DEVELOPMENT OF A SUSTAINABLE ENERGY PLANT.

KEMSLEY PAPER MILL, SITTINGBOURNE, KENT

ST REGIS PAPER COMPANY LIMITED & E.ON ENERGY FROM WASTE UK LIMITED

ENVIRONMENTAL STATEMENT

CHAPTER 11:

HYDROGEOLOGY AND GROUND CONDITIONS

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11.1 Introduction

11.1.1 This chapter provides a description of ground conditions in terms of geology, hydrogeology and land contamination for the proposed Sustainable Energy Plant at Kemsley Mill, Sittingbourne, Kent. An assessment of the likely significant effects the Sustainable Energy Plant (SEP) will have on hydrogeology has been undertaken for the construction and operation phase of the development. An assessment is also undertaken to ascertain whether, and to what extent, human health (i.e. construction workers and future site users), controlled waters, the general environment and the Sustainable Energy Plant (SEP) itself will be impacted by the ground conditions identified on the site.

11.1.2 The likely significant effects are assessed against pre-determined baseline conditions for the site using a Conceptual Site Model (CSM) that enables risks to site users and environmental receptors to be determined. The proposed design for the development is described in detail in Chapter 4, with the proposed layout shown in Figure 4.2

11.2 Legislation and Planning Context

11.2.1 A detailed review of the development plan documents and planning context in relation to the development proposals is provided in Chapter 3. The current environmental legislation that relates to contaminated land is described in Appendix 11.1 and includes:

- Environmental Protection Act 1990 (Part IIA);
- Contaminated Land (England) Regulations, 2006;
- Groundwater Regulations, 1998;
- Water Resources Act 1991 (Section 85);
- The Environment Act (1995);
- The Water Act, 2003;
- Town and Country Planning Act 1990;
- The Building Act 1984 ; and
- The Building Regulations 2000 (Statutory Instrument No. 2531).

11.2.2 The national, regional and local planning policy relevant to the consideration of hydrogeology and ground conditions is also described in Appendix 11.1 and includes:

- Planning Policy Statement (PPS23): 'Planning and Pollution Control'
- South East Plan, Policy NRM1 and NRM2;
- Waste Local Plan, Policy NRM1 (Sustainable Water Resources and Ground water Quality) and Policy NMR2 (Water Quality);
- Swale Borough Local Plan, Policy E3 (Development Control Policy for Land Contamination).

11.3 Assessment Methodology

Relevant Guidance

11.3.1 Contaminated land occurs where historical land-management practices have led to the deliberate or accidental release or disposal of substances onto the land. These substances can pose a risk to humans, controlled waters, ecological systems, produce, livestock and buildings. "Contaminated Land" is defined by section 78A(2) of Part IIA of the Environmental Protection Act 1990 as: "*any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that*:

- Significant Harm is being caused or there is a significant possibility of such harm being caused; or
- Pollution of Controlled Waters is being, or is likely to be caused.'

11.3.2 Within the current regulatory framework the determination of contaminated land uses a risk-based approach. Under the risk assessment procedure, for harm to the non-aquatic environment, or pollution of controlled waters to occur, there must be a 'pollutant linkage'. A pollutant linkage is based on the characterisation of the following:

- Source of contamination (Hazard);
- Pathway for the contaminant to move from source to receptor; and
- Receptor which is affected by the contaminant, including human beings, ecology, controlled waters, physical systems and built structures, which could be affected by the hazard.'

General Approach

11.3.3 The objective of this assessment is to identify and where possible quantify potential impacts on pre-determined baseline conditions during the construction and operation phase of the development. Direct impacts on hydrogeology, geology and human health are considered, in addition to indirect impacts on the environment, controlled waters and other groundwater receptors.

11.3.4 Baseline conditions have been defined by a desk based review of published data sources; consultation; the reported results of intrusive works on the site; and the results of 'baseline assessments' of pre-existing contamination (both soil and groundwater) and ground gases present on the site. Using this information a CSM is developed for both the current and future developed site, from which the likely significance of impacts can be determined.

11.3.5 The assessment and any proposal for remedial measures aims to ensure that the Sustainable Energy Plant (SEP) process will not result in any risk to human health or increased detrimental impact on the environment; and that the developed site would not present any liabilities, with regard to ground conditions, under the Part IIA regulatory regime.

Sources of Information

Previous Investigations

11.3.6 This assessment is largely based on the results from two recent studies undertaken with respect to ground conditions on the site:

- Phase 1 Environmental Site Assessment – Kemsley Paper Mill, Sittingbourne, Kent (RPS, 2009a); and
- Phase 2 Intrusive Investigation – Kemsley Paper Mill, Sittingbourne, Kent (RPS, 2009b).

11.3.7 The report associated with each study is provided in Appendix 11.2 and Appendix 11.3 respectively. These two studies build on previous works undertaken on the site in 2001 and a number of subsequent quarterly monitoring rounds undertaken, as described in the Phase 2 Report provided in Appendix 11.2. The Phase 2 intrusive works included:

- Three cable percussive boreholes to a depth of 20 m and completed as combined gas and groundwater monitoring installations;
- Eight window samples to a maximum depth of 4.0 mBGL;
- Fifteen trial pits excavated to a maximum depth of 3.5 mBGL;
- Soil sampling and analysis;
- A groundwater monitoring round and analysis; and
- Two rounds of ground gas monitoring.

11.3.8 The Phase 2 intrusive investigation undertaken in 2009 was designed to provide baseline data for site assessment, with further investigation envisaged at a later date to inform the final detailed design of the Sustainable Energy Plant (SEP).

11.3.9 The position of each exploratory location on the site is shown in Figure 11.3. Representative soil samples were collected from all exploratory locations and subject to laboratory analysis for a range of targeted parameters and a variety of geotechnical tests. Groundwater levels

have been monitored on the site and groundwater samples analysed for a range of targeted substances. The concentration of ground gases (principally carbon dioxide and methane) have also been monitored on the site.

Consultation & Scoping Exercise

11.3.10 A formal request for scoping opinion was issued in July 2009. The scoping report was issued to all statutory consultees including the Environment Agency (EA) and Swale Borough Council (SBC)

11.3.11 In their response, the EA state that they 'agree that further surveys are required to determine the level of contamination present on site. The impact of this contamination will be assessed in accordance with Planning Policy Statement 25'. It is presumed the EA are referring to PPS23 (Planning and Pollution Control) described in Chapter 3 and Section 11.3 of this chapter.

Desk Study

11.3.12 The following sources of data have also been reviewed for the purpose of baseline characterisation:

- Envirocheck Report (Landmark, 2009);
- British Geological Survey. 1977. Chatham. England and Wales Sheet 272. Solid and Drift Geology. 1:50000, Keyworth, Nottingham: British Geological Survey.
- Environment Agency. 1997. Policy and Practice for the Protection of Groundwater, Groundwater Vulnerability of East Kent, Sheet 47, 1:100000 Scale;
- Environment Agency Website (http://maps.environment-agency.gov.uk/wiyby); and
- British Geological Survey Website (http://www.bgs.ac.uk/Lexicon and http://www.bgs.ac.uk/geoindex).

