stabilisation of the groundwater.
- Topographic survey to assist with assessment of shallow groundwater flow direction and further develop the conceptual site model.

- 5.5.4 The additional monitoring well installations and requisite sampling was undertaken by URS and reported in Report No. 44382712-CRRP0002, which is included in Appendix 6 of this report.

6.0 Stage 5 – Environmental setting

6.1 Topography

- 6.1.1 The topography of the Site is relatively level at approximately 7 mAOD. The southern boundary of the Site adjacent to Hayes Road is slightly lower (6 mAOD) and lies ~450m north of the Severn Estuary.

6.2 Geology of Site

- 6.2.1 The following description of the Site geology is based on the British Geological Survey (BGS) online mapping resource.
- 6.2.2 The Site is underlain by the Mercia Mudstone Group (MMG). The MMG is Early Triassic in age and is described by the BGS as ‘Dominantly red, less commonly green-grey, mudstones and subordinate siltstones with thick halite-bearing units in some basal areas. Thin beds of gypsum/anhydrite widespread; sandstones are also present’.
- 6.2.3 The lower boundary of the MMG is gradational on the Sherwood Sandstone Group, and is taken where mudstone and siltstone become dominant over sandstone, and the incoming of pseudomorphs after halite.
- 6.2.4 The upper boundary of the MMG is defined where the Penarth Group sharply overlies the MMG and signifies the incoming of marine lithologies.
- 6.2.5 The Site has up to ~4.7m of superficial deposits consisting of ash/made ground with silty clay (alluvium) and gravel (storm beach deposits) underneath.
- 6.2.6 There are 6 BGS boreholes within 120m of the southern/western Site boundary. A summary of the geological conditions in each borehole is shown in Tables 5 to 9 below:

Table 5) BGS borehole logs

BGS ID: 378006; BGS Ref: ST16NW139; BNG: (27700): 314550, 168040			
Top depth (m)	Bottom depth (m)	Thickness (m)	Strata Description
0.00	0.61	0.61	ASHES.
0.61	2.44	1.83	Hard CLAY.
2.44	3.96	1.52	Brown CLAY with gravel.
3.96	4.27	0.31	SILT.
4.27	4.57	0.30	GRAVEL.
4.57	4.80	0.23	ROCK.

Table 6) BGS borehole logs

BGS ID: 378007; BGS Ref: ST16NW140; BNG: (27700): 314530, 168070			
Top depth (m)	Bottom depth (m)	Thickness (m)	Strata Description
0.00	0.61	0.61	ASHES.
0.61	2.29	1.68	Hard brown CLAY.
2.29	3.96	1.67	CLAY and gravel.
3.96	4.42	0.46	SILT.
4.42	4.65	0.23	GRAVEL.
4.65	4.72	0.07	ROCK.

Table 7) BGS borehole logs

BGS ID: 378005; BGS Ref: ST16NW138; BNG: (27700): 314500, 168070; GL: +6.25 mAOD			
Top depth (m)	Bottom depth (m)	Thickness (m)	Strata Description
0.00	0.91	0.91	MADE GROUND. Stiff and soft to firm grey silty CLAY and rootlets with a layer of ashes at the base.
0.91	3.05	2.14	Soft to firm brown and grey silty CLAY. Some roots at 3'6"-4'0".
3.05	4.88	1.83	Pieces of hard red MARL in a matrix of soft to firm calcareous silty clay (WEATHERED MARL).
4.88	5.64	0.76	Hard red MARL.
5.64	7.16	1.52	Hard red and grey LIMESTONE and small vugs of calcite crystals.

Table 8) BGS borehole logs

BGS ID: 378003; BGS Ref: ST16NW136; BNG: (27700): 314390, 168110; GL: +6.10 mAOD			
Top depth (m)	Bottom depth (m)	Thickness (m)	Strata Description
0.00	0.38	0.38	Boiler ASHES.
0.38	2.44	1.86	Silty CLAY.
2.44	3.35	0.91	Red MARL.

Table 9) BGS borehole logs

BGS ID: 378008; BGS Ref: ST16NW141; BNG: (27700): 314280, 168240; GL: +6.55 mAOD			
Top depth (m)	Bottom depth (m)	Thickness (m)	Strata Description
0.00	1.37	1.37	ASHES – filling and clay lumps.
1.37	2.13	0.76	CLAY.
2.13	2.51	0.38	GRAVEL.

6.3 Hydrology

- 6.3.1 The dominant surface water feature in the immediate vicinity of the Site is Sully Brook, a small waterway which is a tributary to the Cadoxton River. Sully Brook has its source just to the west of Penarth. It flows southwards through the Cosmeston Lakes Country Park, across the Site flowing to the south-west, beneath Sully Moors Road and joins the Cadoxton just south of the Site, near to Barry docks. The Cadoxton River flows to the south-west and enters the Bristol Channel through a manmade estuary at 'The Bendricks', Vale of Glamorgan; just to the east of Barry docks.
- 6.3.2 At its closest point, the part of the Hexion UK site which is designated Zone E (see Figure 7, Appendix 3) is located approximately 70m to the south of the Cadoxton River.
- 6.3.3 The Tidal Limit reach of the Cadoxton River has been designated in 2000 as Grade C 'Fairly Good' under the EA's General Quality Assessment (GQA) reporting system.
- 6.3.4 The Cadoxton has a flow of less than 0.62 m³/s in this reach (Envirocheck data, 2000).
- 6.3.5 Additionally, there were three drainage channels beneath the Site as indicated on some historical maps. These were no longer shown as present by 1965, presumably due to site predevelopment works.

6.4 Hydrogeology and Groundwater Flow

- 6.4.1 Data on groundwater levels has been obtained from the previous ExCAL report. Historical groundwater investigations show that there is a groundwater table at approximately 5.5-6m below ground level (mbgl), and a shallower perched water table at approximately 5mbgl.
- 6.4.2 Shallow groundwater flows from the southern boundary of the Site northward through the site towards Sully Brook on the northern site boundary.
- 6.4.3 Deeper groundwater flows from the processing areas of the Site, outward in all directions towards the Site boundaries.
- 6.4.4 The permeability of the superficial deposits on the Site is not known.
- 6.4.5 The superficial clay layers underlying the Site are described as 'hard' or 'silty'. It is reasonable to assume a permeability range in clay/silty clay of 5×10^{-7} to 10^{-3} m/day, depending on their degree of compaction (Lewis, 1989).

- 6.4.6 The Mercia Mudstone is of low bulk permeability (e.g. between 10^{-1} and 10^{-3} m/day, with flows mainly parallel to bedding (Tellam and Lloyd, 1981)) and primarily within the more permeable sandstone units. It is classified as a minor aquifer (physical properties of minor aquifers, EA R&D publication 68).
- 6.4.7 Potential receptors of groundwater contamination include the perched groundwater aquifer, Sully Brook, Cadoxton River and the Bristol Channel.
- 6.4.8 The pathways are the Made Ground underlying the site, Sully Brook and the Cadoxton River.
- 6.4.9 Borehole locations are shown in Figure 7 (Appendix 3).

6.5 Drainage System (details from PPC Application Site Report, 2006)

- 6.5.1 All wastewaters produced on-site are captured by a Duplex (clean/foul) drainage system, which directs effluent to one of two interceptor pits (U25 or U39). In the main process area, this is via localised collection pits at A30, A50 and A10. From the interceptor pits, the effluent is discharged to the Severn Estuary at release point W1 via a clean and dirty water lagoon system and effluent treatment plant as appropriate.
- 6.5.2 Also discharged at W1 are wastewaters from the neighbouring Cognis, Zeon and Ineos Vinyls facilities. Wastewater from Cognis enters the Hexion UK drainage system at the U25 interceptor pit. Wastewater from the Ineos and Zeon facilities enter the Hexion UK drainage system at the clean lagoon.
- 6.5.3 A HAZOP assessment of the site's drainage system has been undertaken. The main effluent lines have been investigated and improvements have been undertaken to address identified deficiencies in the drainage system. Specifically, pressure tests conducted on the underground effluent line U25 revealed deficiencies in its integrity. U25 has since been replaced with an above ground effluent transfer pipe.
- 6.5.4 No CCTV surveys have been undertaken on below ground drainage systems at the installation and hence the integrity of site drainage was not established during preparation of the ASR.
- 6.5.5 The BTP implements and maintains an environmental management system that has been certified to ISO 14001 since 1997.
- 6.5.6 The standard of housekeeping during site reconnaissance was observed to be good.

7.0 Stage 6 – Description of site contamination

7.1 Description of previous site pollution

7.1.1 Table 10: Conceptual Site Model is taken from the IPPC application and is a summary of the potential pollution sources, pathways and receptors:

Table 10) Conceptual Site Model (from 2006 ASR)

Potential Sources	Potential Pathways	Potential Receptors
<p>Seepage of substances through concrete hardstanding and unsurfaced areas across the installation.</p> <p>Effluent drainage system.</p> <p>Spillages of raw materials, intermediates and products in process areas.</p> <p>Spillages from external storage areas.</p> <p>Spillages from vehicle offloading activities.</p> <p>Losses from overhead pipelines.</p> <p>Losses from effluent treatment plant.</p> <p>Losses from storage tanks.</p>	<p>Effluent drainage systems creating preferential pathways and/or direct discharge points.</p> <p>Building foundations and other underground services creating preferential pathways.</p> <p>Infiltration to the upper unsaturated zone of the soil.</p> <p>Vertical migration through the soil zone to the deep groundwater unit encountered in previous investigations.</p> <p>Lateral migration within the deep groundwater unit.</p>	<p>River Cadoxton.</p> <p>Sully Brook.</p> <p>Severn Estuary.</p> <p>Groundwater units in the vicinity of the installation. In this instance this can be assumed to be the perched groundwater at 5-6 mbgl.</p> <p>Groundwater and other surface water abstractions within the vicinity of the installation.</p> <p>Land within the vicinity of the installation.</p>

7.1.2 Based on the information in the 2006 IPPC application, the locations in which pollution is most likely to occur can be summarised as follows (see also Figures 8 and 9, Appendix 3):

- Zone E (Effluent treatment plant) – Concrete hardstanding noted to be of poor condition in 2006. Breach of the treatment plant could result in a release of pollutants to the ground via cracked concrete or neighbouring gravel areas. Receptors are the natural ground, perched groundwater and possibly Sully Brook (in groundwater flow direction).
- Zone B (A10 raw material tank farm) – Phenol offloading point contained by concrete hardstanding with no secondary containment in place to prevent flow to neighbouring gravel area. Receptors are the natural ground, perched groundwater and possibly Sully Brook (in groundwater flow direction).

- Zone B (A20 raw material tank farm) – Offloading point to heavy layer distillate tank located over gravelled area with no secondary containment in place. Receptors are the natural ground, perched groundwater and possibly Sully Brook (in groundwater flow direction).
- Zone B (A20 raw material tank farm) – IBC storage at boiler house and PRU on areas of concrete hardstanding with no kerbs or bunding to areas of gravel. Receptors are the natural ground, perched groundwater and possibly Sully Brook (in groundwater flow direction).
- Zone C (A30 reactor area) – Site of the large formaldehyde leak in October 2002 (see section 5.2.4). Receptors are the natural ground, perched groundwater and possibly Sully Brook (in groundwater flow direction).
- Zone C (A50 finished product storage area) – Localised breakdown of expansion joint seals on concrete hardstanding within Area 30 and adjacent roadway. Potential for infiltration of substances through breaches. Receptors are the natural ground, perched groundwater and possibly Sully Brook (in groundwater flow direction).
- Zone G (A50 finished product storage area) – Insufficient secondary containment for storage tanks V401-V412. Concrete kerb containment would not contain 100% of single tank. Breach of kerb would lead to loss of substances to gravel. Drains in the vicinity discharge to A30 effluent collection pit. Receptors are the natural ground, perched groundwater and possibly Sully Brook (in groundwater flow direction).
- Zone Q (Boiler house area) – IBC storage at boiler house and PRU on areas of concrete hardstanding with no kerbs or bunding to areas of gravel. Receptors are the natural ground, perched groundwater and possibly Sully Brook (in groundwater flow direction).
- Zone Q (Diesel tank) – Appropriate secondary containment in place for diesel pump for onsite vehicles. Localised staining of gravels adjacent to bund due to spillage during filling operations and bund overflow (see section 5.2.4). Receptors are the natural ground, perched groundwater and possibly Sully Brook (in groundwater flow direction).

8.0 Stage 7 – Information availability

- 8.1.1 Stage 7 of the EU guidance on baseline report preparation (see Table 1) is omitted as sufficient information already exists to quantify the state of groundwater pollution by RHS.

9.0 Stage 8 – Baseline site report

9.1 Scope of Baseline Report

- 9.1.1 The scope of the baseline report is to include a review of groundwater quality data obtained between March 2008 and September 2010. This data forms the reference data for the site as representative of the period before operations subject to the Permit commenced.
- 9.1.2 There are data gaps from early in this period; therefore, the data capture period was extended beyond the year the Permit was issued (2008) to comprise the two-year period following permit issue. It is considered that this is required to provide an accurate, statistically-robust baseline assessment for the site.
- 9.1.3 Data from 2010 to present is therefore excluded from this assessment.
- 9.1.4 Soil data is unavailable and has not been assessed.

9.2 Approach to Baseline Report Calculations

- 9.2.1 Reference data from March 2008 to September 2010 (6 measurement rounds) was used to calculate the mean zonal concentrations for the RHS listed in section 4.1.6 for each zone of the site as designated in the 2006 ASR (see Table 11 and Figures 1-5). It was not appropriate to assign a zone to BH101, BH201 and BH220. As BH101 and BH220 are adjacent to each other the statistics from these boreholes were lumped together and termed 'outside zone'. BH201 and BH404 (Zone R) could only be considered on an individual basis.
- 9.2.2 Concentrations of each of the RHS from each sampling round (March 2008, September 2008, March 2009, September 2009, March 2010 and September 2010) for all the boreholes in each zone were used to calculate mean values and standard deviation (see Table 12).
- 9.2.3 Data greater than the 95th percentile value for each borehole was considered an outlier and was excluded from the mean calculation for the dataset².

9.3 Review of borehole groundwater quality data (March 2008 – September 2010)

- 9.3.1 In general, the measured RHS concentrations for example for glycols and formaldehyde were below the stated Limit of Detection (LOD) of the analytical methods used. However, concentrations of total phenol were well above the Environmental Quality Standard (EQS) value in Zone A (non-bulk raw material and product storage area).
- 9.3.2 Concentrations of glycols were all <1 mg/l (equivalent to the LOD) when measured in March 2008, and <10 mg/l (equivalent to LOD) when measured in March and September 2010. A change in analytical method/LOD between these measurements is suggested. Glycols was not measured in samples obtained in September 2008, March 2009 or September 2010. It is therefore difficult to assign a baseline value for glycols with any great degree of certainty. Values indicated as 'less than 1' (<1 mg/l), were converted to whole numbers to allow the processing of data. In this example <1 mg/l became 1 mg/l, this represents the maximum

² CIEH/CL:AIRE, 2008. Appendix 1 in *Guidance on Comparing Soil Contamination Data with a Critical Concentration*. Chartered Institute of Environmental Health and Contaminated Land: Applications in Real Environments.

possible value. This conversion to whole numbers then allowed the calculation of mean zonal substance concentrations (see Table 12).

- 9.3.3 Formaldehyde concentrations were all <0.5 mg/l (equivalent to the LOD) in March 2008, September 2008, March 2009, March 2010 and September 2010. Formaldehyde was not analysed as part of the September 2009 dataset. It is difficult to assign a baseline value for formaldehyde given the accuracy of the available data. As the maximum possible value from the available data is 0.5 mg/l (in all boreholes and zones), we suggest this as an appropriate baseline concentration across all the zones.
- 9.3.4 Mean and standard deviation values were calculated for all boreholes within Zone Q (see Figure 7 in Appendix 3). Zone Q is the largest area of the Hexion UK installation and according to the 2006 ASR is defined as a 'perceived area of low environmental sensitivity'. The Zone Q boreholes for which there is data are as follows: BH227, BH305, BH306, BH214, BH111B, BH210 and BH401. Mean values for each zone from each round of measurement were plotted to determine the trend in the mean RHS concentration for each zone. This approach will also be used in zones A and D (see below).
- 9.3.5 There was sufficient data to calculate mean and standard deviation for Zone A RHS concentrations. Zone A is the non-bulk raw material and product storage area, which may include RHS. Therefore, it is important to determine whether the measures in place on the site are adequate to contain the raw materials.
- 9.3.6 Sufficient data also exists to calculate mean and standard deviation values for Zone D RHS concentrations. Zone D is the ACE and furane process area; in which RHS are used. Therefore, it is also important in this area to determine the effectiveness of storage and leakage prevention measures.
- 9.3.7 Boreholes BH301, BH302 and BH303 were included in Zone E (see Figure 7 in Appendix 3). Zone E can be regarded as an environmentally sensitive zone as it is situated between the potential contaminant source (the site processing and storage areas) and the nearest surface water receptor (Sully Brook) to the north; in the direction of shallow groundwater flow.
- 9.3.8 Data is only available for one borehole within Zone R (BH404, see Figure 7 in Appendix 3). Therefore, borehole average RHS concentrations over the six measurement rounds were used to establish the baseline.

