



SEVERN ROAD RESOURCE RECOVERY CENTRE

**CHAPTER 9-
GEOLOGY, HYDROLOGY AND HYDROGEOLOGY**

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SLR REF 402.0036.00374

September 2009



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INTRODUCTION

- 9.1 This Chapter details the geology, hydrology and hydrogeology of the application site and surrounding area and identifies potential hydrogeological impacts associated with the proposed Severn Road Resource Recovery Centre (SRRRC) development.
- 9.2 Impacts are considered for the initial assessment assuming no mitigation is in place, before discussing appropriate mitigation measures and reassessing residual impacts. The assessment is based on a baseline description of the local hydrological and hydrogeological regimes.

SITE SETTING

- 9.3 The development site lies within the Avonmouth Industrial Estate, approximately 7 miles west of Bristol City Centre.
- 9.4 The site is located at National Grid Reference (NGR) 353797, 181739 and consists of the northern part of the Sevalco Plant which historically operated across two sites separated by Severn Road.
- 9.5 The site covers approximately 8.3 hectares of land and is located adjacent to Severn Road. The site lies circa 230 metres east of Chittingen Road, the main road providing a north-south connection within the Avonmouth industrial area.
- 9.6 The Site elevation is approximately 6-7m above Ordnance Datum (aOD) with the surrounding area being predominantly flat with no significant topographic changes¹.
- 9.7 Avonmouth is an extensive, long established industrial area that serves the West of England sub region and beyond. It hosts a wide range of general industrial uses, specialist industries, port facilities, storage and distribution, power generation and waste management uses and has excellent links to the strategic route network.
- 9.8 The Avonmouth area is clearly defined as part of the Severn and Avon flood plains separated from the rest of Bristol to the south-east by the M5 motorway. As an established industrial area, it is well separated from residential development with only a few isolated properties to the east of the site on Minor's Lane approximately 1000 metres away.

POLICY CONTEXT

- 9.9 The development of the proposed site would be undertaken using technical guidance, relevant Pollution Prevention Guidelines and other codes of best practice in order to limit the potential or contamination of ground and surface

¹ SLR Consulting Ltd, Avonmouth – Due Diligence Land Quality Assessment, SLR Ref.: 416-0036-00353 (May 2008)
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waters, the potential for flooding to be caused by the development, and other potential impacts. The development of the site would be in accordance with the following;

- Control of Pollution Act 1974;
- Environment Act 1995;
- The Environment Agency's statutory obligations over the management and control of pollution into water;
- EC Water Framework Directive (2000/60/EC);
- Environment Agency – Pollution Prevention Guidelines
- Control of Water Pollution from Linear Construction Projects – C648 (CIRIA, 2007);
- Code of Practice for Site Investigations, BS5930; and
- Environmental Good Practice on Site C650 (CIRIA 2005).

9.10 The Pollution Prevention Guidelines identified below are the principal documents used for guidance on preventing water pollution and the erosion from construction activities and are jointly produced by the Environment Agency for England and Wales, Scottish Environmental Protection Agency and the Environment and Heritage Services in Northern Ireland and are available via the EA's website²;

- PPG1: General Guide to the Prevention of Pollution;
- PPG2: Above Ground Oil Storage Tanks;
- PPG3: Use and Design of Oil Separators in Surface Water Drainage Systems;
- PPG4: Disposal of Sewage where no Mains Drainage is Available;
- PPG5: Works in, Near, or Liable to Affect Watercourses;
- PPG6: Working at Construction and Demolition Sites;
- PPG8; Storage and disposal of Used Oils;
- PPG18; Managing Firewater and Major Spillages;
- PPG21; Pollution Incident Response Planning;
- PPG22; Dealing with Spillages on highways; and
- PPG23: Maintenance of Structures over Water.