Baseline Assessment Methodology

11.3.13 The preliminary baseline assessment of data gathered through intrusive works on the site involves a qualitative screening of soil, groundwater and gas data against appropriate assessment criteria (AC). This screening exercise will determine whether further quantified assessment or data gathering is required. All baseline assessments undertaken as part of these works are described in detail in the Phase 2 Report provided in Appendix 11.3 and summarised below.

Human Health Assessment of Pre-existing Soil Contamination

11.3.14 A range of AC have been used to assess site available soil data and include:

- New UK CLEA Soil Guideline Values (SGVs); and
- RPS General Assessment Criteria (GACs) derived using the CLEA UK model and former SGVs.

11.3.15 To assess whether observed soil contamination poses a theoretical risk to human health the chemical analytical results for soil have first been screened against the new CLEA soil guideline values for a commercial / industrial end land use. Where SGVs are not available, contaminant concentrations are compared against RPS GACs and former SGVs. On the basis of the results of this screening assessment further works may be required that include further site characterisation and/or addition Quantitative Risk Assessment (QRA), prior to the commencement of construction.

Controlled Water Risk Assessment

11.3.16 To determine the significance of contaminant concentrations in groundwater sample data have been screened against the following water quality AC:

- UK Environmental Quality Standards (EQS) for saline water - applied to surface water, or groundwater that could enter a surface;
- UK Environmental Quality Standards (EQS) for freshwater - applied to surface water, or groundwater that could enter a surface water;
- UK / EU Drinking Water Standards (DWS), taken from UK Water Supply (Water Quality) Regulations (1989 and 2000); and
- World Health Organisation (WHO) Health Standards and Appearance Taste and Odour (ATO) Standards for Drinking Water.

11.3.17 In general the UK EQS values for saline water is considered most applicable to groundwater beneath the site due to the close proximity of The Swale and the fact that The Swale is likely to be the principal receptor of groundwater underlying the site. Where the EQS is given as an alkalinity dependent range, the most conservative value is used for the water screening. The results were screened against the applicable EQS as a guideline, using the DWS and subsequently the WHO standard for screening only when no EQS is available for a given determinant. The greatest potential risk associated with groundwater contamination corresponds with discharge to surface waters, rather than to abstractions used for drinking water supply.

Ground Gas Assessment

11.3.18 Waste Management Paper 27 (Department of the Environment, 1991) and Building Regulations 2000 (Statutory Instrument No. 2531, 2001) require certain measures to be implemented to mitigate risks posed by potentially hazardous, explosive or asphyxiant gases at above guideline concentrations, that is:

- Methane exceeding 1% by volume; and/or
- Carbon dioxide exceeding 5% by volume.

11.3.19 The guidance suggests that a quantitative gas assessment or gas protection measures may be required if methane concentrations in the ground exceed 1% or carbon dioxide concentrations exceed 1.5%. Where significant concentrations of ground or landfill gases are identified further investigation and assessment will be required in line with CIRIA C665 (CIRIA, 2007) to further characterise risk and/or determined appropriate mitigation measures for a site.

Assessment of Significance

11.3.20 The significance of impacts on hydrogeology and the health of construction workers and/or future site users likely to occur during the construction, operation and decommissioning phase of the development shall be determined using the largely qualitatively process described below. In order to assess the significance of the impacts the following definitions of potential significance have been assumed as follow:

- ***Neutral*** - No significant effects;
- ***Minor*** - Impacts are of low magnitude and frequency;
- ***Moderate*** - Impacts are of moderate magnitude and frequency;
- ***Major*** - Impacts are likely to be of high magnitude and frequency with quality standards being exceeded at times; and
- ***Substantial*** - Impacts will be of a consistently high magnitude and frequency).

11.3.21 The effects that result from the Sustainable Energy Plant (SEP) can either be beneficial or adverse.

11.4 Baseline Conditions

Site Setting

11.4.1 The site setting is shown in Figure 11.1. The proposal site is located immediately north-east of the existing Kemsley Paper Mill that is situated on the eastern periphery of Kemsley and approximately 3km to the north of the centre of Sittingbourne. The site is situated on low lying land immediately west of The Swale estuary. Existing ground elevations across the site are low, generally between 5mAOD and 6mAOD, but rising to in excess of 7.5mAOD in the south-west corner of the site. An earth track follows the southern site boundary and declines to a minimum elevation of approximately 3mAOD in the north-east corner of the site adjacent to The Swale.

11.4.2 Current land use on the site comprises an area of marsh land, an area of stockpiled material and a contractor's area and equipment lay down area. A significant volume of stockpiled material is present on the western parts of the site, towards the existing Kemsley Mill. This

material has not been included in the baseline assessment as it shall be removed from the proposal site during pre-construction enabling works. The eastern area of the SEP proposal site is largely derelict, with a sparse vegetative cover.

11.4.3 Outside of the proposal site boundary, Kemsley Marshes are located to the north and a capped former landfill is situated to the south of the access track that delimits the southern proposal site boundary. This landfill is currently in phase of ongoing post-closure monitoring.

Historical Land Use

11.4.4 The historical land use on the proposal site and in the vicinity thereof is described in detail in the Phase 1 Report provided in Appendix 11.2. Principal land uses on the proposal site include a former refuse tip in the north and east of the sit between 1978 and 1983 (See Figure 11.1), before which the site formed part of Kemsley marshes. The site was historically the location of coal stockpiling for the main industrial site to the west. A number of tramways associated with the adjacent paper mill also crossed the site in 1939.

Hydrology

11.4.5 The local hydrology of the site is shown in Figure 11.1. The proposal site is situated on low lying land immediately west of the tidal estuary of The Swale and north of Milton Creek. The eastern boundary of the site is approximately 180m from The Swale, a 13 mile estuary separating the Isle of Sheppey from the mainland of north Kent and to the north of Milton Creek.

11.4.6 A drainage ditch was observed within the Sustainable Energy Plant (SEP) area during a site walkover undertaken by RPS in 2009. The ditch runs along the western boundary of the site in a north to south direction towards Milton Creek. The ditch is poorly maintained and heavily silted.

Geology

11.4.7 The local geological sequence is summarised in Table 11.1, with supporting geological logs appended to the Phase 2 Investigation Report provided in Appendix 11.3. The typical unit thicknesses presented in Table 11.1 are based on the results from exploratory works undertaken on the proposal site in 2009.