Table 11) Site boreholes grouped by zones set out in 2006 ASR, and corresponding data figure numbers

Borehole ID	Zone	Figure number (Appendix 1)
BH227	Q	1
BH305	Q	1
BH306	Q	1
BH404	R	n/a
BH214	Q	1
BH111B	Q	1

BH210	Q	1
BH303	no zone (but consider as zone E)	2
BH302	E	2
BH301	no zone (but consider as zone E)	2
BH133	D	4
BH403	D	4
BH401	Q	1
BH126	A	3
BH223	A	3
BH201	no zone ('outside zone')	5
BH101	no zone ('outside zone')	5
BH220	no zone	n/a
BH209	no zone (but consider as zone E)	2

9.4 Results and Discussion (see Table 12 and Figures 1-5 in Appendix 1)

- 9.4.1 **Glycols** – Zonal mean baseline values for glycols were 7.00 mg/l in Zones Q, E, A, D, R, the 'outside zone' (BH101 and BH220), and BH201. The baseline values are below the EQS limit for diethylene glycol (taken as representative for all glycols). The standard deviation in the March 2008 dataset is zero, as all values were below the instrument LOD of 1 mg/l (see raw data). Likewise, in the March 2010 and September 2010 datasets, the standard deviation was also zero, as all concentrations of glycols were below the instrument LOD, which had increased to 10 mg/l. It is therefore not appropriate to comment on standard deviations in the glycols concentrations within individual boreholes as they result entirely from the increase in instrumental LOD between the March 2008 and the March & September 2010 datasets.
- 9.4.2 **Formaldehyde** – as discussed in section 9.3.3, the actual level of formaldehyde in samples is difficult to determine as the instrumental limit of detection is not sufficient to give an accurate enough concentration; therefore, a baseline concentration of 0.5 mg/l for formaldehyde is proposed. Calculated standard deviation values for formaldehyde are all zero, as each value is 0.5 mg/l (see raw data).
- 9.4.3 **Phenol (total)** - the majority of proposed zonal baseline concentrations for total phenol in Table 12 were below the phenol EQS (0.03 mg/l). Some data outlier concentrations were excluded from the average for BH305, BH223, BH301 and BH126. The justification for this was that the concentrations exceeded the 95th percentile concentration (calculated for each borehole, see raw data). Despite the exclusion of the outliers, concentrations of total phenol in BH305, BH223 and BH126 still exceed the EQS. In particular, concentrations of total phenol are many times higher than the minimum EQS value of phenol (0.03 mg/l) in the vicinity of

Zone A (non-bulk raw material and product storage area). However, the high concentrations recorded in the first 3 measurements appear to be greatly reduced by the time the last 2 measurement rounds were completed. It is suggested that the average concentrations for the last 2 measurement rounds (0.055 mg/l) is a more appropriate concentration to use as a baseline value (shown in parentheses in Table 12; see also Figure 4 in Appendix 1).

- 9.4.4 Mean zonal standard deviation values for total phenol range between 0.005 and 230.02 (see Table 12). Both the mean and standard deviation values are greatly skewed by the very high concentrations of total phenol recorded in BH223 (Zone A) in September 2008, March 2009 and September 2009. As discussed in 9.4.3, the last two sampling rounds in March 2010 and September 2010 recorded greatly reduced levels. This suggests, firstly that the elevated concentrations of total phenol in BH223 are localised in extent; and secondly, that they have reduced or dissipated between September 2009 and March 2010.

Table 12) Baseline determinand values for relevant hazardous substances for Zones Q, E, A, D, 'outside zone' and BH201

	Glycols	Formaldehyde	Phenol (total)
Zone Q mean (baseline) concentration (mg/l)	7.00	0.50	0.02
Zone Q 95th percentile concentration (mg/l)	10.00	0.50	0.045
Zone Q standard deviation	4.37	0.00	0.05
Zone E mean (baseline) concentration (mg/l)	7.00	0.50	0.03
Zone E 95th percentile concentration (mg/l)	10.00	0.50	0.11
Zone E standard deviation	3.41	0.00	0.07

Zone A mean (baseline) concentration (mg/l)	7.00	0.50	132.05 (0.055)
Zone A 95th percentile concentration (mg/l)	10.00	0.50	547.00
Zone A standard deviation	4.65	0.00	230.02
Zone D mean (baseline) concentration (mg/l)	7.00	0.50	0.012
Zone D 95th percentile concentration (mg/l)	10.00	0.50	0.03
Zone D standard deviation	5.20	0.00	0.01
Zone R mean (baseline) concentration (mg/l)	7.00	0.50	0.010
Zone R 95th percentile	n/a	n/a	n/a

concentration (mg/l)			
Zone R standard deviation	n/a	n/a	n/a
'outside zone' mean (baseline) concentration (mg/l)	7.00	0.50	0.010
'outside zone' 95th percentile concentration (mg/l)	10.00	0.50	0.015
'outside zone' standard deviation	4.65	0.00	0.005
BH201 mean (baseline) concentration (mg/l)	7.00	0.50	0.010
BH201 95th percentile concentration (mg/l)	n/a	n/a	n/a
BH201 standard deviation	n/a	n/a	n/a

9.5 Conclusions

- 9.5.1 Groundwater quality data from site monitoring boreholes has been reviewed to comprise the Baseline Assessment for the Hexion UK Limited site at Sully Moors Road, Penarth; in accordance with European Commission Guidance concerning baseline reports under Article 22(2) of Directive 2010/75/EU on industrial emissions.
- 9.5.2 Feedback on previous submissions by NRW has been considered in producing this report, and it is considered that all comments have been fully addressed (see Table 13 below).
- 9.5.3 Baseline concentrations of the RHSs glycols and formalin/formaldehyde in the specific zones as set out in the ASR have been determined for the time period March 2008 to September 2010. Mean zonal standard deviation values are generally low, and the high mean values of total phenol in BH223 (Zone A) appear to be both localised and transient.

Table 13) Summary of NRW feedback and the steps taken in this report to address NRW concerns.

NRW Comments and Advice	Response
The statistical approach used by ExCAL presents a 'mean of means', which probably smooths out parameter concentrations over the whole site. NRW recommend presenting the data according to each of the site zones, as defined by the ASR (see Figure 7, Appendix 3).	Results have been analysed within each zone as recommended.
Data outliers have been included in the statistical analysis without any justification for their inclusion (the example is given of data distortion by an outlier in BH101).	Data greater than the 95 th percentile value for each borehole has been considered an outlier and excluded from the dataset ³ .
Datasets extending over 7 years have been used to generate reference data. Reference data in a Site Condition Report (SCR) or baseline report is used to benchmark baseline conditions at a specific time before operations commence or when the SCR is first produced. At the time of site surrender a comparison must take place between the reference data and the definitive cessation of activities. The reason for collecting groundwater data during a site's operational	Dataset has been taken from 2008 to 2010. This is extended beyond the point of permit issue to ensure that sufficient data has been captured to provide a robust statistical analysis. This approach was discussed with NRW prior to commencement of this work.

³ CIEH/CL:AIRE, 2008. Appendix 1 in *Guidance on Comparing Soil Contamination Data with a Critical Concentration*. Chartered Institute of Environmental Health and Contaminated Land: Applications in Real Environments.

phase is so that an ongoing comparison with reference data can be made, so that action can be taken if evidence of deterioration is found, rather than waiting until site closure.	
Borehole-specific baselines – NRW were unable to understand the proposed borehole-specific baselines proposed in the ExCAL report. E.g. the BH 302 sulphate range is 240.3 – 718 mg/l, but the proposed baseline is 942.2 mg/l.	This comment is specific to the ExCAL report and the approach, or data analysis has not been replicated in this report. Sulphate is not a RHS.
NRW were also unable to understand how the site-wide baseline values were calculated.	Site wide baseline values have been established for glycols and for formaldehyde only.

APPENDICES

Appendix 1 – Data figures

Figure 1) Zone Q mean RHS values

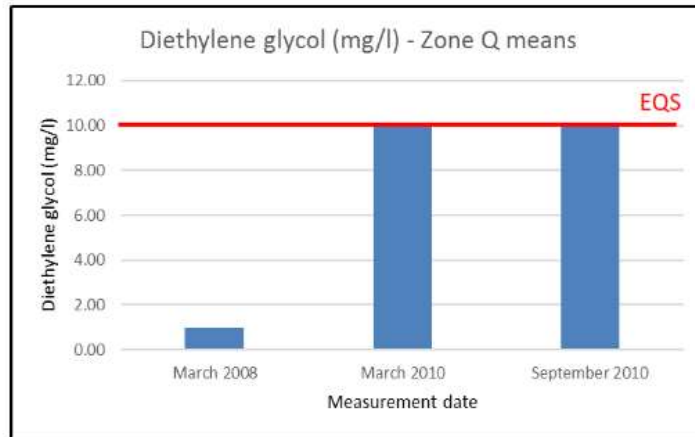
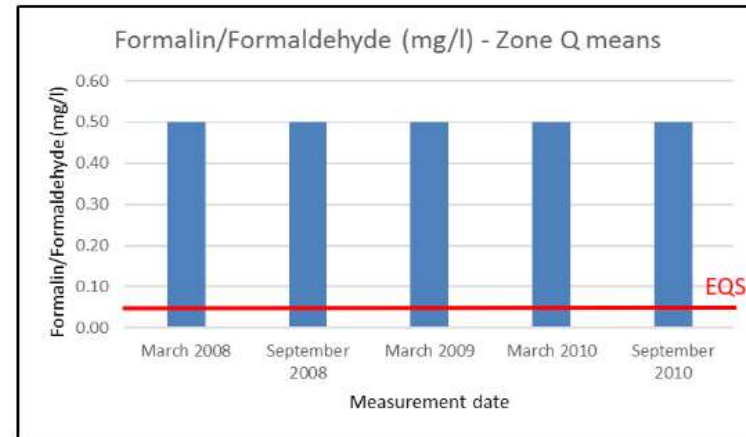
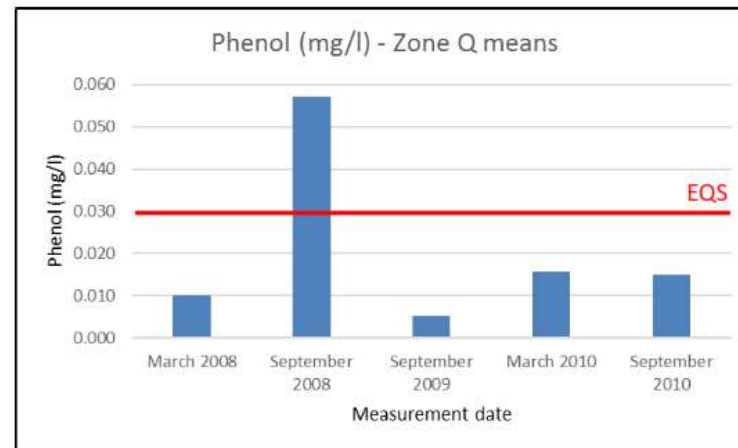


Figure 2) Zone E mean RHS values

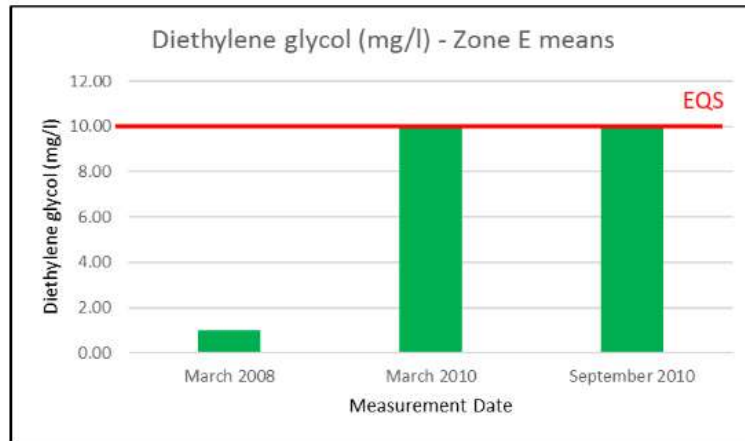
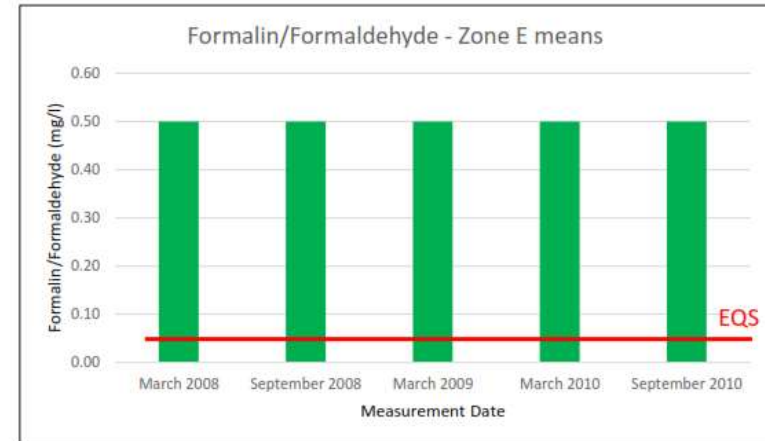
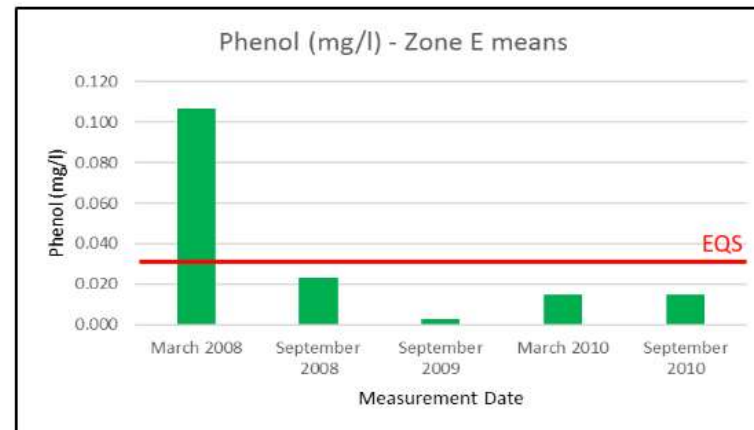


Figure 3) Zone A mean RHS values

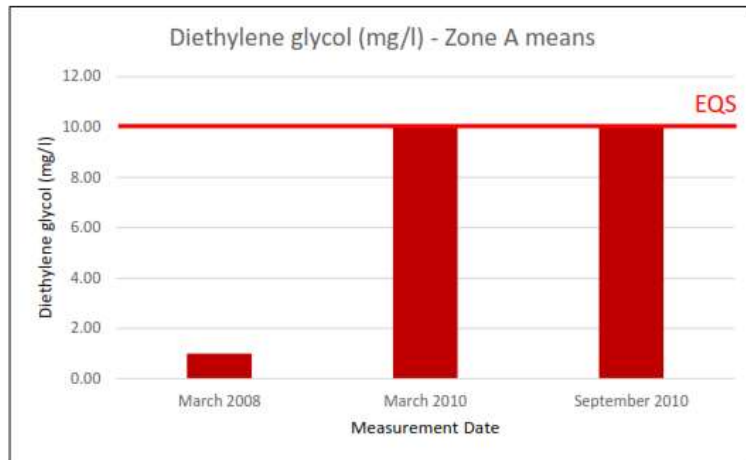
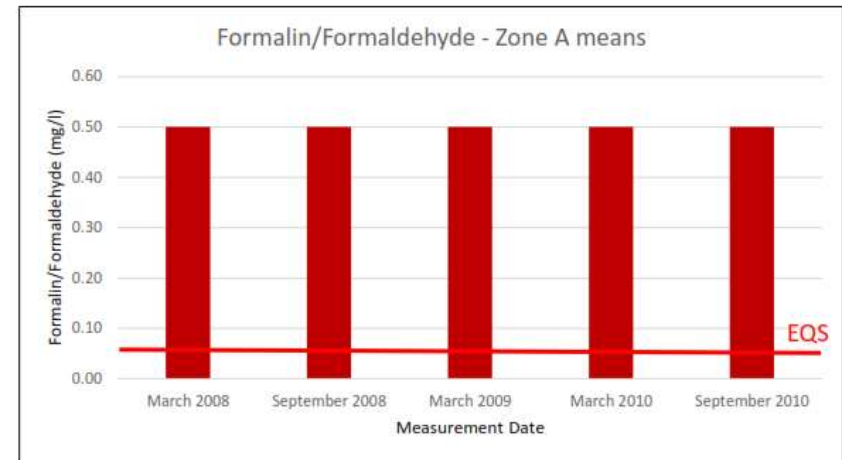
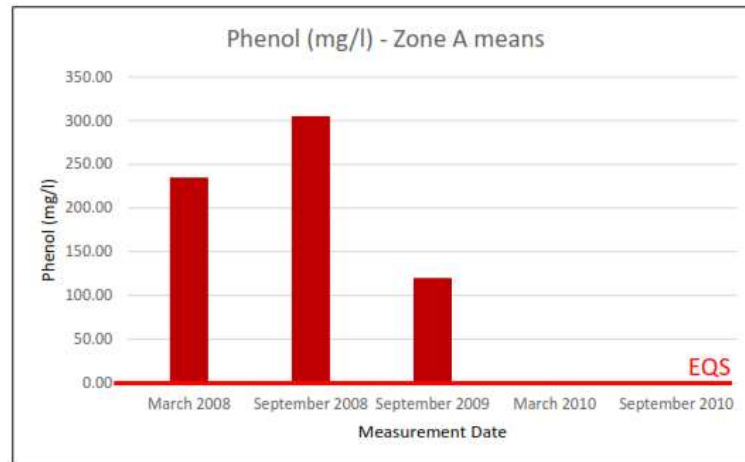