METHODOLOGY

9.11 A qualitative risk assessment methodology has been applied, in which the probability that an impact occurs and the magnitude of the impact, if it were to occur, are considered. These are combined to determine the 'Significance' of the impact. This approach provides a mechanism for identifying the areas where mitigation measures are required, and for identifying mitigation measures appropriate to the risk presented by the development. This approach allows effort to be focused on reducing risk where the greatest benefit may result. Mitigation is considered necessary where the significance of the impact is assessed as 'medium' or 'higher'. The assessment is outlined in Table 9-1 below.

² Environment agency's Website: www.environment-agency.gov.uk
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Table 9-1
Matrix used to Identify the Significance of an Impact

Probability of Occurrence	Magnitude of Potential Impacts			
	Severe	Moderate	Mild	Negligible
High	High	High	Medium	Low
Medium	High	Medium	Low	Near Zero
Low	Medium	Low	Low	Near Zero
Negligible	Low	Near Zero	Near Zero	Near Zero

9.12 The definition of 'degrees of magnitude' for various examples of potential impacts, in terms of hydrogeology is detailed in Table 9-2.

Table 9-2
Magnitude of Potential Geological, Hydrogeological & Hydrological Impacts

Magnitude	Potential Impact
Negligible	No impact of alteration to existing important geological environs; No alterations or very minor changes with no impact to watercourses, hydrology, hydrodynamics, erosion and sedimentation patterns; No alteration to groundwater recharge or flow mechanisms; and No pollution or change in water chemistry to either groundwater or surface water
Mild	Some loss of soils with no long term impact; Minor or slight changes to the watercourse, hydrology or hydrodynamics; Changes to site resulting in slight increase in runoff well within the drainage system capacity; Minor changes to erosion and sedimentation patterns; and Minor changes to the water chemistry.
Moderate	Slope failure or instability which may cause foundation problems, loss of extensive areas of peat or agricultural soil, damage to important geological structures/features; Some fundamental changes to watercourses, hydrology or hydrodynamics; Changes to site resulting in an increase in runoff within system capacity; Moderate changes to erosion and sedimentation patterns; and Moderate changes to the water chemistry of surface runoff and groundwater.
Severe	Slope failure or instability which causes loss of life, permanent degradation and loss of important geological feature. Wholesale changes to watercourse channel, route, hydrology or hydrodynamics; Changes to site resulting in an increase in runoff with flood potential and also significant changes to erosion and sedimentation patterns; and Major changes to the water chemistry or hydro-ecology.

SOURCES OF INFORMATION

9.13 The following sources of information have been consulted in order to investigate the geology, hydrogeology and hydrology of the area surrounding the application site.

- British Geological Survey Sheet 264 – Bristol (1:50,000 Scale) Solid and Drift Edition, 2004;

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- National Rivers Authority Policy and Practice for the Protection of Groundwater (now the Environment Agency) Groundwater Vulnerability Map 37 – Southern Cotswolds;
- Environment Agency Website – www.environment-agency.gov.uk;
- Environment Agency Information Request, May 2009
- Bristol City Council Information Request, May 2009
- Landmark Envirocheck report, February 2008;
- Ministry of Agriculture, Fisheries and Food (MAFF), Technical Bulletin 34 Climate and Drainage (1976);
- Site Investigation works undertaken by SLR in June and July 2009
- Monitoring data collected by SLR between July and August 2009

BASELINE CONDITIONS

Geology

- 9.14 The published geological map³ for the area indicates that the proposed development is underlain by Estuarine Alluvium (Tidal Flat Deposits), comprising of organic rich clay and silt, which is underlain by Triassic Mercia Mudstone Group.
- 9.15 An in-crop of coal lies unconformable at the base of the Mercia Mudstone at some depth beneath the site. The in crop lies in a synclinal structure and is recorded on the geological map at a horizontal distance of approximately 300m to the north-west (nearest distance).
- 9.16 An extract of the published geological map is presented as Drawing 9-1.
- 9.17 A summary of the geology in the vicinity of the site is presented in Table 9-3 below.