Table 11.1. Geological Sequence

Age	Unit / Formation	Description[1]	Typical Thickness on Site (m) (Depth, mBGL)
Recent	Made Ground	Brown grey gravelly sands and clays with	0.45 – 4.6

		frequent infill materials including bricks, plastics, and wood. Peat and gravels of coal dust, ash and clinker present in places.	(0.9 – 4.6)
	Alluvium	Grey brown orange mottled firm to stiff clay.	3.2 – 3.55 (7.0 -7.4)
Eocene	London Clay Formation (part of Thames Group)	Stiff grey clay with sand bands at depth.	Maximum of 4.9 (7.0 – 14.0)
Palaeocene	Woolwich & Reading Beds (Lambeth Group)	Glauconitic sands at base overlain by grey clays and sands with brackish fauna and interleaved red and variegated clays and sands	Not Proven (> 14.0)
	Thanet Sand Formation	Pale yellow-brown, fine-grained sand that can be clayey and glauconitic.	Not Proven
Cretaceous	Chalk	Pure, white microporous limestone.	Not Encountered

1 Where site-specific data is not available lithological descriptions are taken from BGS Lexicon of Named Rock Units (http://www.bgs.ac.uk/Lexicon)

11.4.8 Made Ground was encountered across the whole site to depths of 0.9mBGL to 4.6mBGL. The Made Ground comprises brown and grey gravelly sands and clays with frequent infill materials including bricks, concrete, plastics, and wood. These infill materials were more commonly found in locations within the northern and western site areas (e.g. Trial Pits TP10, TP11 and TP13). Ash and clinker were also identified. In the far south of the site underneath the hard standing area, gravels cobbles and coal residues were encountered. This comprised a thick layer of 1.9m beneath hardstanding in trial pit TP6, and a thinner layer between 0.75 mBGL and 1.2 mBGL in borehole WS4. Coal residues in Made Ground relate to historical stockpiling on the site and subsequent conveyance to the main industrial site to the east.

11.4.9 The Made Ground was generally underlain by a typically grey brown orange mottled firm to stiff clays, presumed to be estuarine alluvium. These deposits were sandy, gravelly and friable in places, and were generally encountered to a depth of 7.0 mBGL to 7.4 mBGL.

11.4.10 London Clay was identified in all deep boreholes and was generally stiff and grey in nature with occasional sands, and sand bands present at depth. This low permeability clay unit is present to a depth of 14.0mbGL and is underlain by a dense grey slightly silty sand presumed to be the Woolwich & Reading Beds and possibly the Thanet Sands. The base of this granular unit was not intercepted. Between 4.0m and 9.4m of low permeability clays were identified between the base of the Made Ground and underlying Woolwich & Reading Beds.

Hydrogeology

11.4.11 The London Clay and alluvial clay that underlie the site are classified as 'unproductive' units (EA, 2003) that can be considered non-aquifers. Shallow groundwater was identified in three trial pits and one borehole constructed on the site and appeared to be clean with no evidence of an oily sheen or colouring. Groundwater was also identified in five of the eight window samples completed at shallow depth (principally within the Made Ground), with a groundwater elevation of between 2.39mAOD (WS5) and 5.79mAOD (WS4). Shallow deposits on the site are therefore characterised by a localised and laterally discontinuous water body perched on the underlying low permeability clay deposits, with levels that generally decline to the east towards The Swale.

11.4.12 Groundwater is present in the granular deposits (Woolwich and Reading Beds) that underlie the London Clay Formation, with an elevation of between 1.46mAOD (BH3) and 1.74mAOD (BH2). This suggests that groundwater contained in these granular deposits is confined by the overlying clays, with a shallow gradient orientated towards The Swale in the east. Groundwater levels in the Woolwich and Reading Beds are thought to be subject to tidal fluctuations, complicating the interpretation of spot level measurements. Groundwater levels within the shallow, near-surface deposits (where present) are greater than the groundwater levels observed in the underlying Woolwich & Reading Beds. This suggests a downward potential for groundwater flow from the Made Ground to the underlying granular deposits. However, vertical flow the intervening London Clay and alluvium is unlikely to be a significant transport pathway owing to their low permeability. Lateral groundwater flow will therefore dominate in the Made Ground, where saturated higher permeability pathways are present.

11.4.13 The principal receptor of laterally flowing groundwater in the shallow Made Ground or deeper aquifer unit is The Swale. This tidal estuary is of high ecological value being designated as a Special Protection Area (SPA) under the EC Birds Directive (74/409/EEC) and Site of Special Scientific Interest (SSSI) under the Wildlife and Countryside Act 1981 (as amended). Groundwater will be discharged to The Swale directly by bank-side seepage or indirectly by seepage into surface drainage channels at low elevations.

11.4.14 The site does not lie within a groundwater Source Protection Zone (SPZ) and no groundwater abstractions are identified in the vicinity of the proposed site. No designated or ecologically sensitive groundwater dependent receptors have been identified down-gradient of the site.

11.4.15 Chloride concentrations measured in groundwater range from 130mg/l (Borehole WS1) to 800mg/l (Borehole WS7) suggesting fresh to brackish groundwater in both shallow and deep boreholes, which is consistent with the estuarine location of the site. Sulphate concentrations also range from 480mg/l (BH3) and 1,700mg/l (BH1), with the exception of WS7 where a sulphate concentration 80 mg/l was measured. Again this attests to largely non-potable

nature of shallow perched groundwater and deeper confined groundwater encountered on the site.

Baseline Assessments

Human Health Assessment of Pre-existing Contamination in Soils

11.4.16 The Made Ground was encountered as ashy sand in Trial Pits TP9, TP11, TP12 and boreholes BH1 and WS1. Clinker was encountered at a number of locations including Trial Pits TP4 and TP9, boreholes WS1, WS5 and WS7 within the top 4m in the central and southern site areas. These layers occasionally exhibited a slight hydrocarbon odour. Sand, silt and gravel sized fragments of coal were encountered in the south of the site. There was little olfactory evidence of soil contamination by volatile compounds, with all measurements by a Photo-Ionisation Detector (PID) of below 5 parts per million (ppm).

11.4.17 Between twenty-four and forty soil samples were subject to laboratory analysis for a targeted suite of parameters in 2009. The analytical results and detailed soil assessment is presented in the Phase 2 Report provided in Appendix 11.3 and summarised below.

11.4.18 The highest concentrations of inorganic and organic determinands were typically within shallow Made Ground in the north and east of the site. Hotspots of organic determinants, most notably Polycyclic Aromatic Hydrocarbons (PAH) (Max. concentration of 400mg/kg in WS7) and Total Petroleum Hydrocarbons (TPH) (Max. concentration of 2300mg/kg in TP9) have been identified. Elevated concentrations of metals, most notably copper, lead and zinc, have also been identified. Although elevated, the soil concentrations observed do not exceed respective Soil Guideline Values (SGV) or human health Generic Assessment Criteria (GAC) for an industrial / commercial end land use. This suggests that shallow soils on the site represent little risk to future site users for an industrial / commercial end land use.