Figure 4) Zone D mean RHS values

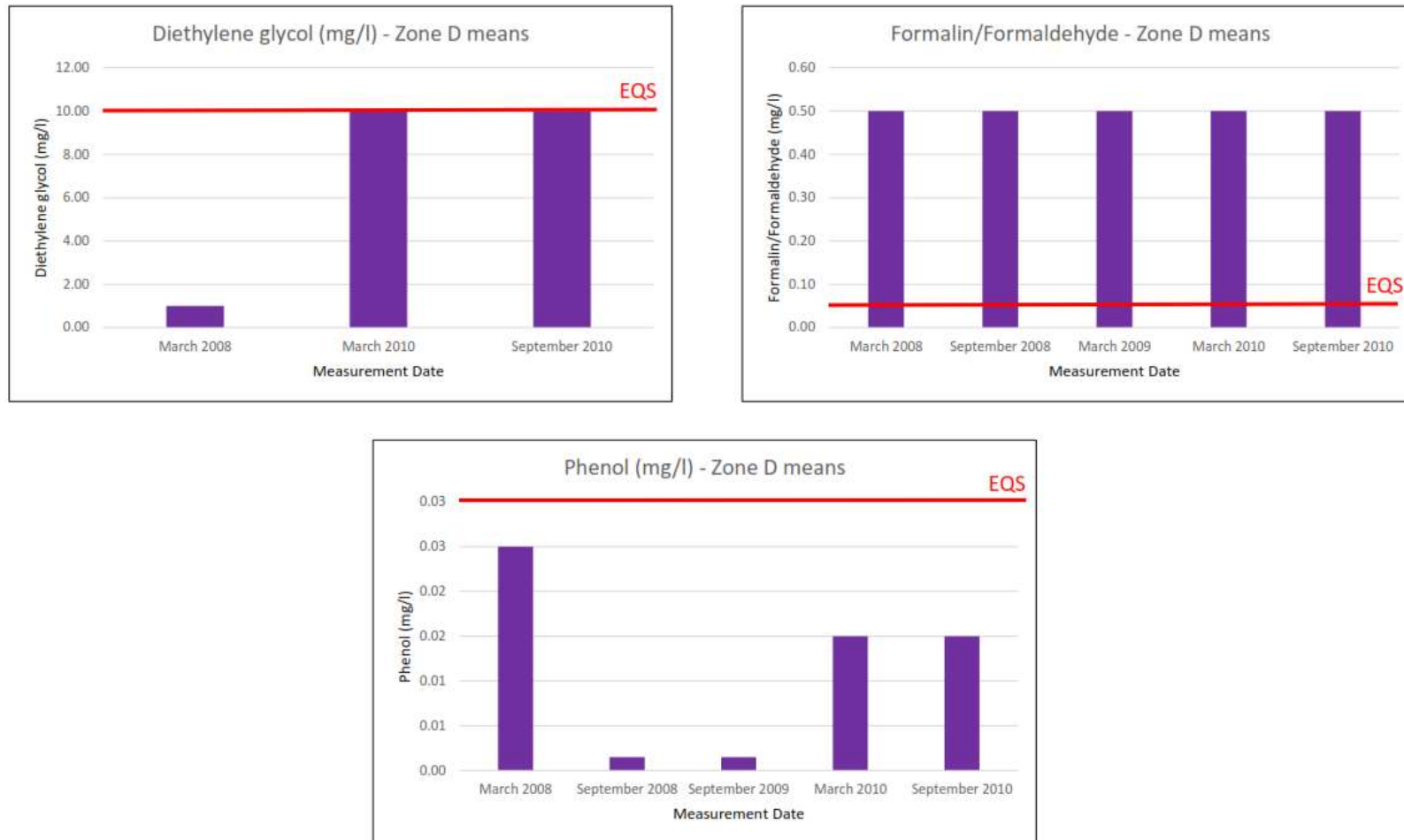
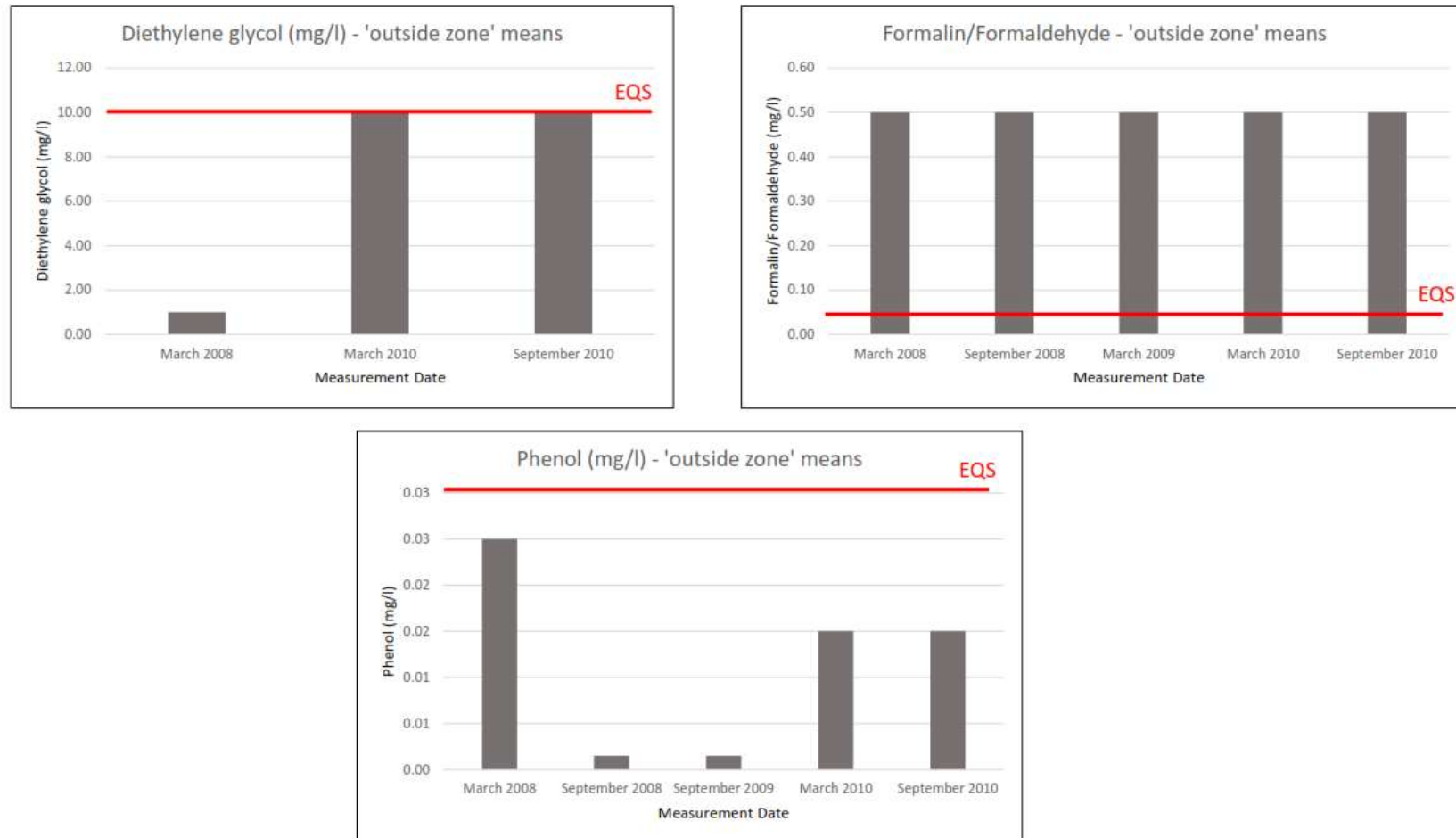


Figure 5) 'outside zone' (BH101 & BH220) mean RHS values



Appendix 2 – Previous correspondence with NRW

Ian Beatty
EH&S Manager
Barry Site
Hexion UK Ltd
Sully Moors Road, Sully
Penarth
Vale Of Glamorgan
CF64 5YU

Our Ref: NRW/SE OPS/ Taff & Ely
I&WR / AK / Site Baseline Report
letter / 05012016

Your Ref: Excal Baseline Report
Jan 2014

Date: 5th January 2016

Dear Ian

**HEXION UK LTD
DATA ANALYSIS AND ENVIRONMENTAL BASELINE DETERMINATION REPORT JANUARY
2014
EXCAL REPORT 84-01-09**

Thank you for submitting the above report. This followed on from our site visit and meeting on the 22nd January 2013. Whilst reference data had been collected for the site our concern was that data had only been presented in a "raw" unprocessed format and should be re-presented after some statistical interpretation, e.g. *Zone 1 Benzene in soil 0-0.5m 20 mg/kg +/- 3mg/kg* and/or statistically meaningful data populations had been characterised. Once data sets had been characterised they could then be compared with similar data sets at site surrender.

We apologise for the length of time it has taken to respond to comment on this report. There were two reasons for this:

1. **The Environmental Permitting (England and Wales) (Amendment) Regulations 2013** brought the Industrial Emissions Directive (2010/75/EU) into force on the 27th February 2013. The IED directive brought in new requirements for operators to tackle potential soil and groundwater contamination from *relevant hazardous substances*. As part of this process EU wide guidance on baseline reports and sampling was to be produced by the Commission for member states. This guidance was subsequently published on the 6th May 2014.
2. **Natural Resources Wales (NRW)** was formed on the 1 April 2013 from Environment Agency Wales, Countryside Council for Wales and the Forestry Commission Wales. The Environment Agency then embarked on a revision of the H5 guidance for Applicants Site

Cyfoeth Naturiol Cymru
Plas-yr-Afon, Parc Busnes Llanelwyr, Llanellwyr, Caerdydd,
CF3 0EY
Llinell gwasanaethau cwsmeriaid: 0300 065 3000
Eboist: www.cyfoethnaturiolcymru.gov.uk

Natural Resources Wales
Rivers House, St Mellons Business Park, St Mellons, Cardiff,
CF3 0EY
Customer services line: 0300 065 3000
Email: www.naturalresourceswales.gov.uk

Ar 1 Ebrill 2013, unodd Cyngor Cefn Gwlad Cymru, Asiantaeth yr Amgylchedd Cymru a Chomisiwn Coedwigaeth Cymru gan greu un corff, sef Cyfoeth Naturiol Cymru.

As of 1 April 2013, the Countryside Council for Wales, Environment Agency Wales and Forestry Commission Wales became Natural Resources Wales/Cyfoeth Naturiol Cymru.

Condition Report – guidance and templates. NRW chose to adopt this guidance when it was issued.

It seemed sensible to wait for the publication of both documents before giving further advice to operators, including Hexion. Unfortunately, the H5 guidance has still not been published by the Environment Agency. A change in the UK Government approach to guidance and how it is presented on the gov.uk website is, we understand, one of the reasons for the delay.

We recommend that operators make themselves familiar with the content of the EU Commission guidance on baseline reports (attached to the covering email to this letter) and this is available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.C_.2014.136.01.0003.01.ENG

Your permit is likely to be updated following publication of the relevant BREF BATc – for the Speciality Organics sector the latest timetable suggests BATc issued 2019 and compliance with IED (by way of permit reviews) to be completed by 2023. Although the fine timetable is subject to the review of the EU Chemical Strategy, which may alter the order, timing and number of chemical sector BRefs. This is likely to include a condition to implement the “protecting soil and groundwater” requirements of the IED Directive. You will need to submit a site condition report (SCR) **containing** a baseline report. We will either send you a notice requiring you to send us a baseline report within your SCR which we can assess when we update your permit **or** issue a variation to the permit with an improvement condition requiring you to send us a baseline report within a SCR by a specified date. Please note these plans are provisional and timescales may change. Much if not all of the information required by a baseline report will already have been included in your original SCR although a review of that document might be required. A substantial change in your operations before the permit review may also trigger the need for a baseline report.

Periodic Monitoring of Soil and Groundwater required by Article 16 of the IED

For IED installations that need a baseline report your permit will be modified to carry out periodic monitoring of soil and groundwater. This must be at least once every five years for groundwater and every 10 years for soil but the frequency can be increased where the risks are higher. This monitoring is to demonstrate that soil and groundwater are being protected during the life of the site. In addition to the information in the Commission communication further information will be forthcoming when the revised H5 guidance is issued.

EXCAL Data analysis and environmental baseline determination report January 2014

We accept that Hexion (Momentum as was) have characterised the site with the soil and groundwater data that has been collected. We do not expect further reference data to be collected unless this is required following your production of a baseline report at permit review. However, we still have observations to make over the presentation of this reference data. These include:

- 1 We are puzzled by the mean of means approach. This must be smoothing out parameter concentrations over the whole site. The Application Site Report (ASR) that was agreed some years ago divided the site into zones. Presenting reference data for groundwater for each zone is a more defensible position.
- 2 Data outliers have been included in the statistical analysis without any justification for their inclusion.

e.g. BH101 As data mg/l

Sep 07	Mar 08	Sep 08	Mar 09	Sep 09	Mar 10	Sep 10	Mar 11	Oct 11	May 12	Nov 12	Apr 13	Oct 13	Mean
3	1.9	3.1	2.6	3.0	6.77	15.5	-	7.39	1	19	172.7	19	21.24

Clearly the mean for this data set has been completely distorted by the outlier of 172.7.

- 3 Data sets extending over 7 years been used to generate reference data. Reference data in a SCR or Baseline report is used to benchmark baseline conditions at a specific time before operations commence or when the SCR is first produced. At surrender a quantified

comparison has to take place between the reference data and the definitive cessation of activities. The reason for collecting groundwater data during operations at a site is so that an ongoing comparison with reference data can be made so that action can be taken if deterioration has occurred rather than waiting until site closure. **Reference data should not change once agreed and cumulative baselines should not be used.**

- 4 Borehole specific baselines - We don't understand the borehole specific baselines proposed in Table 2 given the range of data in the Appendices and the ranges quoted in the text above. E.g. BH 302 sulphate range quoted is 240.3 – 718 but 942.2 is proposed as the baseline value.
- 5 Site wide baseline values – we don't understand how these have been calculated.

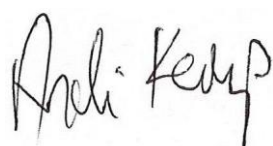
In summary whilst reference data have been collected we do not think the data is being presented in a form such that a quantified comparison can be made when operations cease. Can I suggest we discuss the above comments before further work is undertaken and what might be an appropriate timescale in which any further work should be undertaken.

To that end we propose:

1. Discuss this letter with your advisors.
2. Arrange a meeting on site to discuss the data and way forward, between NRW and Hexion UK Ltd (and their advisors).

If you have any immediate comments on the content of this letter, please contact Andi Kemp.

Regards

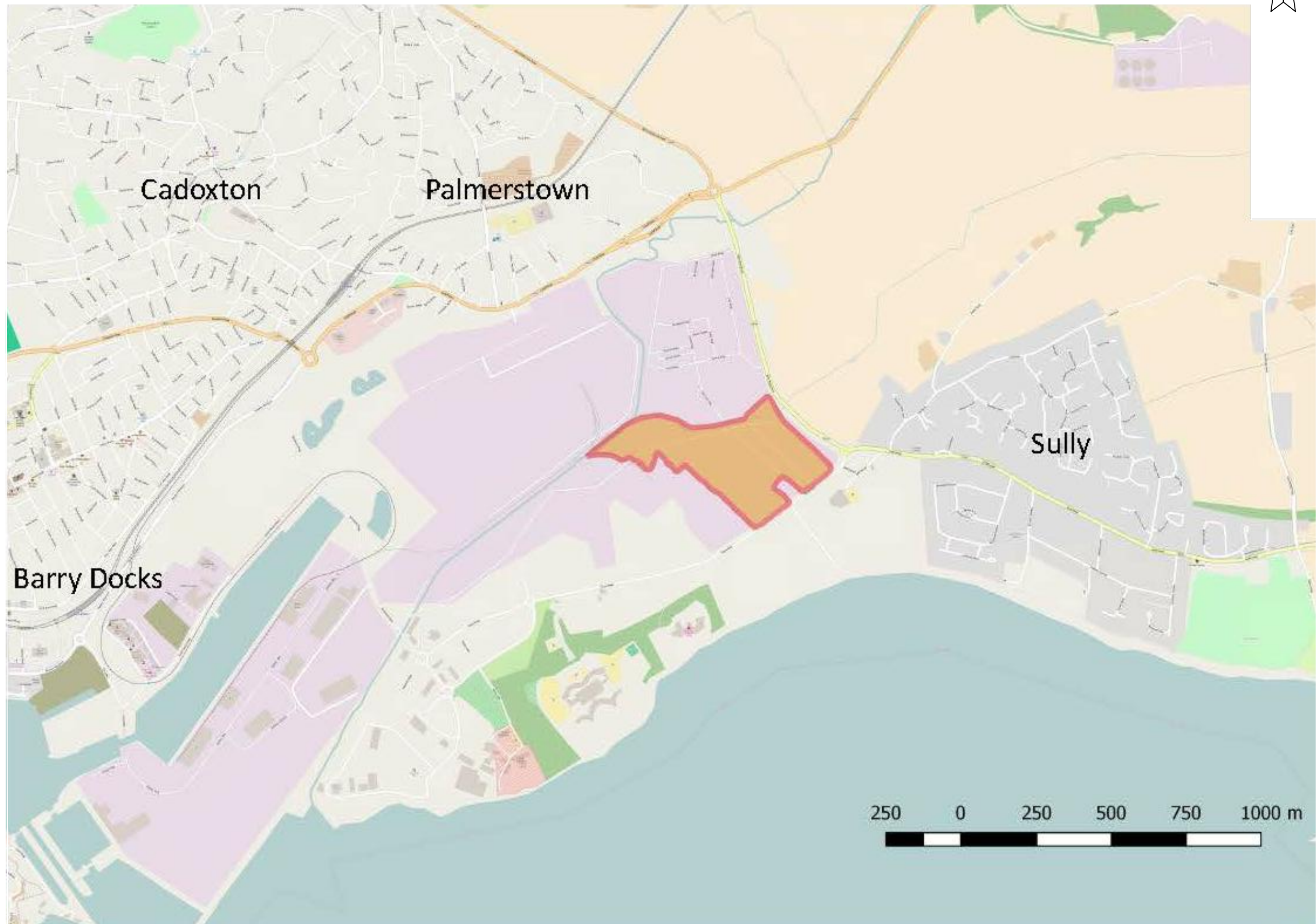


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Cyfoeth Naturiol Cymru / Natural Resources Wales
Ffôn/Tel: 03000 653081

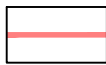
E-bost/E-mail:

Andi.Kemp@cyfoethnaturiolcymru.gov.uk
Andi.Kemp@naturalresourceswales.gov.uk

Figure 6) Site location plan (outlined in red and shaded orange)



Key

 Site Boundary



Samuel House, 5 Fox Valley Way, Stocksbridge, Sheffield, S36 2AA

CLIENT:
Hexion UK Limited

SCALE: NTS PROJECT REF: CRM.517.001

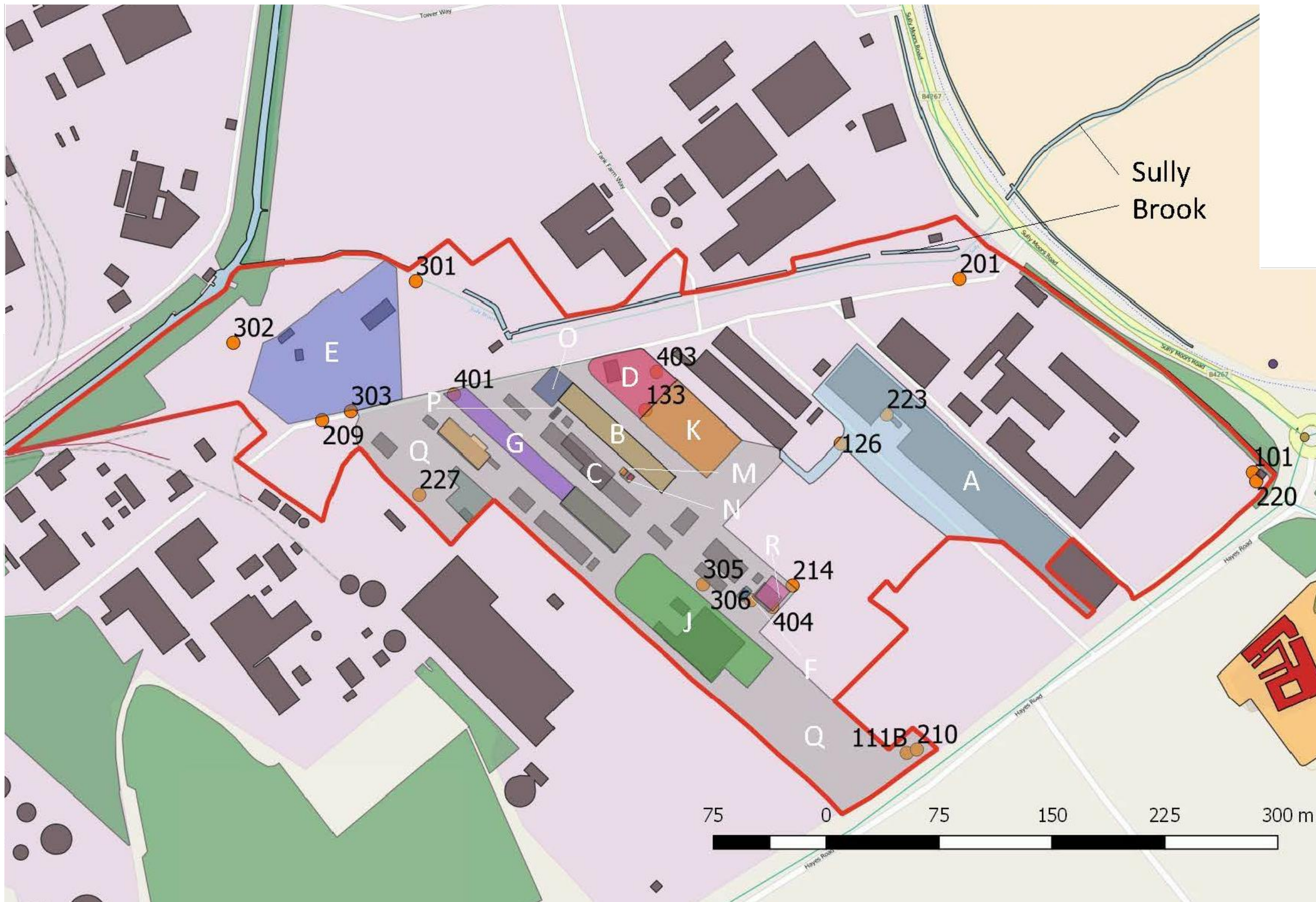
DRAWN: NP CHECKED: JG DATE: Aug 2016

PROJECT:
Hexion

TITLE:
Location Plan

FIGURE NO:
CRM.517.001.D.001

Figure 7) Hexion UK Site Borehole Locations (numbers in black). The letters in white mark the areas of the installation (as previously reported in the 2006 ASR).