Table 9-3
Summary of Geology in the Vicinity of the Site

Era	Unit	Description	Typical Thickness
Quaternary	Tidal Flat Deposits	Organic rich clay and silt	-
Triassic	Mercia Mudstone Group	Red mudstone with greenish-grey sandstone	55 - 1241m

- 9.18 A total of twenty four intrusive investigations were advanced on the site between 14th and 16th April 2008, to determine ground conditions¹. The investigation comprised the drilling of five boreholes, installed as monitoring wells, (BH1 to BH5) and the excavation of nineteen Trial Pits (TP1 to TP19). Details on this site investigation can be found within the relevant SLR Report.
- 9.19 Additional site investigation was undertaken in June 2009 to further develop the geological and hydrogeological setting at the application site. The investigation comprised the following:

³ British Geological Survey Sheet 264-Bristol (1:50,000 Scale) Solid and Drift geology, 2004
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- drilling of sixteen boreholes;
 - 8 drilled within the Alluvium/Made Ground to shallow depths (<5m) with 5 installed as permanent monitoring wells (BH6, BH7, BH10, BH12 and BH13);
 - 4 drilled to the base of the alluvium with all installed as permanent monitoring wells (BHC01, BHC02, BHC04, BHR04);
 - 4 drilled within the Mercia Mudstone with 2 installed as permanent monitoring wells; BHR01 and BHC03 (installed within the weathered material towards the top of the unit); and
 - 2 Trial Pits to a maximum depth of 1.20mbgl and installed with permanent monitoring wells.
- 9.20 The ground conditions encountered beneath the site comprised Made Ground overlying Estuarine Alluvium, underlain at depth by Mercia Mudstone.
- 9.21 The strata encountered during the intrusive site works in June 2009 are summarised below with trial pit and borehole logs presented in Appendix 9-1

Made Ground

- 9.22 Made Ground was encountered across the entire site to depths of between 0.15 and 1.7mbgl and comprised of gravelly clay, clayey gravel, cobbles and boulders and sandy clay
- 9.23 Two shallow boreholes encountered contamination in the form of hydrocarbon staining and odour (BH6) and free phase hydrocarbons (BH7) within the shallow soils. Ground contamination is discussed further in Chapter 10 of the Environmental Statement.

Alluvium

- 9.24 Alluvium was encountered across the site beneath the Made Ground in all areas. The Alluvium generally comprised of grey mottled black silty clay and silt becoming sandy with depth. In the upper levels the Alluvium was a brown mottled grey firm silty and sandy clay becoming soft and grey in colour towards the base. Thin layers of black peat were present throughout the Alluvium
- 9.25 At the base of the Alluvium a layer of sandy grave or gravelly silt and clay was encountered and either thought to be a series of braided channels or coming into weathered Mercia Mudstone.

Mercia Mudstone

- 9.26 The Mercia Mudstone was proven from a depth of between 10.50m and 16.00mbgl and consisted of red dolomitic siltstone and mudstone. The mudstones have occasional bands of green or grey green colouring attributed to the oxidation state of iron in the material. In this area the

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mudstone contains celestite (strontium sulphate) which has been commercially exploited during the last 100 years⁴.

- 9.27 At the top of the unit the material was weathered and recovered as either a clayey sand or gravelly clay or a very weak sandy mudstone.

Hydrogeology

Aquifer Characteristics

- 9.28 The published Groundwater Vulnerability Map⁵ for the area classifies the estuarine alluvium as a Non-Aquifer which shows negligible permeability and an insignificant water resource. The NRA regional appendix⁶ classifies the Mercia Mudstone as a Minor Aquifer, with unpredictable groundwater within local sandstone bands and predominate flow mechanism through fractures.
- 9.29 An extract of the Aquifer Vulnerability map is presented on Drawing 9-2.