11.4.19 Six soil samples were analysed for presence of asbestos, with asbestos being identified in one (WS8, 0.8 mBGL – 1.2 mBGL). The asbestos was identified as amosite (brown) asbestos. The source of the asbestos could not be confirmed by the laboratories although a gauze type material was identified within soils at this location which could have potentially been the source. Additional investigation works to further characterise the nature and distribution of asbestos contamination within soils shall be undertaken before development of the site to determine the potential risk to the health of construction works.

Controlled Water (Groundwater) Assessment

11.4.20 Nine groundwater samples were subject to laboratory analysis for a targeted suite of parameters in 2009. The analytical results and detailed groundwater assessment is

presented in the Phase 2 Report provided in Appendix 11.3 and summarised in Table 11.2 below.

Table 11.2. Baseline Assessment of Groundwater Quality

Parameter[1]	Detection Limit (µg/l)	No. Samples	Maximum Concentration (µg/l)		Saline EQS	No. Samples Above EQS	UK DWS	No. Samples above UK DWS
Copper	1.6	9	30	WS3	15	4	2000	0
Chromium	1	9	11	WS7	5	3	50	0
Nickel	1.5	9	63	WS5	30	3	50	4
Selenium	1	9	14	WS7	-	-	10	1
Sulphate	3	9	1700	BH1	400	8	250	8
TPH (C6 – C40)	10	9	3300	WS3	-	-	10	1
B(a)P	0.009	9	1.5	WS3	0.7[2]	1	0.01	3
PAHs	0.1	9	12	WS3	-	-	0.1	5

1 TPH denotes Total Petroleum hydrocarbons; B(a)P denotes Benzo(a)pyrene; and PAH denotes polycyclic Aromatic Hydrocarbons.

2 WHO Standard for Drinking Water.

11.4.21 Elevated concentrations of nickel, selenium, sulphate, TPH and PAHs have been identified on the proposal site. The majority of concentrations that exceed either the EQS for saline waters or the UK DWS were identified in shallow perched groundwater within Made Ground and alluvium. Concentrations above any AC occur infrequently in groundwater from the underlying granular aquifer and is principally restricted to nickel and sulphate. It is considered that these elevated concentrations may represent natural baseline variability as opposed to the impact of near surface contamination.

11.4.22 Groundwater quality data currently available for the site provides no evidence for the active migration of leachate from the adjacent closed landfill on to the proposal site.

Ground Gas Assessment

11.4.23 From the initial two rounds of ground gas monitoring, concentrations of ground gas are generally low with methane concentrations rarely above 0%. However one concentration of carbon dioxide was measured above current guidance levels for the assessment of soil gases (Waste Management Paper 27 (Department of the Environment, 1991) and Building Regulations 2000 (Statutory Instrument No. 2531, 2001)) at Borehole WS3 (5.5%). There was little olfactory evidence of soil contamination by volatile compounds, with measurements by a PID that range from 0ppm to 5ppm across the site.

11.4.24 Baseline monitoring data available to date indicates a low risk from ground gas on the site. However, further gas monitoring and gas assessment will be undertaken in accordance with CIRIA C665 (CIRIA, 2007) to confirm this assessment prior to construction. This will confirm

any risks to human health and buildings, and inform the detailed design on the requirement or otherwise for ground gas protection measures to be incorporated, which can include:

- Reinforced concrete cast in situ floor slab (suspended, non suspended or raft) with at least 1200 gDPM2;
- Beam and block or pre cast concrete slab and minimum 2000 gDPM/reinforced gas membranes;
- Possible under-floor venting or pressurisation in combination with the above depending on use; and
- All joints and penetrations sealed, with minimum 2000 g/reinforced gas proof membrane and passively vented under floor subspace with monitoring facility.

11.4.25 Gas data currently available for the site provides no evidence for the active migration of landfill gases from he adjacent closed landfill on to the proposal site.

Conceptual Site Model (CSM)

11.4.26 In accordance with current UK guidance (Environment Agency 2005 and 2006a) the CSM for a contaminated site is best described in terms of Source-Pathway-Receptor (Pollutant Linkages). Potential sources of pre-existing contamination identified on site include the localised occurrence of inorganic and organic contaminants within Made Ground which include hotspots of inorganic determinants, PAH and TPH and brown asbestos (amosite) within Made Ground at a single location (WS8). Currently unknown areas of pre-exiting contamination may also reside in Made Ground on site. The closed landfill site to the south of the proposal site also represents a potential source of leachate and/or gas contamination that could potentially affect the proposal site.

11.4.27 The principal receptors identified on site include:

- Ground workers / construction staff;
- Site end users (e.g. staff and visitors to site);
- Shallow perched groundwater in the Made Ground and alluvium;
- Deep groundwater in granular deposits (Woolwich & Reading Beds and Thanet Sands) confined by the overlying London Clay; and
- The Swale Estuary.

11.4.28 The principal pathways identified on site include:

- Contact, inhalation and/or digestion of shallow soil contamination during construction works;
- Contact, inhalation and/or digestion with contaminated groundwater during construction works;

- Lateral flow of shallow groundwater, principally through the Made Ground and direct seepage to The Swale, east of the site;
- Lateral flow of shallow groundwater, principally through the Made Ground and direct seepage to drainage ditches (pre-existing or new) that discharge to The Swale;
- Vertical transfer of contaminated perched groundwater to the underlying confined groundwater through the London Clay and/or new pathways created during construction; and
- Lateral flow of confined deep groundwater in Woolwich and Reading Beds and seepage to the Swale.
- Lateral transfer of landfill gas and/or leachate from the closed landfill site to the south on to the proposal site by migration through shallow deposits and /or deeper groundwater.

11.5 Incorporated Enhancement and Mitigation

Construction Phase

11.5.1 All construction works shall be undertaken under the control of a Construction Environmental Management Plan (CEMP) produced by, or on behalf of, EON and to include all mitigations stated below. The CEMP shall ensure that all relevant national guidance and current UK best practice is adhered to. This shall include, but not be restricted to the following:

- BS5930: 1999 Code of practice for site investigations;
- BS10175: Investigation of potentially contaminated land. Code of practice;
- Pollution Prevention Guideline 6: Working at demolition and construction sites;
- Pollution Prevention Guideline 8: Safe Storage and Disposal of Fuel Oils;
- Groundwater Protection: Policy and Practice (GP3) (Environment Agency);
- CIRIA 132: A guide for safe working on contaminated sites; and
- CIRIA 73: Role and responsibility in site investigation.