Key	
	Site Boundary
	Non-bulk raw material and product storage
	Bulk raw material storage
	Reactor Area
	Ace and Furane Process
	Effluent treatment plant and associated pipework and interceptor pits
	Diesel Tank
	Bulk Product Storage
	Flammables & Waste Compound
	QA Laboratory
	Grinding and Blending
	Bulk raw material storage in tankers
	Non-bulk intermediate storage
	Acid Plant
	Phenol Recovery Unit
	Line drainage and rework store
	Urea Tent
	Areas of perceived low environmental sensitivity
	Boiler House



Samuel House, 5 Fox Valley Way, Stocksbridge, Sheffield, S36 2AA

CLIENT:
Hexion UK Limited

SCALE: NTS PROJECT REF: CRM.517.001

DRAWN: NP CHECKED: JG DATE: Aug 2016

PROJECT:
Hexion

TITLE:
Hexion Boreholes Location

FIGURE NO:
CRM.517.001.D.002

Figure 8) Location of potential contaminant sources (from URS report, 2006).

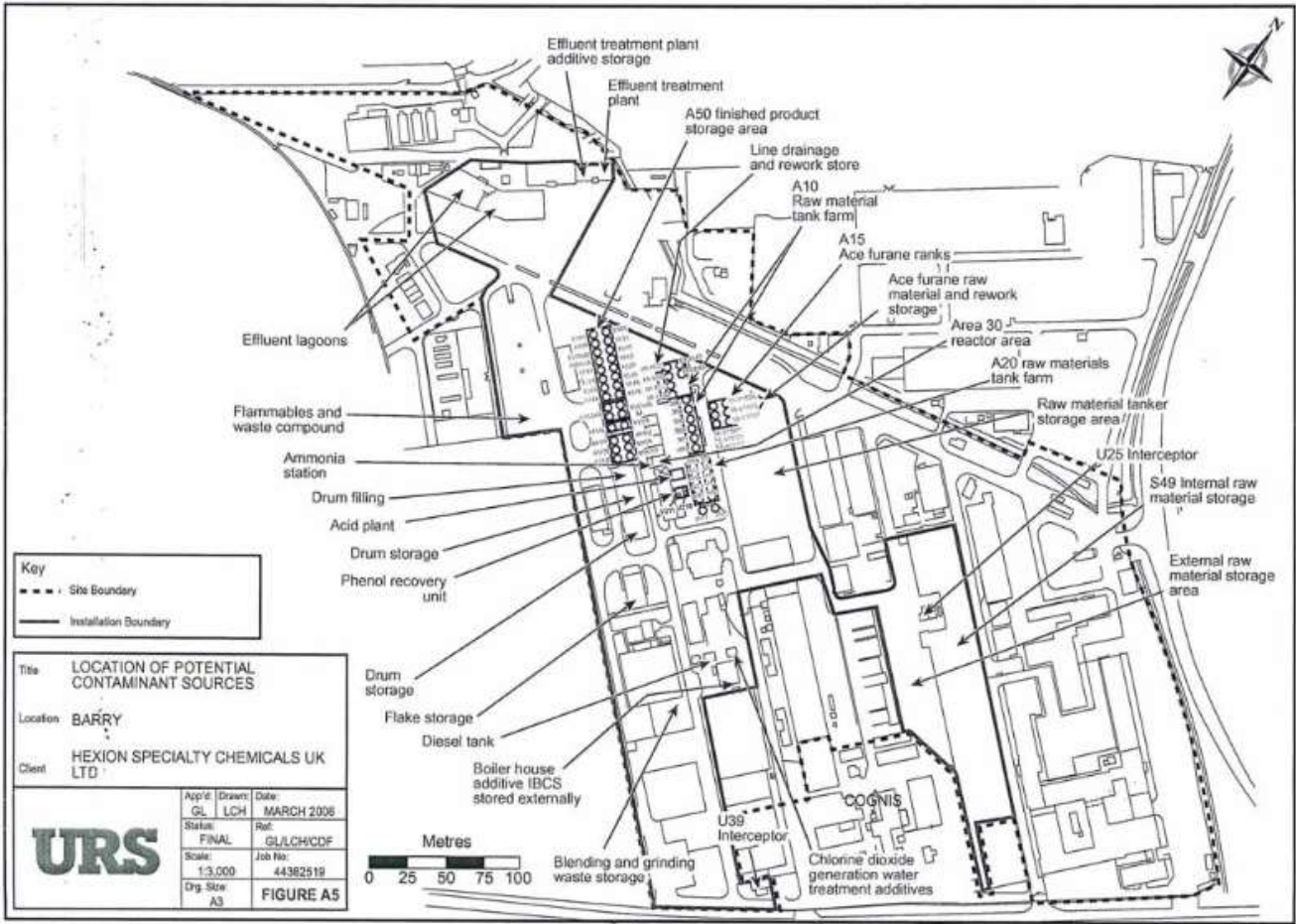
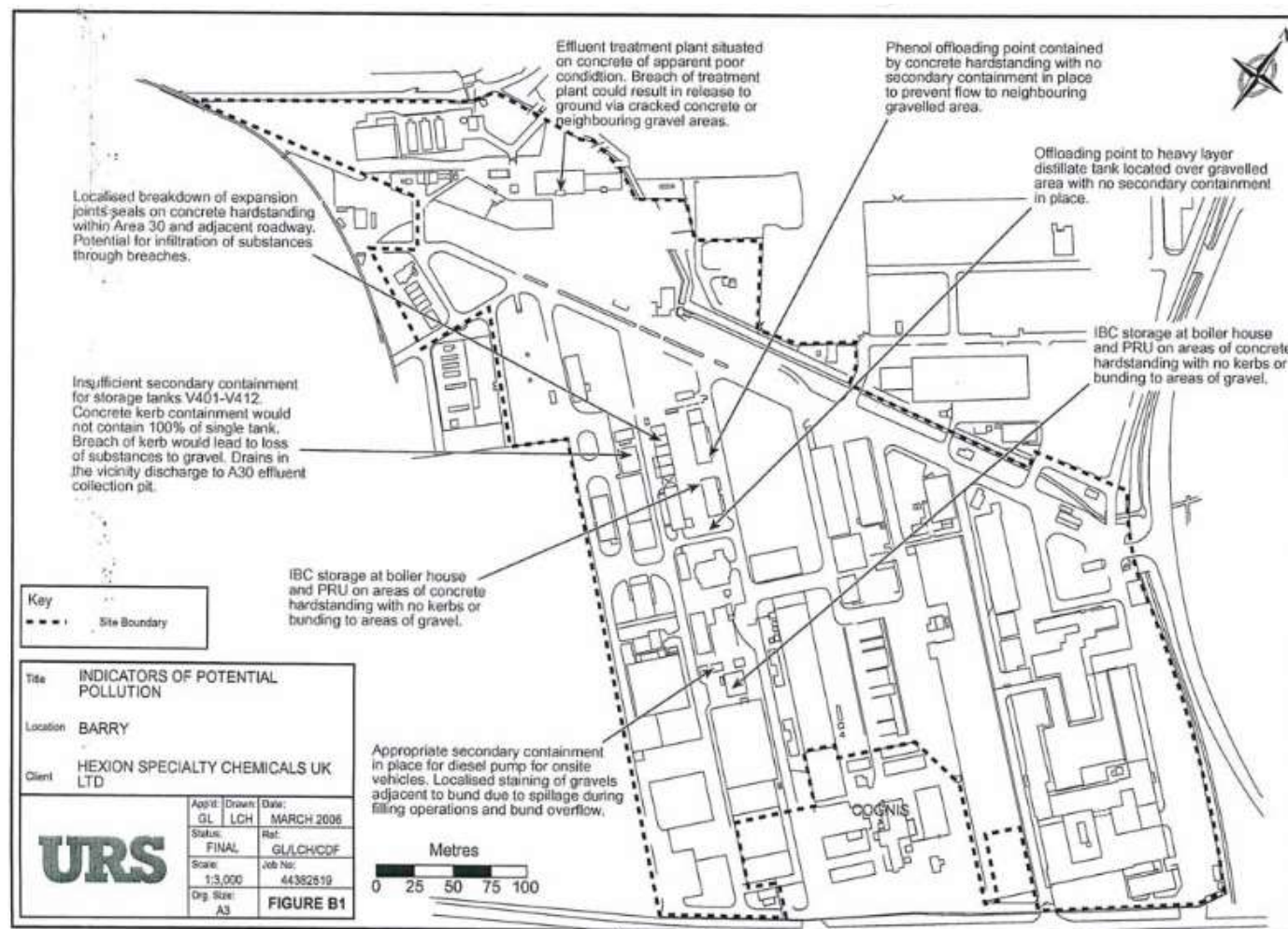


Figure 9) Indicators of potential pollution (from URS report, 2006)



Appendix 4 – Raw data

Raw data will be sent separately via e-mail.

Appendix 5 – Legal Framework

The Hexion UK installation is subject to Article 22(1) of Directive 2010/75/EU on industrial emissions (IED). The full European Commission Guidance concerning baseline reports under Article 22(2) of Directive 2010/75/EU on industrial emissions is appended below.

COMMUNICATION FROM THE COMMISSION

European Commission Guidance concerning baseline reports under Article 22(2) of Directive 2010/75/EU on industrial emissions

(2014/C 136/03)

CONTENTS

1. Introduction	3
2. Objective of this guidance	4
3. Scope of this guidance	4
4. Legal provisions concerning a baseline report	4
4.1. Relevant text in the IED	4
4.2. Key words and phrases used in the IED	6
4.3. Landfill Directive	6
5. Stages in producing a baseline report	7
5.1. Stage 1: Identifying the hazardous substances that are currently used, produced or released at the installation	9
5.2. Stage 2: Identifying the relevant hazardous substances	9
5.3. Stage 3: Assessment of the site-specific pollution possibility	10
5.4. Stage 4: Site history	11
5.5. Stage 5: Environmental setting	12
5.6. Stage 6: Site characterisation	13
5.7. Stage 7: Site investigation	13
5.8. Stage 8: Production of the baseline report	15
Appendix – baseline investigation and report checklist	17

1. INTRODUCTION

Article 22(1) of Directive 2010/75/EU on industrial emissions (IED) provides that, 'Without prejudice to Directive 2000/60/EC, Directive 2004/35/EC, Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration⁽¹⁾ and to relevant Union law on soil protection, the competent authority shall set permit conditions to ensure compliance with paragraphs 3 and 4 of this Article upon definitive cessation of activities'.

Article 22, paragraphs 2 to 4, contains provisions for the definitive cessation of activities involving the use, production or release of relevant hazardous substances in order to prevent and tackle potential soil and groundwater contamination from such substances. A key tool in this respect is the establishment of a 'baseline report'. Where an activity involves the use, production or release of relevant hazardous substances and having regard to the possibility of soil and groundwater contamination, a baseline report is to be drawn up before starting the operation of the installation or before a permit for the installation is updated for the first time after 7 January 2013. The report will form the basis for a comparison with the state of contamination upon definitive cessation of activities. Where information produced pursuant to other national or Union law reflects the state at the time the report is drawn up, that information may be included in, or attached to, the baseline report.

Article 3(19) of the IED clarifies that the baseline report needs to provide information on the state of soil and groundwater contamination by relevant hazardous substances.

⁽¹⁾ OJ L 372, 27.12.2006, p. 19.

Article 22(2) specifies that a baseline report should contain at least the following information:

- '(a) information on the present use and, where available, on past uses of the site; and
- (b) where available, existing information on soil and groundwater measurements that reflect the state at the time the report is drawn up or, alternatively, new soil and groundwater measurements having regard to the possibility of soil and groundwater contamination by those hazardous substances to be used, produced or released by the installation concerned.'

According to the last subparagraph of Article 22(2) of the IED, 'the Commission shall establish guidance on the content of the baseline report.'

That guidance is established in the present Communication, for the Member States to use in the course of IED implementation. Likewise, the Commission will use it when assessing the information related to the baseline report in Member States' reports on the implementation of the IED.

It is considered that this guidance can generally be applied to all installations falling within the scope of Chapter II of the IED. However, it is important when deciding on the course of action for developing a baseline report at the installation level that consideration is given to the need for such a report to be as comprehensive as possible. It is in the operator's interest to ensure that the state of contamination of soil and groundwater identified in the baseline report is sufficiently detailed as this information will be used to determine which contamination has been added in the course of the operation of the installation concerned since the baseline has been established.

2. OBJECTIVE OF THIS GUIDANCE

This guidance aims to clarify in a practical manner the wording and intent of the IED so that Member States implement it in a consistent manner. However, it is not a legally binding interpretation of the IED. The only legally binding text remains that of the IED itself. Furthermore, an official interpretation of the IED can only be given by the European Court of Justice.

3. SCOPE OF THIS GUIDANCE

This guidance provides information on the legal provisions concerning a baseline report and covers the following elements of Article 22 of the IED that should be addressed in the baseline report:

- (i) Determining whether a baseline report is required to be produced;
- (ii) Designing baseline investigations;
- (iii) Designing a sampling strategy;
- (iv) Developing the baseline report.

This guidance does not cover those elements of Article 22 concerning actions required at the definitive cessation of activities as described in Article 22(3) and (4).

4. PROVISIONS REFERRING TO A BASELINE REPORT

4.1. Relevant text in the IED

The following key elements from the text of the IED are of relevance in relation to baseline reports.

Article 3 – Definitions

(2) 'pollution' means the direct or indirect introduction, as a result of human activity, of substances, vibrations, heat or noise into air, water or land which may be harmful to human health or the quality of the environment, result in damage to material property, or impair or interfere with amenities and other legitimate uses of the environment;

(3) 'installation' means a stationary technical unit within which one or more activities listed in Annex I or in Part 1 of Annex VII are carried out, and any other directly associated activities on the same site which have a technical connection with the activities listed in those Annexes and which could have an effect on emissions and pollution;

(18) 'hazardous substances' means substances or mixtures as defined in Article 3 of Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures;

(19) 'baseline report' means information on the state of soil and groundwater contamination by relevant hazardous substances;

(20) 'groundwater' means groundwater as defined in point 2 of Article 2 of Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy;

(21) 'soil' means the top layer of the Earth's crust situated between the bedrock and the surface. The soil is composed of mineral particles, organic matter, water, air and living organisms.

Article 12 – Applications for permits

(1) Member States shall take the necessary measures to ensure that an application for a permit includes a description of the following:

(d) the conditions of the site of the installation;

(e) where applicable, a baseline report in accordance with Article 22(2).

Article 22 – Site closure

(2) Where the activity involves the use, production or release of relevant hazardous substances and having regard to the possibility of soil and groundwater contamination at the site of the installation, the operator shall prepare and submit to the competent authority a baseline report before starting operation of an installation or before a permit for an installation is updated for the first time after 7 January 2013.

The baseline report shall contain the information necessary to determine the state of soil and groundwater contamination so as to make a quantified comparison with the state upon definitive cessation of activities.

The baseline report shall contain at least the following information:

(a) information on the present use and, where available, on past uses of the site;

(b) where available, existing information on soil and groundwater measurements that reflect the state at the time the report is drawn up or, alternatively, new soil and groundwater measurements having regard to the possibility of soil and groundwater contamination by those hazardous substances to be used, produced or released by the installation concerned.

Where information produced pursuant to other national or Union law fulfils the requirements of this paragraph that information may be included in, or attached to, the submitted baseline report.

The Commission shall establish guidance on the content of the baseline report.

(3) Upon definitive cessation of the activities, the operator shall assess the state of soil and groundwater contamination by relevant hazardous substances used, produced or released by the installation. Where the installation has caused significant pollution of soil or groundwater by relevant hazardous substances compared to the state established in the baseline report referred to in paragraph 2, the operator shall take the necessary measures to address that pollution so as to return the site to that state. For that purpose, the technical feasibility of such measures may be taken into account.

Without prejudice to the first subparagraph, upon definitive cessation of the activities, and where the contamination of soil and groundwater at the site poses a significant risk to human health or the environment as a result of the permitted activities carried out by the operator before the permit for the installation is updated for the first time after 7 January 2013 and taking into account the conditions of the site of the installation established in accordance with Article 12(1)(d), the operator shall take the necessary actions aimed at the removal, control, containment or reduction of relevant hazardous substances, so that the site, taking into account its current or approved future use, ceases to pose such a risk.