Recharge Mechanisms

- 9.30 The Flood Estimation Handbook (FEH)⁷ data shows that the average annual rainfall at the site is 778mm.
- 9.31 The site lies within MAFF Agroclimate⁸ area 30 which suggest a mean total annual rainfall of 807mm. The reported effective annual rainfall (excess winter rain) varies between 165mm and 675mm a year with an average of 335mm/year.
- 9.32 The Environment Agency⁹ has a rainfall gauge at Henbury, located approximately 3.5km to the south-east of the site. The data covers the period November 1998 to March 2009; however, the EA note there is no check-gauge at this site to validate the data. A second rain gauge is present at Frampton Cotterell approximately 13 km to the east of the site. For the time period January 1999 to December 2008, total annual rainfall ranges between 638mm/year and 1004mm/year with an average annual rainfall of 791mm/year.
- 9.33 Owing to the Alluvium being classed as a Non-Aquifer, the majority of recharge will form surface water run-off as opposed to infiltrating and recharging the Alluvium.

⁴ G W Green, British Regional Geology, Bristol and Gloucester region, Third Edition, 1992.

⁵ National Rivers Authority, now the environment Agency, Policy and Practice for the Protection of Groundwater, Groundwater Vulnerability Sheet 37 – Southern Cotswold (1:100,000 Scale)

⁶ National Rivers Authority, now the Environment Agency, Policy and Practice for the Protection of Groundwater, Regional Appendix, Wessex Region

⁷ The Institute of Hydrology, Flood Estimation Handbook (FEH) CD ROM, 2006

⁸ Ministry of Agriculture, Food and Fishery (MAFF), 1976, Climate and Drainage, Technical Bulletin 34, HMSO, London

⁹ Data from Environment Agency Information Request, EA Ref - NWX/CSC/28038 dated 1st May 2009.

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Groundwater Levels and Flows

Groundwater Strike

- 9.34 During drilling in June 2009, seepages of perched water were encountered within the Made Ground. Groundwater within the Alluvium was encountered in all but one borehole. Groundwater strike was shallow in 8 boreholes (between 1.0 and 5.0mbgl) and deep within three boreholes (between 12.0 and 15.0mbgl).
- 9.35 Although an obvious groundwater strike was not observed within the boreholes drilled into the Mercia mudstone groundwater levels did rise. Borehole BHR01 (permanent installation) saw levels rise to circa 3.0mbgl.

Groundwater Level Monitoring

- 9.36 Permanent groundwater monitoring wells were installed within a number of boreholes across the site as detailed in point 9.19. Their locations are presented on Drawing 9-3.
- 9.37 Groundwater level monitoring was undertaken on 7 occasions following the completion of the drilling works (between 3rd July 2009 and 18th August 2009) at 16 No. groundwater monitoring boreholes.
- 9.38 Previous work¹⁰ in the area suggests that groundwater flow within the Alluvium is in a general westerly direction towards the Severn Estuary, and is understood to be tidally influenced.
- 9.39 A summary of groundwater levels across the site are presented in Table 9-4 below and a groundwater hydrograph is presented in Appendix 9-2.
- 9.40 Review of the groundwater level data indicates that groundwater within the shallow Alluvium show reasonable fluctuation between boreholes across the site and within some individual boreholes. This can be attributed to heterogeneity of the aquifer and suggests that groundwater is present within isolated perched water bearing horizons with limited continuity, therefore limited groundwater flow. Available data show that highest groundwater levels are predominately found in BH10 and BH12 towards the centre of the site and fall towards the edge of the site and the Rhines (drainage ditches). Lowest groundwater levels were consistently observed in BH02 located to the south-east of the site.
- 9.41 It is noted that shallow boreholes that have been screened across Made Ground as well as the shallow Alluvium may be influenced by perched water within in the Made Ground. In addition monitoring has been affected by adverse weather conditions causing localised flooding around the site.