11.5.2 During construction dust generation will be minimised by covering or damping down of dusty surfaces during dry weather and wheel washing of vehicles exiting the site. To alleviate the potential impact from accidental fuel and chemical spills, potentially hazardous substances will be stored within bunded and/or drip trays situated away from any surface water drainage present on the site. The CEMP will include appropriate site-specific method statements for the works which would cover storage and use of chemicals and fuels during construction. Emergency procedures will include the use of spill kits and booms to deal with fuel and chemical spillages in accordance with regulatory guidance (e.g. Environment Agency pollution prevention guidelines).

11.5.3 Precautionary measures will be put in place to protect construction workers involved in earthworks, by way of an earthworks methodology / construction management plan part of the CEMP. This plan will be designed to mitigate risks relating to the disturbance of residual soil or groundwater contamination, identification removal and validation of contamination hotspots and all statutory requirements associated with the earthworks such as discharge consents spoil generation handling and where appropriate off site disposal where required. This plan will also include the groundwater management plan referred to earlier. Appropriate PPE will be worn at all times during excavation and/or handling excavated soils.

11.5.4 The CEMP will include the Remedial Strategy and Materials Management Plan, the results/recommendations from the piling Risk Assessment and the findings of the full ground gas assessment.

Operation Phase

11.5.5 Regular inspection of tanks, bunds, hardstanding and subsurface structures (e.g. pipe-work, drains etc) will be undertaken in order to assess ongoing integrity of all pollution prevention features included in the facility design. Inspections will be undertaken by qualified personnel on a regular basis and compiled into a monitoring report and submitted to the EA on an agreed basis as part of the Environmental Permitting (EP) regime. The storage and use of potentially polluting substances stored on site will be audited. Any refuelling activities will be undertaken on areas of hard-standing with spill kits available to enable a quick and effective response to any spillages.

11.6 Identification and Evaluation of Likely Significant Effects

Construction Phase

11.6.1 Significant excavations are proposed on parts of the site, most notably in the vicinity of the fuel storage bunkers where a Finished Floor Level (FFL) of -1.2mAOD is proposed. This implies a maximum excavation depth of approximately 7.2m in central parts of the site. Elsewhere, the proposed FFL is approximately 5.8mAOD, which will require minor excavations in the west and south-west of the site, with additional fill to raise ground levels in the east and south-east towards The Swale.

11.6.2 Only limited evidence of soil contamination has been identified across the proposal site. The short-term exposure of construction workers to soils excavated and transported during construction represents a risk to human health of ***minor adverse*** significance. These adverse effects can be mitigated by adopting standard PPE and personal hygiene protocols (implemented through the CEMP) and the derivation of remedial target concentrations for key contaminants through a site-specific Quantified Risk Assessment (QRA) for Human Health.

Remedial targets shall be presented in a Site Remedial Strategy and Materials Management Plan to be included in the CEMP. This plan will also provide contingency plans for dealing with any currently unknown source of soil contamination that may be encountered on the site during construction.

11.6.3 Some asbestos contamination has been identified in soils on the site and the significance of the risk to human health posed by asbestos on the site is currently considered to be ***minor adverse***. The risk to construction workers shall be re-evaluated following further characterisation of the extent of asbestos contamination in the vicinity of WS8 undertaken prior to the development of the proposal site. Appropriate handling and disposal methods will be determined following these works and included in the CEMP if required.

11.6.4 Little groundwater is expected to be encountered in the shallow excavations required over the site. Although groundwater in the shallow aquifer is generally non-potable, exposure to this water does not represent a significant risk to the health of construction workers assuming appropriate personal hygiene protocols and PPE are used during construction, as specified in the CEMP. The risk to human health from exposure to groundwater is considered to be of **minor adverse** significance.

11.6.5 Groundwater quality in the shallow aquifer exceeds saltwater EQS for a number of parameters. However, the discharge of shallow groundwater to The Swale (either directly or via seepage into surface drains) is considered to represent a low risk to water quality in The Swale considering: the discontinuous occurrence of shallow groundwater on the Site; the complexity of the existing pathways to The Swale; and diffuse discharge mechanisms that would be involved. The significance of such an impact is therefore considered to be ***minor adverse***. Furthermore, the proposed land raise along the eastern part of the proposal site and the construction of the new drainage systems in this area is likely to minimise the potential impact from pre-existing pathways between shallow perched water and The Swale.

11.6.6 The granular deposits underlying the London Clay (i.e. Woolwich and Reading Beds) may be intercepted in the areas of deepest excavation proposed on the site. In the absence of appropriate control measures, the ingress of groundwater into deep excavations represents a risk to construction workers of ***moderate adverse*** significance. Although groundwater levels in the deep aquifer are low (c. 1.2 mAOD) appropriate groundwater management precautions may be required and these will include, where appropriate, aquifer dewatering to lower confined water pressures, use of sheet piling to support the excavation and/or sump pumping to control groundwater ingress. A groundwater control and management plan will therefore be produced by a suitably qualified specialist following further investigation works undertaken on

the site to inform the SEP design. The groundwater control and management plan shall be included within the CEMP.

11.6.7 The uncontrolled discharge of potentially contaminated groundwater to the surface water drainage system may result in an adverse impact on surface water features and ultimately The Swale. This risk shall be mitigated by the analysis of extracted groundwater and adoption of the appropriate discharge arrangements which will be specified in the CEMP prior to construction. On the basis of the groundwater quality identified on the site, any discharge of groundwater shall be controlled by a discharge consent issued by the Environment Agency or the appropriate authorisation from the local Water Company if discharge is to be to the foul sewer system. Alternatively arrangements for off-site disposal may be required, although this is considered unlikely.

11.6.8 Temporary groundwater control and/or dewatering would locally reduce groundwater levels in the deep confined aquifer on the site. This will result in a temporary reduction in the flux of groundwater flow towards The Swale. In the absence of any groundwater dependent receptors down gradient of the site (e.g. abstractions, wetlands, rivers and springs) the significance of this temporary impact on controlled waters is ***neutral***.

11.6.9 The concentration of potentially hazardous ground gases (i.e. carbon dioxide, methane and VOCs) identified on site is generally low. The significance of the risk from ground gas across the site currently therefore appears to be ***neutral***. However the monitoring dataset is limited and additional gas monitoring and assessment will be completed prior to the construction phase. The gas risk assessment will confirm the level of risk to future site users and will inform whether gas protection measures are required as part of detailed design.

11.6.10 Data currently available for the site provides no evidence of the active migration of landfill gases or leachate from the adjacent closed landfill on to the Proposal Site. The risk posed to construction works during construction as a result of such lateral migration is therefore considered to be of ***minor adverse*** significance. This risk will be mitigated through the procedures and PPE specified in the CEMP.

11.6.11 Deep excavations in the vicinity of fuel storage bunkers and potential use of pile foundations may open new preferential pathways for contamination transport from the surface and/or near surface. This may result in a deterioration of water quality in deep groundwater by accidental spillages during construction and or leakage of shallow perched groundwater. The significance of this impact on groundwater is considered to be ***minor adverse*** but is unlikely to affect any other controlled waters or groundwater dependent environmental receptors.