(4) Where the operator is not required to prepare a baseline report referred to in paragraph 2, the operator shall, upon definitive cessation of the activities, take the necessary actions aimed at the removal, control, containment or reduction of relevant hazardous substances, so that the site, taking into account its current or approved future use, ceases to pose any significant risk to human health or the environment due to the contamination of soil and groundwater as a result of the permitted activities and taking into account the conditions of the site of the installation established in accordance with Article 12(1)(d).

4.2. Key words and phrases used in the IED

For the purpose of this guidance the following clarifications are provided to enhance understanding of the following terms used in the context of the IED.

‘Relevant hazardous substances’ (Article 3(18) and Article 22(2), first subparagraph) are those substances or mixtures defined within Article 3 of Regulation (EC) No 1272/2008 on the classification, labelling and packaging of substances and mixtures (CLP Regulation) which, as a result of their hazardousness, mobility, persistence and biodegradability (as well as other characteristics), are capable of contaminating soil or groundwater and are used, produced and/or released by the installation.

‘The possibility of soil and groundwater contamination at the site of the installation’ (Article 22(2), first subparagraph) covers a number of important elements. Firstly, due consideration should be given in a baseline report to the quantities of hazardous substances concerned – where very small quantities are used, produced or released on the site of the installation then the possibility of contamination is likely to be insignificant for the purpose of producing a baseline report. Secondly, baseline reports must consider the soil and groundwater characteristics of the site and the impact of those characteristics on the possibility of soil and groundwater contamination taking place. Thirdly, for existing installations, their characteristics may be considered where they are such that it is impossible in practice that contamination can take place.

The term **‘contamination’** is understood as being interchangeable with the term **‘pollution’** as defined in Article 3(2) of the IED.

‘Quantified comparison’ (Article 22(2), second subparagraph) requires the ability for both the extent and degree of contamination to be compared between a baseline report and that at the time of the definitive cessation of activities. Solely qualitative comparisons are therefore excluded by the use of this term in Article 22(2). It is in the operator’s interest to ensure that quantification is sufficiently accurate and precise to enable a meaningful comparison at the definitive cessation of activities.

The **‘information necessary to determine the state of soil and groundwater contamination’** (Article 22(2), second subparagraph) is understood as including at least the following two elements:

- Information on the present use and, where available, on past uses of the site. In the context of this requirement, the term **‘where available’** should be understood as being accessible to the operator of the installation whilst having regard to the reliability of such information on past uses.
- Information on the concentrations in the soil and groundwater of those relevant hazardous substances that will be used, produced or released by the installation. Where known future developments at the site at the time the report is drawn up may result in additional hazardous substances being used, produced or released, it is advisable to include information on the concentrations in the soil and groundwater of those relevant hazardous substances as well. Where such information does not already exist, new measurements should be taken where there is a possibility of soil and groundwater contamination by those hazardous substances to be used, produced or released by the installation (see also above on the meaning of ‘Quantified’).

4.3. Landfill Directive

Landfills represent a particular type of activity under the IED (Annex I, activity 5.4) as they are also covered by Council Directive 1999/31/EC on the landfill of waste (Landfill Directive). Article 1(2) of the Landfill Directive makes clear that for those landfills that are subject to the IPPC Directive (2008/1/EC), the relevant technical requirements are contained within the Landfill Directive and that the relevant technical requirements of the IPPC Directive are fulfilled when the Landfill Directive is complied with.

As the provisions of Article 22 of the IED were not included under the former IPPC Directive, it cannot be concluded that in case of landfills no baseline report would be required. The provisions of the Landfill Directive, in particular point 3 of its Annex I (general requirements concerning the protection of soil and groundwater) should ensure that no hazardous materials enter into the soil and groundwater. Furthermore, the Landfill Directive contains several useful elements for drawing up a baseline report, which should be complemented on a case-by-case basis. For the quantification of the soil and groundwater status, particular procedures and methods may be necessary to take account of the particular features of a landfill (lining). In case other directly associated activities take place on the site of a landfill, these may require by themselves that a baseline report has to be produced.

5. STAGES IN PRODUCING A BASELINE REPORT

A number of key tasks should be undertaken to both determine whether a baseline report needs to be produced for a particular situation and in order to produce the baseline report itself.

Eight stages have been identified in this process, covering the following main elements:

Stages 1-3: to decide whether a baseline report is required;

Stages 4-7: to determine how a baseline report has to be prepared;

Stage 8: to determine the content of the report.

Where during stages 1-3 it is demonstrated on the basis of the available information that a baseline report is not required, there is no need to progress to the later stages. A record of such a demonstration should be made and held by the competent authority, including the reasons for such a decision.

It may be that an installation that is not required to produce a baseline report would make changes to the activities on site in the future such that a baseline report will be required, for example when hazardous substances are proposed to be included in a new process for the first time. In that case, the need to produce a baseline report in connection with the update of the permit shall be reassessed in line with this guidance.

Where possible, use should be made of existing information for completing stages 1 to 5.

In some cases, information supplied in accordance with the requirements of Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment may be usefully used to inform elements of the baseline report.

Also, the following sources of information might be of relevance for drawing up the baseline report:

- information gathered in the context of Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances (Seveso III Directive), in particular in relation to stage 4;
- information included in the BAT reference documents, especially the one on Emissions from Storage, in particular in relation to stages 6 and 7.

However, where this is not possible new information should be collected.

Whilst the stages are numbered 1-8 for ease of reference, it is possible for the stages to be undertaken in a different order or simultaneously.

Table 5.1

Main stages of preparing the baseline report

Stage	Activity	Objective
1.	Identify which hazardous substances are used, produced or released at the installation and produce a list of these hazardous substances.	Determine whether or not hazardous substances are used, produced or released in view of deciding on the need to prepare and submit a baseline report.
2.	Identify which of the hazardous substances from Stage 1 are 'relevant hazardous substances' (see Section 4.2). Discard those hazardous substances that are incapable of contaminating soil or groundwater. Justify and record the decisions taken to exclude certain hazardous substances.	To restrict further consideration to only the relevant hazardous substances in view of deciding on the need to prepare and submit a baseline report.
3.	For each relevant hazardous substance brought forward from Stage 2, identify the actual possibility for soil or groundwater contamination at the site of the installation, including the probability of releases and their consequences, and taking particular account of: — the quantities of each hazardous substance or groups of similar hazardous substances concerned; — how and where hazardous substances are stored, used and to be transported around the installation; — where they pose a risk to be released; — In case of existing installations also the measures that have been adopted to ensure that it is impossible in practice that contamination of soil or groundwater takes place.	To identify which of the relevant hazardous substances represent a potential pollution risk at the site based on the likelihood of releases of such substances occurring. For these substances, information must be included in the baseline report.
4.	Provide a site history. Consider available data and information: — In relation to the present use of the site, and on emissions of hazardous substances which have occurred and which may give rise to pollution. In particular, consider accidents or incidents, drips or spills from routine operations, changes in operational practice, site surfacing, changes in the hazardous substances used. — Previous uses of the site that may have resulted in the release of hazardous substances, be they the same as those used, produced or released by the existing installation, or different ones. Review of previous investigation reports may assist in compiling this data.	Identify potential sources which may have resulted in the hazardous substances identified in Stage 3 being already present on the site of the installation.

Stage	Activity	Objective
5.	Identify the site's environmental setting including: <ul style="list-style-type: none"> — Topography; — Geology; — Direction of groundwater flow; — Other potential migration pathways such as drains and service channels; — Environmental aspects (e.g. particular habitats, species, protected areas etc.); and — Surrounding land use. 	Determine where hazardous substances may go if released and where to look for them. Also identify the environmental media and receptors that are potentially at risk and where there are other activities in the area which release the same hazardous substances and may cause them to migrate onto the site.
6.	Use the results of Stages 3 to 5 to describe the site, in particular demonstrating the location, type, extent and quantity of historic pollution and potential future emissions sources noting the strata and groundwater likely to be affected by those emissions – making links between sources of emissions, the pathways by which pollution may move and the receptors likely to be affected.	Identify the location, nature and extent of existing pollution on the site and to determine which strata and groundwater might be affected by such pollution. Compare with potential future emissions to see if areas are coincident.
7.	If there is sufficient information to quantify the state of soil and groundwater pollution by relevant hazardous substances on the basis of Stages (1) to (6) then go directly to Stage 8. If insufficient information exists then intrusive investigation of the site will be required in order to gather such information. The details of such investigation should be clarified with the competent authority.	Collect additional information as necessary to allow a quantified assessment of soil and groundwater pollution by relevant hazardous substances.
8.	Produce a baseline report for the installation that quantifies the state of soil and groundwater pollution by relevant hazardous substances.	Provide a baseline report in line with the IED.

Each of the 8 stages is explained in further detail below.

5.1. Stage 1: Identifying the hazardous substances that are currently used, produced or released at the installation

Produce a list of all hazardous substances dealt with inside the installation boundary (either as raw materials, products, intermediaries, by-products, emissions or wastes). This should include all hazardous substances associated with both the IED Annex I activities and directly associated activities which have a technical connection to the activities carried out and which could have an effect on soil or groundwater pollution.

Where hazardous substances are listed under trade names the chemical constituents should also be identified. For mixtures or compounds the relative proportion of the largest constituent chemicals should be identified.

5.2. Stage 2: Identifying the relevant hazardous substances

From the list produced in Stage 1, determine the potential pollution risk of each hazardous substance by considering its chemical and physical properties such as: composition, physical state (solid, liquid, and gas), solubility, toxicity, mobility, persistence, etc. This information should be used to determine whether or not the substance has the potential to cause pollution of soil and groundwater. The data, together with the rationale used to interpret it, should be presented so it is clear in the baseline report why substances have been excluded or included.

Where a group of substances display similar characteristics they may be considered together provided that justification for the grouping is given.

Sources of information may include the classification and labelling inventory which contains classification and labelling information on substances notified under Regulation (EC) No 1272/2008 (the CLP Regulation) and chemical information on substances registered under Regulation (EC) No 1907/2006 (the REACH Regulation). Other sources of information can also include the risk assessment reports for 141 chemicals under Council Regulation (EEC) No 793/93 (Existing Substances Regulation). All these sources can be found on the ECHA website ⁽¹⁾.

Where it is clear that the hazardous substances used, produced or released at the installation are incapable of causing contamination of soil and groundwater a baseline report does not need to be produced.

The identified relevant hazardous substances should be taken forward to Stage 3 for further consideration.

5.3. Stage 3: Assessment of the site-specific pollution possibility

Each substance brought forward from Stage 2 should be considered in the context of the site to determine whether circumstances exist which may result in the release of the substance in sufficient quantities to represent a pollution risk, either as a result of a single emission or as a result of accumulation from multiple emissions.

Specific issues to be considered include:

- (i) The quantity of each hazardous substance handled, produced or emitted in relation to its environmental effects.

Caution must be exercised given that a continuous leakage of a limited quantity over a period of time may cause significant pollution. Where input-output information is held on hazardous substances this should be examined to determine possible emissions to soil and groundwater;

- (ii) The location of each hazardous substance on the site e.g. where it is or will be delivered, stored, used, moved around the site, emitted etc., in particular in view of the characteristics of the soil and groundwater at that part of the site;
- (iii) In case of existing installations: the presence and integrity of containment mechanisms, nature and condition of site surfacing, location of drains, services or other potential conduits for migration.

The method of storage, handling and use of relevant hazardous substances needs to be identified and whether there are any containment mechanisms to prevent emissions occurring; e.g. bunds, hard-standing, handling procedures.

A detailed physical inspection of the site is to be undertaken to verify the integrity and efficiency of the measures to prevent releases occurring.

Examples of the types of information to be gathered are:

- whether structures and site surfacing are cracked or damaged. Identify whether joints or cracks are present in the vicinity of potential emission points;
- whether there are signs of chemical attack to concrete surfaces;
- whether process drains are in good condition. Where safe to do so, inspect manholes, gullies and open drains;
- identify drainage routes, service corridors etc. and locate outfalls;
- identify signs of emissions already having been made, examine their nature and extent and consider the likelihood of emissions recurring;
- identify whether any direct or indirect emissions of hazardous substances to ground or groundwater occur on site.

Based on the above, the circumstances under which an emission to soil or groundwater may occur and the likelihood of such emissions should be described and the substances which may be emitted to the environment and result in a potential pollution risk should be identified.

⁽¹⁾ <http://echa.europa.eu/information-on-chemicals/>

Circumstances under which emissions may occur include:

Accidents/Incidents e.g. tanker overturning on site road; vessel rupturing; leaking underground tank; seal breaking; accidental discharge; leaks from drain ruptures; fire;

Routine operations e.g. drips during delivery or from pipe joints, small spills during decanting/transfer of product, leaks from blocked or broken drains, cracks in concrete hard-standing;

Planned emissions e.g. discharges to land or groundwater.

Where it is apparent that due to the quantities of the hazardous substances used, produced or released at the installation, or due to the soil and groundwater characteristics of the site there is no significant possibility for contamination of soil or groundwater, then a baseline report is not required.

In case of existing installations, where measures are taken which make it impossible in practice that contamination of soil or groundwater occurs, a baseline report is also not required.

Where, as a result of this stage, it is considered that a baseline report is not required it is still expected that a record of such a decision, including the reasons for the decision, will be made by the operator and further assessed and held by the competent authority.

5.4. Stage 4: Site history

The purpose of this section is to determine which of the relevant hazardous substances identified by Stage 3 have the potential to be present on site in the soil and groundwater already as a result of activities to date and to determine whether they are coincident with potential future emission points.

The site history should consider both (i) the history of the site prior to development of the current/proposed installation and (ii) the operational history of the current/proposed installation as follows:

- (i) List the former uses of the site from green field to development of the proposed installation. Identify whether these uses are likely to have involved any of the relevant hazardous substances identified in Stage 3. If so, where were they likely to have been handled, what is the likelihood of emissions to soil/groundwater having occurred and what remediation, if any, has been undertaken? Where available, site specific data should be used.
- (ii) For an installation which is already operational at the time of producing a baseline report, what is the likelihood of emissions having occurred during the history of operations at the site? Specific points worth considering are:
 - Location, nature and extent of accidents, incidents, or direct discharges made historically (permitted or otherwise) which might have caused a release of relevant hazardous substances to soil or groundwater
 - What changes or improvements have been made to the process, chemicals handled, storage locations, disposal methods etc. and why? For example, were they as a result of a previous incident, accident, near miss etc., were they made to reduce the risk of emissions, to improve efficiency, reduce waste etc. Do they indicate emissions may have occurred?
 - Maintenance records – do these show good integrity for drains, tanks, bunds, pipelines etc.? Have they been kept since the start of the activity or were they introduced recently?
 - Details of site investigations undertaken previously and remedial works carried out.
 - Physical inspection data gathered during Stage 3 may also provide information on the presence of staining, evidence of corrosion, presence of new surfacing, etc.

5.5. Stage 5: Environmental setting

As a result of Stages 1-4 the locations on the site are identified where future emissions could occur and where emissions may already have occurred. Stage 5 aims to determine the fate of any such emissions, the strata and groundwater which may be affected and to establish the extent and depth to which the land needs to be characterised. This requires an understanding of the characteristics of the ground and groundwater at of the site as well as the surrounding areas that may influence the site of the installation itself.

Where available, site specific data should be used. When not available use reference data, qualitative/subjective assessment, inferred or extrapolated data. In each case the source of the data should be identified, and where this is not site specific justification for the use of the selected data and include details of any margins of error which apply.

In considering the site characteristics the following data should be collated:

Topography

Local topography and type of ground surface (concrete, open ground etc.) in the vicinity of each emission point will dictate the immediate effect of any emissions, as will the location of the emission in relation to the ground surface (e.g. ground level, above ground, overhead pipe work, below ground level etc.).

The type and slope of the ground surface can be shown on a site plan. In addition, the base of banded compounds, pits etc. relative to the surrounding ground level should be clearly identified, particularly where they are below ground level (either in part or in full).

Geology and Hydrogeology

Provide a description of the soil and rock strata beneath the site and the physico-chemical properties of each strata which may influence the fate and transport of substances through the ground.

Identify whether groundwaters (including perched waters) are present, or are likely to be present, in each of the strata and, where known, indicate the hydraulic gradient.

Provide an indication of what the soil and groundwater properties mean in terms of the movement of substances through the ground.

A simple summary of the data, rather than a full geotechnical description, is sufficient in the report, further details can be provided or made available for future reference as required.

In addition, this should draw together all available information to present the overall site conditions, rather than separating out published geology and hydrogeology from previous investigation findings and current investigation findings.

Hydrology

Indicate the presence of surface water features, their direction of flow, quality/classification and location of bed depth relative to the site surface. Provide an indication of how each water body might be affected by emissions from the site.

Man-made pathways

Identify man-made pathways, service corridors, drains, mines etc., which may act as migration routes for hazardous substances and identify the likely migration direction remembering that this may be against the natural topographic or hydraulic gradient.

Surrounding land use and interdependencies

Identify surrounding land use to determine industries/activities, especially those up gradient, which may handle the same or similar substances, and may cause pollution to migrate onto the site. In terms of pollution migration on to the site at the time of surrender of the permit it is for the operator to demonstrate that they have not caused pollution whilst operating. It is, therefore, important to know if adjacent properties could be a source of the same or similar pollutants.

5.6. Stage 6: Site characterisation

A description of the site should in particular demonstrate the location, type, extent and quantity of historic pollution and potential future emissions sources noting the strata and groundwater likely to be affected by those emissions

Models can be useful in this context allowing links to be made between sources of emissions, the pathways by which pollution may move and the receptors likely to be affected. Bringing together different pieces of information should help to understand better what risks there might be to both the environment and human health from contamination.

A conceptual site model is a representation setting out both the existing levels of pollution and possible future pollution sources for a given area of land. This can be produced using the information obtained in Stages 3-5. This is likely to comprise existing information and, to a lesser extent new information that is not related to Stage 7 below. Where the operator proposes to use existing information in order to inform the development of a conceptual site model, the reliability, accuracy and appropriateness of the data should be considered.

Rather than provide a single general model of the site, either as a drawing, or text, it may be preferable to produce more detailed individual models for each area of concern at the installation. For example, a conceptual model of the area around a tank, which could indicate the construction of the bund, the direction of slope of the ground, whether fill points are inside or outside the bund, the type of surfacing around the area, and the underlying geology and water table. This information would then be used to suggest where any relevant hazardous substances that are released may end up.

The nature and complexity of conceptual site models will vary by site and by the activity or activities undertaken.

5.7. Stage 7: Site investigation

If there is sufficient information from Stages 1-6 to characterise the site both laterally and vertically and to allow the baseline status in terms of quantified levels of pollution of soil and groundwater by relevant hazardous substances to be defined, then go directly to Stage 8. When choosing to use existing information the operator, in providing it, and competent authority, in assessing it, need to be aware of the uncertainty and risk associated with using such data. Such risks include:

- historic data failing to take adequate account of releases of relevant hazardous substances that may have taken place in the period since the original data was collected;
- historic data failing to take account of all relevant hazardous substances but rather focussing on a proportion of the relevant hazardous substances; and
- historic data failing to take into account changes in the activities undertaken on site since its original collection that may have resulted in changes to the hazardous substances used, produced or released from the installation.

The best way of ensuring that data is comprehensive is to ensure the method of determination as well as analysis are clearly established and communicated. In the case of existing installations, where the reliability and quality of historic soil state information cannot be established (for example because the results are based on out of date methods or were incomplete) the most suitable course of action is to re-take the measurements.

Where only part of the site can be characterised or there is insufficient information on which to formulate a baseline report then additional information should be obtained by site investigation. New measurement, whether taken prior to commissioning or as a result of a permit review, is the best method of obtaining a baseline on the state of the soil and groundwater.

Sampling strategy

Where it is established that new measurements will be needed, consideration of suitable sampling strategies i.e. the way in which new measurements of soil and groundwater will be undertaken, is required. For choosing the most appropriate strategy, it is advisable to communicate between operator and competent authority.

Selected sampling strategies should provide sufficient confidence that measurements and samples taken accurately reflect the actual level of contamination by relevant hazardous substances so as to enable a determination of the current state and condition of the soil and groundwater. The baseline report should include the proposed method for assessing the contamination status of the site e.g. the statistical tests to be used and any ISO/CEN, or in their absence, national standards to be applied. In reporting the results of the baseline investigation, the approach to sampling as well as the methods of analysis need to be adequately described in the report. It follows that, when the site is assessed at the definitive cessation of activities, it will be necessary to use the same approach and either the same methods or methods which have been shown to produce comparable analytical performance.

Sampling strategies should:

- be focused on identified relevant hazardous substances and their hazardous degradation products and metabolites to be evaluated in respect of their physico-chemical properties in relation to the probability of contamination of the soil or the groundwater;
- take into account the hydrogeological and hydraulic conditions of the site. Suitable upstream/downstream measuring points must be reviewed prior to their establishment on the site of the installation. The possible dynamics in respect of directions of flow and fluctuations in the groundwater table should be taken into consideration in groundwater inspections;
- recognise the impact of natural and process-related influencing factors on the samples taken and the sampling strategy (place and method), contaminant linkage, heterogeneity of the pollutant distribution in the soil or in the groundwater, the handling of the sample between the time of obtaining it and its measurement and the measurements taken within the laboratory; and
- consider from the outset the capture of both the current state (including historic contamination) of pollution as well as the need for assessment of pollution at the definitive cessation of activities. Clear mapping and marking of the sampling points is a pre-requisite.

Either non-targeted sampling, targeted sampling or a combination of both is recommended. The selection must be made having regard to the site setting, conditions and local environment, including the nature and quantity of substances to be measured. A description of these approaches is provided below. Where a different sampling technique is proposed e.g. multi-incremental sampling, the level of reliability of results in comparison to non-targeted or targeted approach should be considered by both the operator and competent authority:

- (i) Targeted sampling — is focused sampling in zones of suspected pollutant concentrations (storage points, transshipment points or the like). As with non-targeted sampling, a prior decision is needed on what probability of detection is required, having regard to the costs involved.
- (ii) Non-targeted sampling — is typically sampling, which, with adequate data density, produces clear and unequivocal information about the average substance concentrations and about their range. Given that this approach looks to produce an accurate representation of the entire site by using uniform sampling over the entire installation the selection of sampling locations must not be influenced by external circumstances such as the existing buildings and use or suspected pollutant concentrations. Difficulties may be encountered when using non-targeted sampling for existing sites with respect to established structures, services and utilities.

This approach treats the site as an area of land requiring baseline data (i.e. the site is treated as a single entity and the layout of the installation or the specific risks posed by tanks, process plant etc. do not need to be taken into account). In adopting such an approach, a prior decision will be needed on what the probability of identifying pollution should be in each case, having regard to the inevitably higher number of samples and associated costs needed to provide higher probability.

Uncertainties associated with soil and groundwater data

In respect of uncertainties associated with soil and groundwater data for both non-targeted and targeted sampling, there are two important elements to consider:

- (i) Groundwater baseline data collection: Groundwater conditions can change more quickly than soil conditions and groundwater quality is subject to change and variation due to factors external to the permitted process such as seasonal variation in groundwater level and quality, other pollution sources, migration of contaminant plumes, changes in pH value or the reduction and oxidation potential of the aquifer, heavy rainfall events etc. The sampling of more than one set of groundwater data in order to establish baseline state (e.g. a set of quarterly monitoring results covering a one year period as a minimum) can significantly improve the confidence with which an operator can report baseline state of the groundwater.
- (ii) Use of statistical data analysis techniques for assessing soil data: Statistical methods can assist in quantifying the uncertainty attached to estimates of the average or mean concentration of contaminants in soils and thereby provide a more informed basis for decision making by site assessors and regulators. Measured contaminant concentrations obtained during a site investigation can be compared against a user defined 'critical concentration' or indicator of risk.

If statistical methods are to be used then the data obtained during the investigation must be assessed to be suitable for this purpose (e.g. sufficient data from appropriate depths, locations and of consistent quality). Employing this approach requires a well-developed conceptual model, as described in Stage 6, which then informs the sampling strategy needed to collect data suitable for statistical analysis

Analysis of samples

To ensure comparability of the baseline investigation results with those taken at a later date, validated methods of analysis should be applied (i.e. formal and documented proof that an analytical method is suitable for its intended purpose and is accurate and reproducible). Where CEN or ISO standards, or in their absence, national standards exist, these should be applied.

The essential requirement is that the analytical performance of methods used in compiling the baseline report and in assessing the site at definitive cessation be directly comparable with each other. It is particularly important that the scope and recovery of the determinant(s) in the method be directly comparable. Especially since laboratory best practice may change over time, it is paramount to ensure that the methods of analysis used are adequately described in order to inform future analysis as required under the IED.

It is possible that, following an investigation to collect baseline soil and groundwater data, further investigation could be needed e.g. if the investigation identified historic pollution (created as a result of the permitted activities or otherwise) requiring further delineation and remediation.

Following site investigation further or updated conceptual site models may be required as described under Stage 6.

5.8. Stage 8: Production of the baseline report

The purpose of this stage is to summarise all of the evaluated information collected in Stages 1-7 to produce a report which identifies the state of soil and groundwater contamination by relevant hazardous substances. The baseline report itself should provide an accurate and clear description about what data has been used to establish the state of the soil and groundwater, what methods have been used to sample and analyse the substrata and how the results have been verified, statistically or methodologically. It should, in essence, clearly outline a series of actions that are fully reproducible at site cessation together with the results so as to enable a quantified comparison. A checklist is included in the Appendix to this document for this purpose.

Where potentially polluting substances are present the baseline report should identify which strata or ground-water bodies they are associated with and describe their concentration, nature and extent. Providing a clear statement of which relevant hazardous substances are not present is just as important as identifying those which are.

The baseline report should:

- be presented in a logical and structured format;
- contain sufficient information to establish the scope and impact of the current activity or activities covered by the permit, including the dates of all relevant soil and groundwater measurements;
- provide a clear and accurate description of the approaches used and the results obtained by the assessment as well as the location of any intrusive works, wells, boreholes and other sampling points in accordance with a standardised geographic referencing system;
- provide a clear description of the analytical techniques used to establish the concentrations of hazardous substances in soil and groundwater with reference where appropriate to national or international standards used as well as any guidance provided by Member States that existed at the time of the investigation;
- state the scientific uncertainties and limitations of the approach taken in preparing the report;
- Include all relevant technical data (measurements, calibration certificates, analytical standards, accreditations, maps, sampling logs etc....) so as to ensure, at final cessation, a valid quantified comparison can be made.

Variation in the type, depth and presentation of baseline reports between different activities covered by the IED is anticipated and acceptable so long as it remains possible to determine adequately the state of soil and groundwater contamination by relevant hazardous substances at the time the report is assembled.

Appendix

Baseline investigation and report checklist

<p>DECIDING WHETHER A BASELINE REPORT IS REQUIRED</p> <p>Identification of the hazardous substances used, produced or released at the installation</p> <p>Assessment to identify those hazardous substances that are capable of contaminating soil or groundwater (relevant hazardous substances)</p> <p>Identification of the possibility of the relevant hazardous substances actually causing contamination</p> <p>Identification of any possible sources of historical contamination</p>
<p>DETAILS OF DATA COLLECTION</p> <p>Existing data</p> <p>Relevant plans of the installation (showing boundaries and key points of interest).</p> <p>Review and summary of previous reports, with report references</p> <p>Summary of any risk assessment carried out at the site of installation relevant for baseline data collection</p> <p>Site Investigation</p> <p>Rationale for investigation – may include list of potential contaminant sources relevant to each proposed investigation location</p> <p>Constraints applicable to the placement of site investigation locations</p> <p>Methods used for forming exploratory holes e.g. boreholes, trial pits, window samples</p> <p>Methods used for collecting, preserving and transporting samples to the analytical laboratory</p> <p>Sampling & Monitoring</p> <p>Rationale for sampling strategy e.g. if targeted rationale of targets; if non-targeted justification for spacing and layout</p> <p>Description and explanation of monitoring programmes for groundwater and surface waters</p> <p>Details of monitoring and sampling including locations, depths, frequencies</p> <p>Analysis</p> <p>Rationale for selection of analytical methods</p> <p>Description and performance of analytical methods.</p>
<p>PRESENTATION & INTERPRETATION OF DATA WITHIN TEXT OF REPORT</p> <p>Description of conditions encountered at the site, including groundwater regime and surface water features</p> <p>Summary tables of chemical analyses and site monitoring</p> <p>Description of type, nature and spatial distribution of contamination, with plans where appropriate</p> <p>Analysis of the data set and derivation of representative concentrations for individual contaminants to a suitable level of significance</p> <p>Evaluation of site investigation results against the outline conceptual model</p>

PRESENTATION OF RAW DATA (ANNEX TO REPORT)

Plan showing monitoring and sample point locations

Description of site works and on-site observations

Exploratory borehole, core or drilling logs

Details of response zone and other construction details of borehole monitoring installations

Monitoring results

Description of samples submitted for analysis

Relevant Quality Assurance/Quality Control data – this may include accreditations of staff, calibration certificates of equipment, laboratory accreditations (national and international standards)

Laboratory analytical reports, completed in accordance with the relevant QA/QC data, including relevant international analytical or test method standards.

Chain of custody records for sample and data collected

Appendix 6 – Design of Site Protection and Monitoring Programme



**Design of a Site Protection
and Monitoring Programme
Requiring Reference Data**

PPC Permit PP3238LX

**Hexion Specialty Chemicals
UK Limited**

Barry, South Wales

February 2007
Rev1

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CONTENTS

Section	Page No
SUMMARY	3
1. INTRODUCTION	4
1.1. Site Location	4
1.2. Details of Installation	5
2. OBJECTIVES	6
3. INTRUSIVE INVESTIGATIONS	7
3.1. Investigation and Sampling Strategy	7
3.1.1. General	7
3.1.2. Constraints on Investigations	10
3.1.3. Soil Investigation and Sampling Techniques and Protocols	11
3.1.4. Groundwater Investigation and Sampling Techniques and Protocols	11
3.1.5. Soil-Gas and Vapour Investigation and Sampling Techniques and Protocols	12
3.1.6. Surface Water Investigation and Sampling Techniques and Protocols	12
3.2. Sample Locations	12
3.2.1. Up and Down-Hydraulic Gradient of IPPC Boundary	15
3.2.2. Specific Zone Assessment of Identified Potential Sources of Pollution	16
3.3. Analytical Strategy	17
3.3.1. Justification of Analytical Suites	17
3.3.2. Justification of Analytical / Field Technique and Detection Limits	18
3.3.3. Laboratory Accreditation / Quality Assurance and Quality Control	20
4. MONITORING PROGRAMME	22
4.1. Objectives of the Monitoring Programme	22
4.1.1. Objectives of Environmental Monitoring Programme	22
4.1.2. Objectives of Infrastructure Monitoring Programme	22
4.2. Environmental Monitoring Infrastructure	22
4.2.1. Location	22
4.2.2. Groundwater Monitoring	22
4.2.3. Soil Vapour	23
4.2.4. Soil Monitoring	23
4.2.5. Procedure for the Inspection and Maintenance of Environmental Monitoring Infrastructure	23
4.3. Environmental Monitoring Programme	24
4.3.1. Monitoring Frequency	24
4.3.2. Sampling and Analysis Protocols	24
4.3.3. Personnel Issues	25
4.4. Infrastructure Monitoring Programme	25
4.4.1. Personnel Issues	27
4.5. Assessment and Reporting Procedures	28
4.5.1. Assessment Procedure	28
4.5.2. Reporting Procedure	28

CONTENTS

Section	Page No
4.5.3. Recording and Data Management	28
5. OTHER ISSUES	28
6. REFERENCES	29
7. GLOSSARY	30

APPENDICES

Appendix A	-	Figures
Appendix B	-	Investigation and Sampling Protocols
Appendix C	-	Analytical Protocols and Laboratory Accreditation
Appendix D	-	Quality Assurance and Quality Control
Appendix E	-	Inspection and Monitoring Protocols

SUMMARY

This document represents the design Site Protection and Monitoring Programme (SPMP) for Hexion Specialty Chemicals UK Limited ('Hexion'), Barry Thermosets Plant ('BTP'), submitted to the Environment Agency in pursuance of Condition 2.8.1 of the Permit No. PP3238LX (the 'Permit') authorising the operation of Hexion Specialty Chemicals UK Limited, Barry Thermosets Plant (the 'installation').

This design document is required by Condition 2.8.1 to be submitted to the Agency within 2 months of the date of issue of the Permit.

An intrusive investigation is required to be undertaken to characterise substances identified as being potentially present in, on or under the ground in the Application Site Report (the 'ASR') submitted with the Permit Application. This document also contains the scope of those investigations to collect Reference Data and should be read in conjunction with the ASR for the installation.

The Environmental Monitoring Programme for the installation is presented in Section 4 and Appendices B to E. The results of routine monitoring will be collated into a Monitoring Report and sent to the Agency for the 31st of January each year. The Monitoring Report will also contain any recommendations for changes to the Site Protection and Monitoring Programme, which will be incorporated into the SPMP subject to the agreement, in writing, of the Agency.

The testing, inspection and maintenance programme for pollution prevention infrastructure at the site (the Infrastructure Monitoring Programme) has been designed as detailed in Section 4.4 and Appendix E2.

1. INTRODUCTION

This Design SPMP has been prepared by URS Corporation Limited (URS) on behalf of Hexion Specialty Chemicals UK Limited with regard to the Barry Thermosets Plant installation located at Barry, South Wales. This represents completion of the authorised scope of works as outlined in URS' proposal 3034583 dated 25th July 2006.

This report provides for the environmental and infrastructure monitoring programme requirements of the installation, as required by the installation's PPC Permit (Permit Number PP3238LX) and describes:

- the objectives of the Environmental and Infrastructure Monitoring Programme (Section 4.1 of Environment Agency Technical Guidance note IPPC H7, Reporting Template 2);
- the Environmental and Infrastructure Monitoring Programmes (Sections 4.3 and 4.4 respectively of Environment Agency Technical Guidance note IPPC H7 (Reporting Template 2); and
- the Environmental and Infrastructure Monitoring Protocols (Appendix E of Environment Agency Technical Guidance note IPPC H7 (Reporting Template 2).

The Design SPMP has been prepared for the installation, for which reference data is required, to address the permit requirements and has been designed based on the Guidance for the Large Scale Organic Chemicals Sector (S4.01), in accordance with and using the appropriate template format given in the Land Protection Guidance.

In undertaking the above, consideration will be given to the improvement programme for the installation described in Section 2.5 and Schedule 1 Table S1.3 of the installation's permit to operate under the Pollution and Prevention and Control (England and Wales) Regulations 2000 (permit number: PP3238LX).

The infrastructure monitoring programme includes a system for the regular assessment, recording and the reporting of monitoring results. It is proposed that the infrastructure and monitoring programme will:

- be undertaken in accordance with appropriate industry standards;
- be undertaken in accordance with infrastructure manufacturers recommendations; and
- comply with Health and Safety Regulations.

1.1. Site Location

The BTP installation is located approximately 1 km west of the centre of the village of Sully and approximately 3 km east of the town centre of Barry and within a predominantly industrial setting. The centre of the site is at National Grid Reference ST 145 683. The

site covers an area of approximately 20 hectares, of which the installation occupies approximately 45% of this area. A site location map is present as Figure A1 of Appendix A.

The BTP installation is part of the Barry Chemical Complex and is bordered by other companies in the complex including a gas fired power station (Centrica) and polyvinyl chloride manufacturer (Ineos Vinyls UK Limited - Ineos) to the north, a nitriles rubber manufacturer (Zeon Chemicals Ltd) to the west and a site formerly operated as an acid-ester manufacturer to the south.

The Hexion site is located in a former coastal marsh and is essentially flat lying at an approximate elevation of 6-7 metres above Ordnance Datum (maOD). Land to the east of the site rises to an elevation of between 35 and 54maOD. Land to the south west rises to an approximate elevation of 15maOD at Windmill Hill.

1.2. Details of Installation

Details of the site operations are presented in Section 1.2 of the ASR for the installation. The listed activities within the installation comprise:

- Polymer (various grades of phenolic resin) manufacture as defined in Section 4.1 Part A(1)a) (viii) of Schedule 1;
- Styrenated phenol manufacture as defined in Section 4.1 Part A(1)a) (ii) of Schedule 1; and,
- Biological treatment of non hazardous waste (effluent treatment) as defined in Section 5.3 Part A(1)c) (i) of Schedule 1.

At the time of the Application, the BTP installation comprised listed activities, technically linked activities, and activities, which as agreed with the Environment Agency, are not included in the installation. All activities are described in Tables 1.2-1, 1.2-2, and 1.2-3 of the ASR.

The installation covers an area of approximately 9 hectares, the installation boundary and associated site zones are presented as Figure A2 of Appendix A. It is understood that there are no reported planned substantial changes to the current operations at the installation.