These effects will be mitigated through the production of the piling risk assessment that will inform design and the CEMP.

11.6.12 Dust and silt may be disturbed by the excavation and movement of soils by machinery during construction. If left uncontrolled this could result in the silting-up of the local drainage systems and possible emission to The Swale. Such an impact is considered to be of ***minor adverse*** significance and will be controlled by the management of surface run-off during construction and damping down during dry weather. Both measures will be specified in the CEMP.

11.6.13 During construction there is potential for the accidental spillage of hazardous substance from vehicles, plant and the storage of materials on the site. The magnitude of the impact due to accidental spillage of fuels from construction vehicles is dependent on the frequency and size of the spillage. Depending on the size of such an event, it is considered that the impact of a fuel or chemical spillage would be of ***neutral*** to ***minor adverse*** significance considering the presence of low permeability deposits overlying the deeper aquifer unit. The potential for an accidental release of hazardous substances will be minimised through the CEMP, by specific protocols regarding the designation of bunded storage areas on the site, restriction of refuelling to specified areas on the site, the control / handling / use of hazardous substances on the site and the availability of spill kits.

Operation Phase

11.6.14 Based on soil assessments undertaken to date the potential impact from current soil conditions identified on site on human health of future site users is considered to be of ***neutral*** significance. This appraisal will be confirmed by the screening of excavated soils against site specific AC determined from a QRA for human health to determine appropriate end-use.

11.6.15 The floor slabs and raft or pad foundations proposed for many structures included in the design (See Chapter 4), most notably in the area of where ground levels must be raised above the surrounding flood plain in the east of the site, is likely to involve the use of an imported, clean and largely granular sub-base. This could promote lateral transfer of shallow perched groundwater towards The Swale. However, significant flow is not anticipated owing to the construction of largely impermeable surface cover over the majority of the site and the use of clean materials is likely to attenuate contamination concentrations along an easterly flow path beneath the site and towards The Swale. Thus the potential significance of the impact of shallow groundwater on the quality in The Swale and/or new sustainable urban drainage (SUDs) features on the site is therefore considered ***neutral***.

11.6.16 Piled foundation, where used, and deep structures associated with the development may intercept deeper groundwater in the Woolwich and Reading Beds underlying the site. Although this may result in a small alteration to natural groundwater levels and flow, it is unlikely to adversely affect any groundwater dependant receptors and the significance of this impact therefore considered to be ***neutral***. These structures may create new pathways between the shallow perched groundwater and deeper groundwater, although these will be mitigated through a piling risk assessment. The significance of this impact on deep groundwater quality is therefore considered to be ***minor adverse***.

11.6.17 The geological site setting suggests that the lateral migration landfill gases from the closed landfill site to the south on to the Proposal Site is unlikely to pose a significant risk to future users on the site. Furthermore, the continued post-closure peripheral gas monitoring on this closed facility (see Section 11.4.3) should identify any risk from gas emissions should they arise in the future. The significance of the impact of landfill gas ingress from the adjacent site is therefore considered to be ***minor adverse***.

11.6.18 The storage, handling, transport and disposal of these materials may potentially contaminate soils and shallow groundwater on the site. Waste materials and ash will be dry, contained in closed facilities and removed from site by HGV. The potential impact of these sources of contamination on soil and groundwater is therefore considered ***minor adverse***. This impact will be mitigated through requirements of the EP regime for the site.

11.7 Mitigation

Construction Phase

11.7.1 A groundwater management plan will be developed for site to minimise risks associated with intercepting the confined deep aquifer and resulting groundwater ingress. This plan will identify all groundwater control measures required (i.e. aquifer dewatering and/or sheet piling and sump pumping) and will include a plan regarding the handling, storage and disposal of groundwater encountered on site following UK best practice.

11.7.2 A piling risk assessment will be produced prior to construction.

11.8 Residual Impact

11.8.1 Residual impacts, following the implementation of all mitigation measures are summarised in Table 11.3.

Resource	Phase	Residual Effect (Additional Mitigation Measure)	Sensitivity of Receptor	Magnitude of Impact	Duration	Significance	Geographical Level of Importance of Issue				
							I	N	R	D	L
Hydrogeology, Controlled Waters and Human Health	Construction	Inhalation, dermal contact or ingestion of contaminated soils during excavation and / or movement	High	Minor	Short Term	Minor Adverse					✓
		Inhalation, dermal contact or ingestion of contaminated groundwater during shallow excavation and / or movement	High	Minor	Short Term	Minor Adverse					✓
		Inhalation, dermal contact or ingestion of asbestos (further SI to characterise extent)	High	Minor	Short Term	Minor Adverse					✓
		Ingress of groundwater into deep foundation excavations (Groundwater Management Plan)	High	Minor	Short Term	Minor Adverse					✓
		Lateral transport of contaminated shallow perched groundwater to The Swale.	Medium	Minor	Medium Term	Minor Adverse					✓
		Vertical transport of contaminated shallow perched groundwater to deep groundwater.	Low	Minor	Medium Term	Neutral					✓
		Groundwater level and flow reduction resulting from dewatering and/or control	Low	Minor	Short Term	Neutral					✓
		Explosion and/or asphyxia by ground gas during excavation	High	Negligible	Short Term	Neutral					✓
		Accidental Spillage of potentially contaminating substances	Low	Minor	Short Term	Neutral					✓
	Operation	Inhalation, dermal contact or ingestion of contaminated soils as a result of exposure and/or re-use on the site. (Site-specific QRA?)	High	Negligible	Medium Term	Neutral					✓
		Explosion and/or asphyxia by ground gas.	High	Negligible	Medium Term	Neutral					✓
		Impacts form accidental spillage and or leakages from vehicles and/or stored substances	Medium	Minor	Medium Term	Minor Adverse					✓
		Reduced groundwater quality in deep aquifer resulting from construction pile foundations	Low	Minor	Medium Term	Minor Adverse					✓
		Lateral transport of contaminated shallow perched groundwater to The Swale through preferential pathway created by granular sub-base.	Medium	Minor	Medium Term	Minor Adverse					✓
		Impact on levels and flow directions in deep aquifer by construction of deep foundations and/or piled foundations	Low	Minor	Long Term	Neutral					✓

Key: I: International N: National R: Regional D: District L: Local

11.9 Conclusions

11.9.1 An assessment of the likely impact of current ground conditions and the Sustainable Energy Plant (SEP) may have on hydrogeology, controlled waters and human health has been undertaken for the proposed Sustainable Energy Plant at Kemsley Mill, Sittingbourne, Kent. The site is situated on low lying land immediately adjacent to The Swale estuary and a closed landfill site to the south. The site was the location of former coal storage and a refuse tip. The site is now largely derelict with some stockpiled material in the west. It is assumed that all stockpiled material will be removed before construction and is not therefore included in this assessment.

11.9.2 This assessment has been based on a review of historical documents available at the time of writing and the results of Phase 2 intrusive works undertaken by RPS in 2009. The largely qualitative risk assessments referred to in this chapter are contained in the interpretive report presented in Appendix 11.3.

11.9.3 The site is characterised by a veneer of Made Ground and alluvial clays that overlie the London Clay, with silty sands of the Woolwich and Reading Beds beneath. A laterally discontinuous perched water body has been identified at shallow depth, with continuous saturated conditions identified in the underlying granular deposits. The London Clay is thought to effectively separate shallow perched groundwater form water in the granular deposits at depth. Groundwater flow in both water bodies is therefore orientated to the east towards The Swale. Groundwater will ultimately be discharged to The Swale either directly (through intervening estuarine muds) or indirectly (through existing drainage features on the site) although this flux will be quantitatively trivial. The Swale is an ecologically important site, with SPA and SSSI designation.

11.9.4 Pre-existing soil contamination, principally dominated by TPH and PAH, has been identified in shallow deposits on the site. However baseline assessments suggest the concentrations are acceptable for industrial / commercial end land use and do not represent an unacceptable risk to construction workers. Brown asbestos has been identified at one locality on the site and additional characterisation investigations will be undertaken before construction.

11.9.5 Shallow groundwater demonstrates elevated concentrations of nickel, selenium, sulphate, TPH and PAHs relative to saltwater EQS at a number of localities.

11.9.6 Shallow waters are more heavily contaminated than deep groundwater, the latter exhibiting elevated concentrations of only nickel and sulphate. It is considered that these elevated concentrations may represent natural baseline variability as opposed to the impact of near surface contamination.

11.9.7 The principal concerns relating to the development include the risk to human health caused by groundwater ingress to deep excavations, the lateral migration of contaminated shallow groundwater towards The Swale and asbestos containing materials identified in shallow soils. By undertaking some additional targeted works and associated assessment, in addition to the production of a robust Construction Environmental Management Plan (CEMP) for the development, all potential impacts that may result from the development have been reduced to ***neutral*** or ***minor adverse*** significance. Additional works will include intrusive investigation to inform design and asbestos presence on the site; additional gas monitoring in line with CIRIA C665 (CIRIA, 2007); the production of groundwater management plan and piling risk assessment; and the production of QRA for human health and controlled waters.

11.10 References

Construction Industry Research and Information Association (CIRIA). 2007. Assessing risks posed by hazardous ground gases to buildings. Report C665.

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Environment Agency. 2006b. Pollution Prevention Guideline 8: Safe Storage and Disposal of Fuel Oils. Bristol: Environment Agency

Environment Agency. 2005. Model Procedures for the Management of Land Contamination. Contaminated Land Report 11 (CLR11). Bristol: Environment Agency, September 2005

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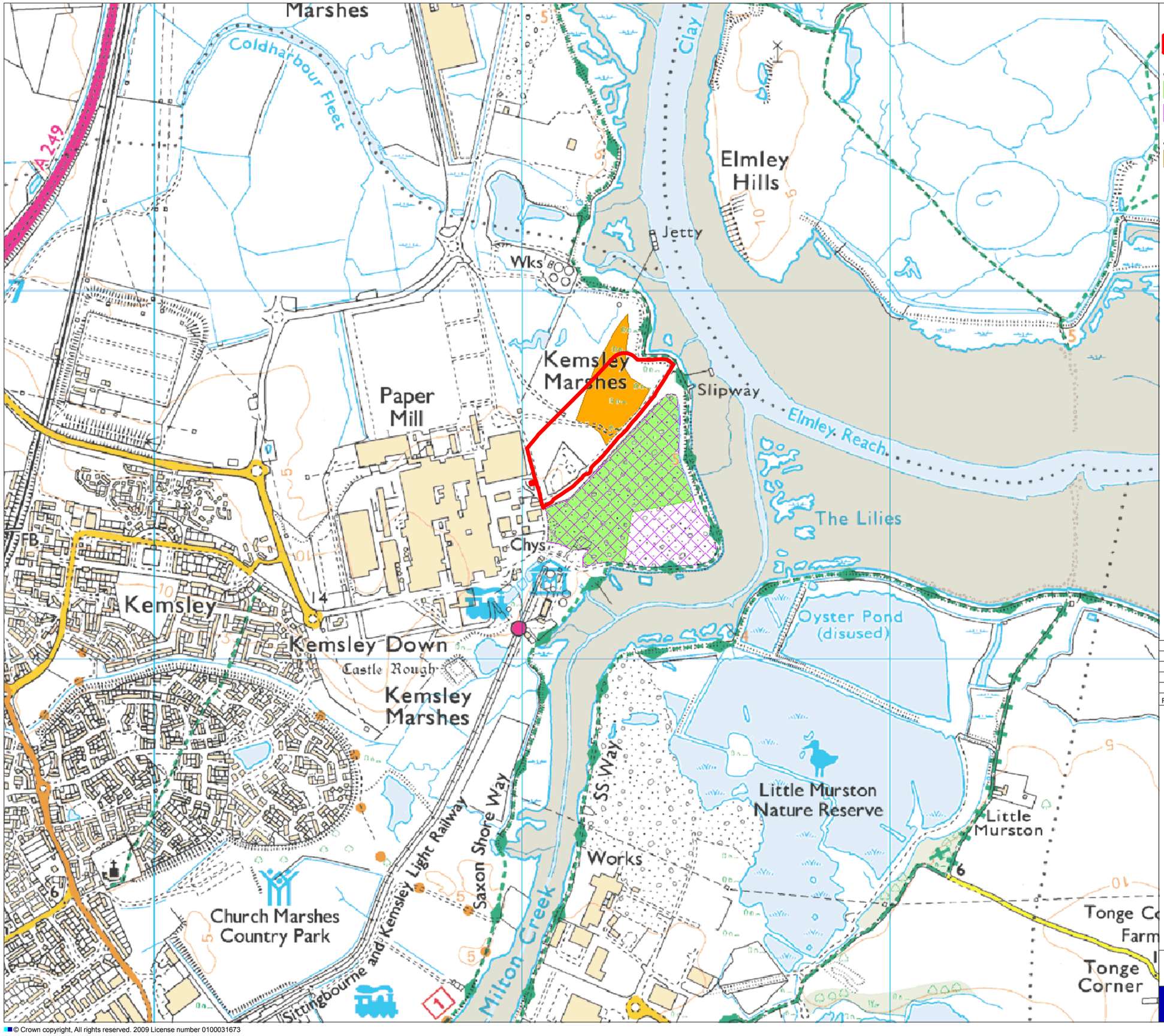
RPS Planning and Development 2009b. Phase 2 Intrusive Site Investigation, Kemsley Paper Mill, Sittingbourne, Kent. Report Ref. JER4418 R 090909 AP, September 2009.