2. OBJECTIVES

The objectives of this SPMP report are:

- to design investigations to collect Reference Data for the installation by:
 - obtaining sufficient information with respect to the site to allow the refinement of the Conceptual Site Model (CSM) of the site and its surroundings; and
 - to design a robust and adequate intrusive investigation, which would allow the collection of Reference Data for the installation.
- to design a monitoring programme for the installation to:
 - monitor the effectiveness of pollution prevention infrastructure and provide early warning of any release of polluting substances to ground or groundwater;
 - to collect data on the condition of the ground at the installation to assist in future permit surrender process;
 - to provide defensive monitoring at the site boundaries for pollutant migration onto the site of the installation; and
 - to monitor the movement of pollutants in the ground and / groundwater beneath the site of the installation.
- to review and if necessary amend the inspection, testing and maintenance programme for pollution prevention infrastructure at the installation to ensure their continued integrity.

3. INTRUSIVE INVESTIGATIONS

The objectives of the intrusive investigation are:

- to collect data to reduce the uncertainties in the CSM presented as Section 6 of the Application Site Report (ASR) submitted with the permit application;
- to collect sufficient data on the potentially polluting substances identified in Table D2 of Appendix D of the ASR in order to set Reference Data for the site; and
- to install permanent monitoring points, to facilitate operational monitoring in line with the recommendations contained in Section 4 below.

3.1. Investigation and Sampling Strategy

3.1.1. General

In accordance with Section 3.6.5 of the permit reference PP3238LX it is proposed that the intrusive investigation works and preliminary sampling proposed herein be undertaken within 6 months of the permit issue. Based on the permit issue date of 15th December 2006, it is proposed that the preliminary data be available for review by the Environment Agency by 15th June 2007.

The investigation and sampling will be authorised and approved by Hexion. It is proposed that URS subsequently manage and instigate the initial investigation and sampling works under instruction from Hexion. Drilling works will be undertaken by a specialist drilling sub contractor, approved by URS under the company quality control system under observation by a suitably experienced URS environmental engineer. During the drilling works, a suitably experienced URS environmental engineer will record visual and olfactory indications of contamination in the drilling returns, record the strata types encountered and collect soil samples as scheduled. Soil and groundwater samples will be analysed by Alcontrol Laboratories. The analytical results will be reported to URS for production of the Monitoring Data Report as specified by the guidance.

The investigation strategy has been developed from information presented in Tables D1 (Potentially Polluting Substances) and D2 (Assessment of Likelihood of Pollution) detailed in the ASR, which outlines potential contaminants and areas on the site with the potential for pollution to occur. The investigation has also been developed from the CSM to take into account the potential pathways and receptors as detailed in Appendix E of the ASR.

The site has been divided into a series of zones based on the locations of process activities and associated potentially polluting substances, and the layout of the site containment systems. These zones are illustrated on Figure A2 and are summarised below:

- **Zone A** Non bulk raw material and product storage (S49);

- **Zone B** Bulk material storage;
- **Zone C** Reactor area (Area 30);
- **Zone D** Ace and furane process area;
- **Zone E** Effluent treatment system and plant;
- **Zone F** Bulk diesel storage;
- **Zone G** Bulk product storage;
- **Zone H** Flammables and waste storage compound;
- **Zone I** QA laboratory;
- **Zone J** Grinding and blending;
- **Zone K** Bulk raw material storage in road tankers;
- **Zone L** Raw material flammables storage;
- **Zone M** Acid plant;
- **Zone N** Phenol recovery unit;
- **Zone O** Line drainage and rework store;
- **Zone P** Urea tent;
- **Zone Q** Areas of perceived low environmental sensitivity; and
- **Zone R** Boiler House.

Based on the findings reported in Table D2 of the ASR, it is considered that the potential areas of concern identified at the site predominantly relate to:

- The transfer of bulk raw materials to and from the installation by road tankers (Zone B);
- Storage of bulk raw materials within unbunded areas of tank farms (Zone B);
- Transfer of bulk raw materials to process areas (Zone B);
- The coincidence of transfer pipelines with areas of non-hardstanding (Zones B and C);
- Use of raw materials in production process (Zone C);
- Transfer of effluent from process areas to effluent collection pits and associated above ground and sub surface pipelines (Zone E);

- Effluent treatment plant temporary capture pits / lagoons: integrity and containment (Zone E);
- Transfer of bulk diesel to the installation by road tanker, off loading to bulk storage within the installation and transfer to site vehicles (Zone F);
- Storage and transfer of bulk products within unbunded areas (Zone G);
- Transfer of distillate from reactors to Phenol Recovery Unit (PRU) and processing within the PRU (Zone N);
- Transfer of phenol/raffinate from PRU to bulk storage and effluent treatment plant (Zone N);
- Integrity and containment in IBC storage area at Phenol Recovery Unit (Zone N); and,
- Off loading and storage of material in the vicinity of the boiler house (Zone R).

Intrusive investigations at selected locations within remaining zones of the installation, where there was considered to be little likelihood of pollution occurring, will be undertaken to assess the general geological and hydrogeological conditions underlying the site to reduce the uncertainties in the CSM. The proposed investigation has taken into account the geology and hydrogeology detailed in Section 6.1 of the site ASR, based on previous investigations undertaken at the site to date.

It is intended that 22 existing monitoring wells previously installed at the site be included in the ongoing groundwater monitoring programme for the SPMP. Nine of these wells are installed within the alluvium beneath the site, and 13 are installed within the underlying Mercia Mudstone Group bedrock.

It is proposed that these existing monitoring locations be supplemented by 10 additional boreholes, located at appropriate locations within the site area. Six of the proposed additional monitoring wells will be installed for the monitoring of the shallow aquifer present in alluvium beneath the site, and a further four will be installed with the intention of monitoring the deep bedrock aquifer encountered in previous investigations beneath the site area.

Actual installation details will depend on ground conditions encountered at the time of the intrusive investigation. Locations for proposed groundwater monitoring wells have been selected on the basis of access constraints, operational Health and Safety constraints and positioning on the assumed down hydraulic gradient side of potential source areas.

In each boring, soil samples will be collected at approximately 0.5m intervals for on-site headspace analysis of ionisable volatile organic compounds (VOCs) using a Photo-ionisation Detector (PID). Where groundwater monitoring wells are proposed, locations will be installed as permanent monitoring wells for the purpose of subsequent on-going monitoring.

Groundwater elevations and subsequent sampling of all monitoring well locations will be carried out following installation and allowing for a suitable time period for stabilisation of the groundwater.

A topographic survey will be undertaken by a specialist contractor following the completion of field works including the levelling of monitoring wells relative to Ordnance Datum. The topographic data set together with the relative location of the wells will be used to facilitate the assessment of shallow groundwater flow direction beneath the site to further develop the CSM of the installation.

3.1.2. Constraints on Investigations

The proposed drilling locations would first be checked for the presence of services by site personnel using site plans and local knowledge and then confirmed clear of detectable services using a Cable Avoidance Tool (CAT) prior to being concrete cored and drilled. It is assumed that these works will be undertaken prior to the commencement of works and will not require additional visits to the site. Where areas cannot be cleared of services, proposed locations may be relocated or abandoned. It is presumed that drainage network plans are available for review. However, no further service information (specifically electrical or gas) has been reviewed at this time.

The geological strata beneath the facility is detailed in Section 6.1 of the ASR. The shallow made ground encountered beneath the site is likely to be granular in nature and therefore hand held window sampling (generally used to facilitate sampling in poorly accessible areas) may not be a suitable investigation methodology. Therefore drilling techniques will be restricted to the more robust methods to penetrate the shallow made ground and as such investigation works in areas where access is restricted due to operational and physical access restrictions will be limited. Where this is the case, monitoring wells will be located down-assumed hydraulic gradient of potential source areas.

A risk assessment will be conducted prior to the start of the investigation, with reference to current and historical site operations and the CSM, to assess physical and chemical hazards to which the investigation and monitoring personnel could potentially be exposed. Ongoing workplace monitoring will be conducted throughout the investigation to monitor the exposure to these hazards. Should the risk assessment or ongoing monitoring indicate an unacceptable risk, the investigation works may be halted, or the methodology modified to reduce the risk.

It is proposed that groundwater sampling is undertaken at least one week following completion of the installation works, however, due to the project timescale it may be necessary to develop and sample monitoring wells soon after the completion of drilling. Where this is the case, it is possible that the groundwater samples collected may not be fully representative of in situ conditions.

3.1.3. Soil Investigation and Sampling Techniques and Protocols

The objective of the soil investigation is to collect representative samples from the areas of the installation where there is considered to be reasonable potential for pollution to occur as identified in the Table D2 of the ASR.

It is proposed that soil samples be collected from all 10 of the proposed new borehole locations. Boreholes will be advanced using a track mounted hollow stem auger with split spoons or similar technique to a depth of up to 10m below ground level or to the top of the Triassic Mercia Mudstone Group, whichever is shallower. This technique will permit the collection of shallow soil samples for detailed geological logging of the shallow soils and ensure that good quality representative samples are retrieved.

During drilling, soil samples will be collected from each stratum type and subsequent analysis conducted based on those which field observations suggested have the highest potential to have been impacted. Samples would therefore be obtained from the near-surface made ground, drift deposits and Triassic Mudstone. It is considered likely that the majority of samples analysed would originate from the made ground material due to their potential to have been impacted, specifically related to the depth of the drainage network at the site.

Investigation and soil sampling methodologies and QA/QC procedures are detailed in Appendices B and D respectively.

3.1.4. Groundwater Investigation and Sampling Techniques and Protocols

It is proposed that groundwater monitoring wells be installed in each of the 10 proposed new boreholes, where groundwater is encountered. Monitoring wells will be installed to target either the shallow alluvial deposits or deeper Mercia Mudstone Group as required.

Groundwater monitoring wells will be located in the areas identified in Table D2 of the ASR as having a reasonable potential for pollution to occur, in addition to addressing uncertainties in the conceptual site model and providing general groundwater quality across the site. It is proposed that groundwater monitoring wells be screened across the water table with a minimum screen length of approximately 2m below the water table, where possible. The method statement for well installation and construction is presented in Appendix B.

Twenty-two existing monitoring wells will be sampled and included within the SPMP monitoring round. A number of additional monitoring wells are installed at the site from previous intrusive investigations; however, it is not proposed that these be sampled at this time given that they are generally not located within key areas as identified in the ASR. Where future monitoring data suggests otherwise, these may be included in future monitoring rounds.

Following installation and prior to groundwater sampling, a single groundwater elevation monitoring round will be undertaken within a one-week period for all wells. The method statement for groundwater elevation monitoring and sampling is presented in Appendix B.

3.1.5. Soil-Gas and Vapour Investigation and Sampling Techniques and Protocols

No soil gas monitoring is proposed at this time. However screening of soils will be undertaken at all locations using a PID.

3.1.6. Surface Water Investigation and Sampling Techniques and Protocols

Section 6.2 of the ASR details the nearest surface water feature to the site as the Sully Brook which flows in a westerly direction through the northern area of the site, adjacent to the northern boundary of the installation. The Sully Brook joins the Cadoxton River adjacent to the northwest boundary of the installation, and flows towards the Severn Estuary. Three land drains are located in the vicinity of the site, two being adjacent to Sully Moors Road, approximately 250m and 270m to the east of the installation centre. A land drain is also located at approximately 250m southwest of the installation centre.

The Sully Brook and the River Cadoxton have been identified as potential receptors to the site. No visual or analytical monitoring of these surface waters is proposed at this time, however, should observations of potential impact from site operations be reported, it is proposed that samples be collected for laboratory analysis and the requirement for on-going monitoring be reassessed.

Hexion will monitor the discharge to the Severn Estuary at water discharge point W1 on a weekly basis as a requirement of their PPC Permit. The results of the surface water monitoring will be logged, recorded and maintained as an auditable record of the surface water conditions, and will be reported to the Environment Agency on a three monthly basis, commencing 1st January 2007.

3.2. Sample Locations

Sample locations have been selected with reference to the sources, pathways and receptors identified within the conceptual model for the site detailed in Section 6 of the ASR. Sample locations for the site are shown on Figures A3 & A4 of Appendix A. Discussion of the selection, justification and design for each sample location with respect to individual zones for the site are given in the following sections. A summary of the sampling locations is given in Table 3.2-1 below.

The samples that are selected for analyses will be designed to give a spread of results across the site for the different strata encountered and to analytically assess the level of contamination impact at the targeted areas of the site. Sample locations have also been selected to enable representative sampling of the site groundwater, particularly in reference to locating monitoring wells up and down-hydraulic gradient of the potential pollutant sources.

Table 3.2-1 Proposed Sample Locations

Zone	Monitoring Location	Rational for Location	Soil sample collection	Groundwater monitoring
None (Up-gradient and perimeter wells)	101	Perimeter - shallow GW	-	x
	111B	Perimeter - shallow GW	-	x
	131	Perimeter - shallow GW	-	x
	201	Perimeter - deep GW	-	x
	210	Perimeter - deep GW	-	x
	211	Perimeter - deep GW	-	x
	213	Perimeter - deep GW	-	x
	227	Perimeter - deep GW	-	x
B	133	Down inferred hydraulic gradient	-	x
	121	Up inferred hydraulic gradient of B, overlap with Zone C	-	x
	226	Down inferred hydraulic gradient. Will assist in refining CSM	-	x
	402	Down inferred hydraulic gradient Overlap with Zone C	x	x
	403	Down inferred hydraulic gradient, will assist in refining CSM	x	x
C	116	Down inferred hydraulic gradient. Overlap with Zone N.	-	x
	121	Up inferred hydraulic gradient. Overlap with Zone B	-	x
	226	Down inferred hydraulic gradient. Overlap with Zone B	-	x
	402	Down inferred hydraulic gradient. Overlap with Zone B	x	x
E	104	Up inferred hydraulic gradient.	-	x

Zone	Monitoring Location	Rational for Location	Soil sample collection	Groundwater monitoring
	127	Down inferred hydraulic gradient.	-	x
	206	Down inferred hydraulic gradient	-	x
	207	Down inferred hydraulic gradient	-	x
	209	Up inferred hydraulic gradient	-	x
	223	Down inferred hydraulic gradient	-	x
	225	Down inferred hydraulic gradient	-	x
	228	Down inferred hydraulic gradient	-	x
	301	Potential down hydraulic gradient to Sully Brook. Will assist in refining CSM	x	x
	302	Potential down hydraulic gradient to Sully Brook. Will assist in refining CSM	x	x
	303	Potential down hydraulic gradient to Sully Brook. Will assist in refining CSM	x	x
F	305	Down inferred hydraulic gradient	x	x
	404	Up inferred hydraulic gradient. Overlap with Zone R	x	x
G	131	Up inferred hydraulic gradient	-	x
	304	Down inferred hydraulic gradient	x	x
	213	Up inferred hydraulic gradient	-	x
	227	Up inferred hydraulic gradient	-	x
	401	Down inferred hydraulic gradient.	x	x

Zone	Monitoring Location	Rational for Location	Soil sample collection	Groundwater monitoring
N	116	Down inferred hydraulic gradient. Overlap with Zone C	-	x
	134	Down inferred hydraulic gradient	-	x
	402	Down inferred hydraulic gradient. Overlap with Zone B & C	x	x
R	306	Down inferred hydraulic gradient	x	x
	214	Up inferred hydraulic gradient	-	x
	404	Down inferred hydraulic gradient. Overlap with Zone F	x	x

Note: 100 Series Boreholes - Existing shallow groundwater monitoring wells
 200 Series Boreholes - Existing deep groundwater monitoring wells
 300 Series Boreholes - SPMP proposed shallow groundwater monitoring wells
 400 Series Boreholes - SPMP proposed deep groundwater monitoring wells

3.2.1. Up and Down-Hydraulic Gradient of IPPC Boundary

The CSM within the ASR has referenced two groundwater flow regimes:

- Shallow perched groundwater, at 0.1-0.4m bgl, within made ground and shallow alluvial deposits, and;
- Deeper groundwater within the bedrock at depths of 4.5-6.0m bgl dependant on season.

Shallow groundwater flow is expected to be controlled by recharge, ground / foundation obstruction conditions and location / elevation of discharge points. These controls result in shallow groundwater flow emanating radially from the installation with no clear up-gradient and down-gradient boundaries. The River Cadoxton to the east of the site and the Sully Brook adjacent to the northern boundary both appear to be down-gradient of the installation with respect to shallow groundwater flow. Shallow groundwater monitoring wells at key locations on the perimeter of the installation have therefore been selected in preference to clearly defined up-gradient and down-gradient wells.

Deeper groundwater exhibits a clearer up-gradient boundary along the eastern edge of the site, with flow westwards into the installation area. Up-gradient boreholes for the deep groundwater system have therefore been selected along the eastern boundary of the installation. Potential direct discharge of deep groundwater into the river downstream

of the weir is anticipated, therefore several down-gradient boreholes have been identified along the western boundary.

The sample locations for wells located up-hydraulic gradient or on the perimeter of the IPPC Boundary are shown on Figures A3 & A4 of Appendix A.

SAMPLE LOCATIONS 101, 111B, 131, 201, 210, 211, 213 AND 227 (PREVIOUSLY INSTALLED).

Little potential for pollution occurring was identified in Table D2 of the ASR and therefore no soil sampling is proposed from these locations.

These sample locations were selected to assess the hydrogeological conditions beneath the site to reduce the uncertainties within the conceptual site model and to provide a dataset for comparison with other areas of the site. The locations are also located within close proximity to the site boundaries to assess the potential for flow onto, across and off the site. It is proposed that these wells will provide a monitoring network for future groundwater monitoring rounds to assess trends over time in groundwater quality beneath the site.

3.2.2. Specific Zone Assessment of Identified Potential Sources of Pollution

Sample locations for the specific assessment of identified zones and general groundwater quality monitoring are shown on Figures A3 & A4.

SAMPLE LOCATIONS 104, 116, 121, 127, 131, 133, 134, 206, 207, 209, 213, 214, 223, 225, 226, 227 & 228 (PREVIOUSLY INSTALLED); 301, 302, 303, 304, 305, 306, 401, 402, 403 & 404 (PROPOSED NEW MONITORING WELLS).

It is proposed that groundwater monitoring wells be advanced in all zones across the site to assess the potential impact to groundwater from the identified potential sources. The ASR identified a reasonable potential for pollution associated with Zones B, C, E, F, G, N and R. The rationale for the location of selected sampling points include is identified in Table 3.2-1 in Section 3.2.

It is proposed that soil samples will be collected from each of the newly constructed wells and analysed for a variety of analytical suites including chloride and pH. A number of soil samples will also be collected for analysis of soil properties (TOC and PSD). These will be collected to improve the understanding of soil properties that may influence contaminant migration and their variability across the site area in order to refine the CSM.