PRS Planning and Development/ 2009a. Phase 1 Environmental Site Assessment, Kemsley Mill, Sittingbourne, Kent. Report Ref. JER3773 R 090318 LW, March 2009.

Statutory Instrument No. 2531. 2000. Building and Buildings England and Wales, The Building Regulations 2000, Crown Copyright 2000.

11.11 Glossary

AC	Assessment Criteria
B(a)P	Benzo(a)pyrene
BGS	British Geological Survey
CEMP	Construction Environmental Management Plan
CHP	Combined Heat Power Station
CSM	Conceptual Site Model
DWS	Drinking Water Standard
EA	Environment Agency
EP	Environmental Permitting
EQS	Environmental Quality Standard
GAC	Generic Assessment Criteria
mAOD	Metres Above Ordnance Datum
mbGL	Metres Below Ground Level
PAH	Polycyclic Aromatic Hydrocarbons
PID	Photo-Ionisation Detector
PPE	Personal Protective Equipment
ppm	Parts Per Million
QRA	Quantified Risk Assessment
SBC	Swale Borough Council
SGV	Soil Guideline Value
SPA	Special Protection Area
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
SUD	Sustainable Urban Drainage
TPH	Total Petroleum hydrocarbons
VOC	Volatile Organic Compounds



Legend

Site Boundary

Grovehurst Energy Limited

Licensed Waste Management Facility

Registered Landfill Site (P/05/63)

Kemsley Mill

Historic Landfill

E.ON STREGIS

Rev:	Date:	Amendment:	Name:	Checked:
-	07/12/09	Revised Redline Boundary	RJ	MW

Data Source: RPS 2009

Status: FINAL

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Client: E.ON

Project: Kemsley Mill

Title: Baseline Environmental Setting

Scale: A3 @ 1:10,000

0 250 500m

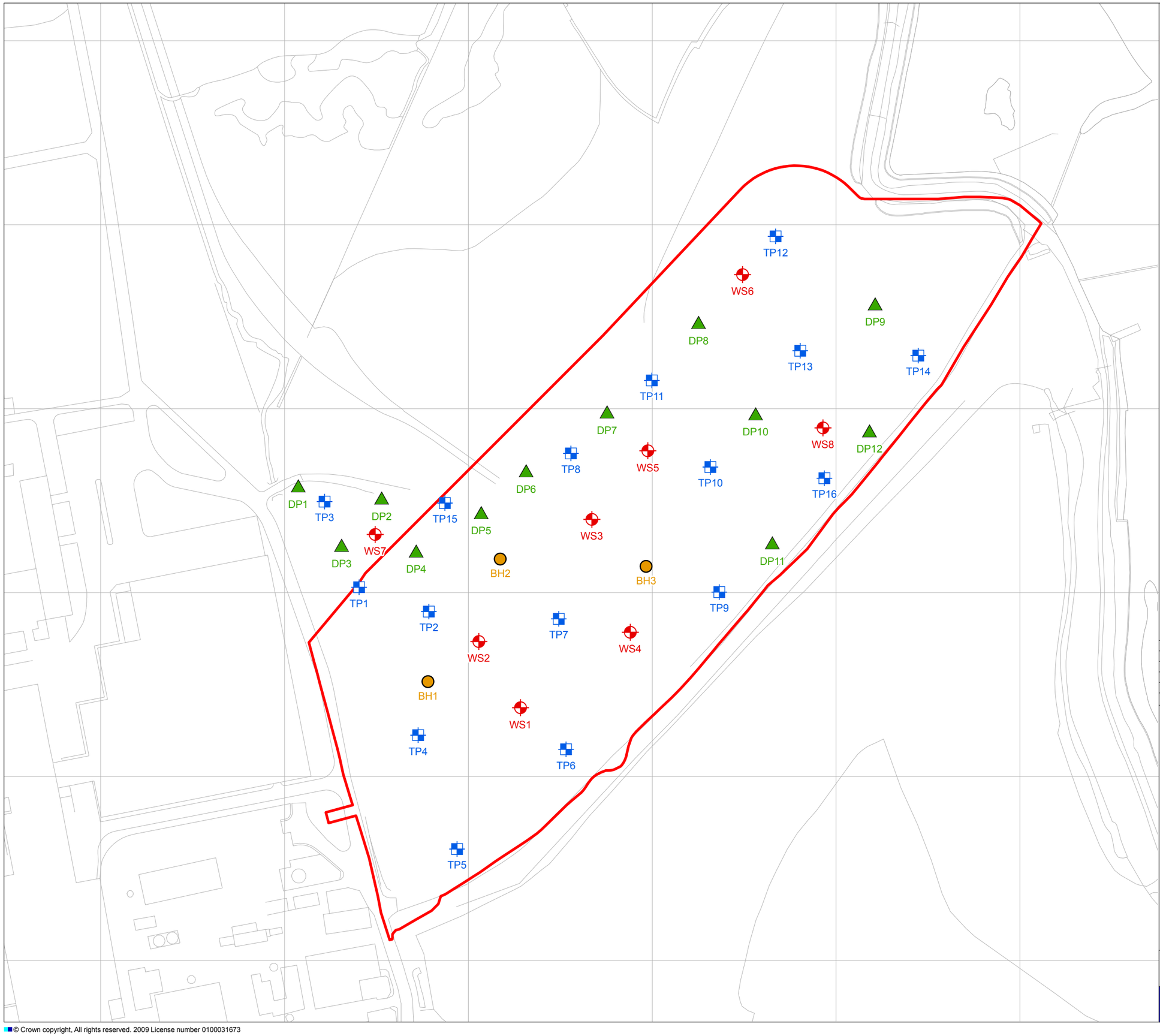
N

Date: 18/11/2009 Datum: OSGB36 Projection: BNG

Drawn: RJ Checked: AG Job Ref: JER4418

Figure No: **11.1** Revision: -

Project Ref: J:\Drawings\JER4418



Legend

Site Boundary

Investigation Locations

- Shell & Auger (3)
- Trial Pit (16)
- Window Sample (8)
- Dynamic Cone Penetrometer (12)

e·on stRegis

Rev:	Date:	Amendment:	Name:	Checked:
-	07/12/09	Revised Redline Boundary	RJ	MW

Data Source: RPS 2009

Status: FINAL

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Client: E.ON

Project: Kemsley Mill

Title: Intrusive Investigation Location Plan

Scale: A3 @ 1:2,000

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N

Date: 18/11/2009 Datum: OSGB36 Projection: BNG

Drawn: RJ Checked: AG Job Ref: JER4418

Figure No: **11.2** Revision: -

Project Ref: J:\Drawings\JER4418