3.3. Analytical Strategy

3.3.1. Justification of Analytical Suites

The analytical suite for each Zone was chosen by reviewing Table D1 of the ASR and is summarised in Tables 3.3.1-1 and 3.3.1-2 below.

3.3.1-1 Up Hydraulic Gradient / Perimeter Locations

Plant Area	Potential Contaminants	Analytical Suite
Up hydraulic gradient and Installation perimeter locations	General Groundwater Quality and potential impact associated with leakage from process plant and equipment, chemical sewers and effluent treatment facilities.	Anions and cations, pH, alkalinity, COD, BOD, metals, ammoniacal nitrogen VOCs (incl TICs) ¹ SVOCs (incl TICs) ¹ Alcohols and acetates ¹ Glycols ¹ Speciated Phenols ¹ TPH with aromatic/aliphatic split ¹ Formaldehyde

Notes ¹ For VOCs, SVOCs, alcohols and acetates, glycols, phenols, and TPH suites, only those chemicals identified in Table D2 of the ASR will be reported as part of the SPMP.

3.3.1-2 Assessment of Drainage and Groundwater Quality Indicators

Plant Area	Potential Contaminants	Analytical Suite
Specific Zones identified as having the potential for pollution in the ASR.	General Groundwater Quality and potential impact associated with leakage from process plant and equipment, chemical sewers and effluent treatment facilities.	Anions and cations, pH, alkalinity, COD, BOD, metals, ammoniacal nitrogen VOCs (incl TICs) ¹ SVOCs (incl TICs) ¹ Alcohols and acetates ¹ Glycols ¹ Speciated Phenols ¹ TPH with aromatic/aliphatic split ¹ Formaldehyde

Notes ¹ For VOCs, SVOCs, alcohols and acetates, glycols, phenols, and TPH suites, only those chemicals identified in Table D2 of the ASR will be reported as part of the SPMP.

In addition it is proposed that a number of soil samples be collected for Total Organic Carbon (TOC) and Particle Size Distribution (PSD).

3.3.2. Justification of Analytical / Field Technique and Detection Limits

The laboratory analytical technique for each analysis is referenced in Appendix C. Standard operating procedure for field testing of samples is reproduced in Appendix B.

The following sections provide a justification for choosing a particular technique for a particular substance in a particular phase. The detection limits of a substance using that technique is justified with respect to expected background concentrations and likely pollutant distribution and concentration.

3.3.2.1. General Groundwater Quality Indicators (Anions / Cations / TOC / COD / BOD/ pH/ alkalinity)

Included in this suite of analytes are Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), chloride, sulphate (water and acid soluble), pH and alkalinity. This suite was selected as these parameters provide an indication of general groundwater quality.

This suite of analytes is to be analysed across the sites groundwater in an attempt to obtain a representative picture of the level of impact of these analytes at the time of the sampling event. In addition it is proposed that these compounds be used to assess groundwater trends over time to indicate potential failures in the site's pollution prevention infrastructure. The detection limits employed should be low enough to enable meaningful comparison with screening criteria developed in line with CLEA guidance. There is not expected to be any interference or masking between the analytes of this suite and any other substance detected on the site. The analytical methods for each parameter are presented in Appendix C.

3.3.2.2. Metals

Included in this suite of analytes are heavy metals (CLEA Metals). Although metals were not specifically identified in the ASR as potential contaminants of concern, there is potential for mobilisation of these compounds based on the potential for reduced pH conditions within soil / groundwater (as result of direct leakage of acids).

Soil and groundwater samples will be analysed for metals in an attempt to obtain a representative picture of the level of impact of these analytes at the time of the sampling event. The detection limits employed should be low enough to enable meaningful comparison with screening criteria developed in line with CLEA guidance. There is not expected to be any interference or masking between the analytes of this suite and any other substance detected on the site. The analytical methods for each parameter are presented in Appendix C.

3.3.2.3. VOCs / SVOCs

Soil and groundwater samples will be analysed for volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). These analyses will identify the presence or absence of organic compounds identified within the ASR. Where TICs (tentatively identified compounds) are listed, only those identified within Table D2 will be reported under the SPMP.

The GCMS screens (for VOC TIC and SVOC TIC) will be used to screen for the majority of organic compounds. In addition to the range of analytical suites proposed in Tables 3.3.1-1 and 3.3.1-2 above, suitable analytical techniques for specialty compounds are currently being explored with commercial laboratories.

The detection limits employed should be low enough to enable meaningful comparison with screening criteria developed in line with CLEA guidance. The Analytical methods for each parameter groundwater samples are presented in Appendix C.

3.3.2.4. Alcohols and Acetates

Soil and groundwater samples will be analysed for a suite of alcohols and acetates, in order to identify the presence or absence of methanol which is stored in bulk quantities within the installation.

The detection limits employed should be low enough to enable meaningful comparison with screening criteria developed in line with CLEA guidance. The Analytical methods for each parameter groundwater samples are presented in Appendix C.

3.3.2.5. Glycols

Soil and groundwater samples will be analysed for a suite of glycols, in order to identify the presence or absence of glycol process chemicals identified in Table D2 of the ASR.

The detection limits employed should be low enough to enable meaningful comparison with screening criteria developed in line with CLEA guidance. The Analytical methods for each parameter groundwater samples are presented in Appendix C.

3.3.2.6. TPH

Soil and groundwater samples will be analysed for TPH (including an aliphatic / aromatic split), in order to identify the presence or absence of total petroleum hydrocarbons identified as potentially polluting substances in the ASR.

The detection limits employed should be low enough to enable meaningful comparison with screening criteria developed in line with CLEA guidance. The Analytical methods for each parameter groundwater samples are presented in Appendix C.

3.3.2.7. Phenols

Soil and groundwater samples will be analysed for a suite of speciated phenols, in order to identify the presence or absence of phenol, which is stored in bulk quantities within the installation.

The detection limits employed should be low enough to enable meaningful comparison with screening criteria developed in line with CLEA guidance. The Analytical methods for each parameter groundwater samples are presented in Appendix C.

3.3.2.8. Formaldehyde

Soil and groundwater samples will be analysed for formaldehyde, in order to identify the presence or absence of this substance, which is stored in bulk quantities within the installation.

The detection limits employed should be low enough to enable meaningful comparison with screening criteria developed in line with CLEA guidance. The Analytical methods for each parameter groundwater samples are presented in Appendix C.

3.3.3. Laboratory Accreditation / Quality Assurance and Quality Control**3.3.3.1. Laboratory Accreditation**

Soil samples from the initial investigation will be analysed by ALcontrol Laboratories. ALcontrol is a UKAS accredited laboratory, and is an approved supplier under URS' Quality Management System (ISO 9001). ALcontrol is also MCERTS and ISO 17025 accredited for many of their analysis techniques. Appendix C details which of analytical techniques are UKAS and MCERTS accredited. The laboratory's quality assurance procedures for individual techniques undertaken outside of UKAS accreditation are reproduced in Appendix C.

3.3.3.2. Quality Control

To ensure sampling and analytical quality assurance and quality control, a selection of samples should be collected and analysed for quality assurance purposes. Field quality assurance should include:

- Groundwater Field Duplicates
- Trip Blank Sample: Sample containers prepared at the analytical laboratory will remain with the groundwater samples from the time the empty sample containers are dispatched from the laboratory until they were returned to the laboratory with the collected samples.
- Rinsate Blank: A rinsate blank will be obtained during the groundwater sampling event by pouring laboratory supplied "ultra pure water" over a piece of groundwater sampling equipment into laboratory supplied sample jars. The sampling equipment proposed is likely to be disposable and dedicated to one

monitoring well, no concentrations are expected to be recorded in the rinsate sample. The rinsate sample will then be analysed.

As part of the laboratory quality assurance program, chromatograms, laboratory blanks, extraction sheets and standard spikes will be used in the analytical and calibration process.

4. MONITORING PROGRAMME

4.1. Objectives of the Monitoring Programme

4.1.1. Objectives of Environmental Monitoring Programme

The objective of an Environmental Monitoring Programme is to monitor the effectiveness of pollution prevention infrastructure and management procedures and provide warning of loss of containment. In addition, the Environmental Monitoring programme is designed to assist in any future surrender of the Permit by providing adequate data determining movement of pollutants onto or off the installation, movement of pollutants within the site and providing long term trends in land quality.

4.1.2. Objectives of Infrastructure Monitoring Programme

The objective of the Infrastructure Monitoring programme is to demonstrate the effectiveness of pollution prevention measures at the site throughout the life of the permit by means of a programme of integrity testing, inspection and maintenance of the infrastructure.

4.2. Environmental Monitoring Infrastructure

4.2.1. Location

Figure A3 & A4 in Appendix A show the location of the 10 proposed monitoring wells and 22 existing wells at the installation. These locations have been proposed based upon potential sources, pathways and receptors at the site, identified within the CSM in Section 6 of the ASR, in Tables D1 and D2 of the ASR and as discussed in Section 3.

4.2.2. Groundwater Monitoring

A full groundwater sampling round is proposed for the 10 monitoring wells following their installation and 22 existing wells across the site. It is subsequently proposed that groundwater monitoring be repeated six monthly to assess trends in groundwater quality over time and review the conceptual site model to review the effectiveness of pollution prevention measures at the site. It is proposed that the frequency of the monitoring be reviewed following a twelve month period (on the basis of the first two sets of monitoring data). On the basis of the results obtained, where trends are stable, the monitoring frequency may be reduced.

4.2.3. Soil Vapour

A soil vapour / soil gas survey is not proposed at the facility at this time.

4.2.4. Soil Monitoring

Soil sampling and assessment of the soil conditions underlying the site is proposed in Section 3.1.3. Soil sampling locations have been detailed in Section 3.2 based upon the CSM presented in the ASR. The requirement for further soil monitoring shall be assessed following the analytical soil results from the proposed intrusive works.

4.2.5. Procedure for the Inspection and Maintenance of Environmental Monitoring Infrastructure

Ongoing groundwater monitoring will occur on an annual basis, the frequency to be reviewed after twelve months (on the basis of the first two sets of monitoring data). Prior to the commencement of future groundwater monitoring, a site walkover will be undertaken to review the status and condition of the wells for inclusion within the monitoring programme.

4.3. Environmental Monitoring Programme

4.3.1. Monitoring Frequency

The proposed environmental intrusive works shall be carried out imminently to ascertain the current soil and groundwater conditions underlying the site. Following the assessment of the analytical results from this investigation the requirement for further monitoring shall be evaluated.

Proposed Works	Timescale (Working Days)
Intrusive Works: Soil Sampling and Installation of Groundwater Monitoring Wells	25 Days
Topographical Survey of Sampling Locations	1 Day
Groundwater Sampling of Installed Wells following a suitable period of stabilisation	5 Days
Receipt of Soil Analytical Test Results	10 Days following sample receipt by laboratory.
Receipt of Groundwater Analytical Test Results	1 Month following sample receipt by laboratory.
Repeat Soil Sampling	Not proposed at this time but requirement will be reassessed in event of identification of failures in the infrastructure or in the event of a spill, process deviation or emergency.
Repeat Groundwater Monitoring	Six monthly or in the event of a known spill, process deviation or emergency.

The required frequency for repeat monitoring of boreholes will be reviewed on completion of the first phase data reporting.

4.3.2. Sampling and Analysis Protocols

The protocols for sample collection and analysis will remain the same as those to be used for the investigations to collect reference data detailed in Section 3.1 and Section 3.3 above and reproduced in Appendix B.

Sampling protocols are contained within Appendix B.

4.3.3. Personnel Issues

Personnel responsible for sampling, maintenance and inspection will be trained in environmental monitoring to an appropriate level to ensure compliance with the quality assurance and quality control plan.

4.4. Infrastructure Monitoring Programme

The installation's permit to operate under the Pollution and Prevention and Control (England and Wales) Regulations 2000 (permit number: PP3238LX) requires improvement in areas with regards to existing inspection, testing and maintenance programme for infrastructure monitoring. The relevant improvement items are shown in table 4.4-1.

Table 4.4-1 PPC Permit Improvement Programme

PPC Permit Improvement	Requirement	Date
IC4	The Operator shall carry out an optimisation study for the operation of the installation effluent treatment plant. This shall include but not be limited to:	Revision of Environmental Assessment 01/08/07
	<ul style="list-style-type: none"> Completion of a revised environmental assessment for water emissions having regard to the Environment Agency's guidance document H1 Environmental Assessment and Appraisal of BAT, or similar, following proposed plant closures; Investigation of methods to reduce formaldehyde levels in effluent emitted via W1; Development of a procedure to carry out regular inspection of sludge build up in the clean lagoon, including removal of sludge, and determine an upper threshold to protect emission limit values applied to releases from W1; Prevention of spillage. <p>A report shall be submitted to the Agency detailing findings and a timetable for the implementation of any improvement identified. The notification requirements of condition 2.5.2 shall be deemed to have been complied with on submission of the</p>	Completion of improvement condition 01/10/07

PPC Permit Improvement	Requirement	Date
	proposals. The proposed measures shall be implemented by the Operator from the date of approval in writing by the Agency.	
IC6	The Operator shall undertake an assessment of subsurface structures and their potential to cause fugitive emissions to surface water and groundwater. The assessment shall take into account the requirements of Section 2.2.5 of the Agency Guidance Note Guidance for the Speciality Organic Chemicals Sector S4.02. A written report summarising the findings shall be submitted to the Agency for approval including a timescale for implementation of any improvements identified. The proposed measures shall be implemented by the Operator from the date of approval in writing by the Agency.	01/11/07
IC7	The Operator shall investigate improvements to the diesel storage tank offloading and fill points having regard to Section 2.2.5 of Environment Agency Guidance Note S4.02. A report shall be submitted to the Agency detailing the findings and a timetable for the implementation of any improvements identified. The proposed measures shall be implemented by the Operator from the date of approval in writing by the Agency.	01/02/08

To address improvement IC4 Hexion shall carry out an optimisation study for the operation of the installation effluent treatment plant in line with the date provided as part of this improvement condition. As part of this optimisation study, Hexion are currently exploring options for the development of a procedure for the inspection of sludge build up in the clean lagoon, incorporating procedures for the removal of sludge from this location.

With reference to improvement item IC6, Hexion shall undertake an assessment of subsurface structures and their potential to cause fugitive emissions to surface water and groundwater in line with the date provided as part of this improvement condition. Proposals for the assessment of subsurface structures are currently being developed by Hexion.

With reference to IC7, Hexion will undertake a review of the condition of the offloading and fill points of the bulk diesel storage, and will instigate appropriate upgrades in line with the requirements of Section 2.2.5 of Environment Agency Guidance Note S4.02.

As part of the site COMAH requirements, BTP operate and maintain records for a risk based inspection programme and preventative maintenance programme for all process plant, including storage vessels, pipework, reactor vessels, valves, pumps, controls and monitoring / control equipment. These programmes are operated to mitigate against potential major accident hazards associated with plant / equipment damage or failure and release of chemicals to the environment.

BTP currently employ the following pollution prevention methods/inspections within the installation:

- **Storage vessels** containing substances considered to present a potential hazard to the environment are within bunds for which there is a requirement as follows:
 - impermeable and resistant to the stored materials;
 - have no outlets;
 - have a capacity of 110% of the largest vessel or 25% of the total tankage;
 - have any contents pumped out or otherwise removed and treated appropriately; and
 - have a programmed visual inspection;
- A significant proportion of the installation is covered with **hardstanding**. The condition of surfacing is subject to informal inspection and ongoing maintenance as required;
- Containers used on site are stored and transported with lids, caps, valves, etc in place and secured. In addition there are procedures in place to deal with **spillages**; and
- Visual inspections of the **effluent lagoons** are undertaken to detect leaks.
- The **outfall** to the Severn Estuary (W1) is periodically inspected and integrity tested by means of dye tests.
- The **effluent treatment plant** cannot be bypassed. In the unlikely event of plant failure sensors on the treatment plant would automatically initiate production shut down.
- ABB are contracted to do tank, bund and pipework inspections on a risk based frequency.

4.4.1. Personnel Issues

Personnel responsible for the inspection, testing and maintenance of pollution prevention infrastructure will have sufficient training, knowledge and experience to adequately perform the task, and to ensure compliance with the Infrastructure Monitoring Programme.

4.5. Assessment and Reporting Procedures

4.5.1. Assessment Procedure

The data obtained from the proposed Site Protection and Monitoring Programme will be used to provide a baseline of ground conditions at the outset of the permit. Any future groundwater monitoring results will be compared against the baseline to understand temporal variations in ground condition during the operation of the facility.

4.5.2. Reporting Procedure

Annual summaries of the environmental and infrastructure monitoring data will be sent to the Agency by the 31st of January each following year along with the results of the data assessment, and recommendations for any amendments to the Monitoring Programme.

4.5.3. Recording and Data Management

The main objective of the recording and data management procedures for the environmental and infrastructure monitoring data is to provide sufficient information to demonstrate a satisfactory condition of the installation without recourse to additional intrusive investigations.

Hexion will be responsible for recording, reporting and retaining the SPMP Data. The Operator shall ensure that records to be kept under the SPMP shall:

- be available for inspection by appointment at any reasonable time;
- be supplied to the Agency on demand;
- be retained at the permitted installation, or other location agreed by the Agency in writing, until all parts of the Permit have been surrendered; and,
- environmental monitoring data reports, infrastructure monitoring and emergency incident records are to be filed and archived as per Hexion SPMP Data Recording and Reporting Procedures (see Appendix E3).

5. OTHER ISSUES

A mothballing programme of the Powder and Flaker plant, Reactors 4, 5 and 6 and the phenol recovery plant commenced in quarter three 2006 and was completed by the end of quarter 4 2006. BTP shall inspect and maintain this area as required prior to any future use.

6. REFERENCES

- IPPC Permit Application, SSE Generation Ltd, March 2006. Application Reference: PP3238LX
- Application Site Report Hexion Specialty Chemicals UK Ltd. URS Corporation Ltd, March 2006. Issue Number 1 - 44382519/FR593.
- Environment Agency Technical Guidance Note IPPC H7: Guidance on the Protection of Land Under the PPC Regime: Application Site Report and Site Protection and Monitoring Programme.

7. GLOSSARY

ASR	Application Site Report
BH	Borehole
BOD	Biological Oxygen Demand
CAT	Cable Avoidance Tool
CLEA	Contaminated Land Exposure Assessment
COD	Chemical Oxygen Demand
TPH	Total Petroleum Hydrocarbons
VOC	Volatile Organic Compounds
WS	Water Sample



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