¹⁰ SLR Consulting Ltd. Former Britannia Zinc Site – Avonmouth: Environmental Liability Assessment, April 2007, written on behalf of SITA UK Ltd, SLR Ref.:402-0079-00180
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- 9.42 The monitoring data shows that groundwater levels installed at the base of the alluvium (BHC01, BHC02, BHC04 and BHR04) are spatially variable across the site. The differences are likely to be attributed to the heterogeneity of the aquifer where water is present in more permeable, water bearing horizons and separated by less permeable horizons acting as aquicludes. Since water bearing units may not extend across the whole site, boreholes, although within the Alluvium may monitor slightly different units; for this reason water levels are likely to vary in an unpredictable manner.
- 9.43 Groundwater levels within these four boreholes are generally lower than levels recorded within the alluvium at shallow depths suggesting that there are two separate groundwater systems (potentially a shallow perched system).
- 9.44 The groundwater within the Mercia Mudstone is monitored near the centre of the site in the vicinity of the proposed Energy from Waste (EfW) bunker. During the site investigation it was noted that although groundwater strike within the Mercia Mudstone was below the depth of the proposed bunker (approximately 12mbgl), the groundwater level rose to circa 3.0mbgl. It was considered necessary to monitor the groundwater at this location to assess any potential issues in the development of the bunker.
- 9.45 Groundwater levels have remained fairly consistent and are generally between 3.40 and 3.6maOD (3.10 and 3.30mbgl). Groundwater levels within the weathered Mercia Mudstone (BHC03) show significant fluctuation, ranging between 2.62maOD and 4.72maOD

Table 9-4 Summary of Groundwater Levels

Geological Unit	Borehole ID	Groundwater Level (maOD)				Range (m)
		Count	Min	Average	Max	
Alluvium - Shallow	BH1	6	5.13	5.43	5.82	0.69
	BH2	6	4.15	4.45	4.97	0.82
	BH3	4	3.31	4.04	5.00	1.69
	BH4	0	-	-	-	-
	BH5	3	5.87	6.17	6.71	0.84
	BH6	5	5.69	5.75	5.84	0.14
	BH7	1	5.94	5.94	5.94	0
	BH10	6	6.25	6.29	6.32	0.07
	BH12	6	5.64	6.05	6.35	0.71
	BH13	6	5.06	5.44	5.82	0.77
Alluvium - Deep	BHC01	6	4.28	4.64	5.68	1.40
	BHC02	6	4.65	4.78	4.96	0.31
	BHC04	6	5.05	5.11	5.18	0.13
	BHR04	4	3.69	3.74	3.83	0.14
Mercia Mudstone	BHC03	4	2.62	3.69	4.72	2.10
	BHR01	4	3.51	3.57	3.67	0.16

Note: Boreholes flushed to ground level
 No access to BH3 on 2 occasions due to excess standing water
 No access to BH4 on all 6 occasions due to inaccessibility
 No access to BH5 on 3 occasions due to excess standing water
 No access to BH6 on 1 occasion due to excess standing water

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Free product evident at BH7, therefore true groundwater level could not be taken
Anomalous values recorded in BHC03 and removed from the data set

- 9.46 The site is located in proximity to the Severn Estuary. Monitoring data collected from data loggers placed in three boreholes on site over a period of a week (2nd July 2009 to 8th July 2009) show that groundwater levels between the three boreholes, in particular BHR01 (Mercia Mudstone) and BHR04 (base of Alluvium) showed a similar response to recharge, however response to recharge is small, with a maximum fluctuation of 0.07m within a 24hour period.
- 9.47 Groundwater Hydrographs are presented in Appendix 9-2.
- 9.48 Data suggests that shallow groundwater is in direct connectivity with the nearby surface water (Rhines) which abut the site boundary as indicated in Drawing 9-3.

Source Protection Zones and Groundwater Abstractions

- 9.49 The Site does not lie within or near a Groundwater Source Protection Zone². There are no private groundwater abstractions within 2km of the site as confirmed by Bristol City Council¹¹.
- 9.50 There are no licensed groundwater abstractions reported within 1km of the site, however there are 4 recorded within 5km. Details are presented in Table 9-5 below. Their locations are presented on Drawing 9-2.

**Table 9-5
Summary of Licensed Abstractions within 5km of the Site**

Ref	Licence Number	Licence Holder	NGR	Abstraction Period	Distance from Site (m)	Purpose	Source	Annual Quantity (m3)
L1	18/54/020/G/129	Rhodia UK Ltd	ST 53157760	All Year	4037	Industrial	Ground water	1,513,302
L2	18/54/020/G/132	Rhodia UK Ltd	ST 53158015	All Year	1695	Industrial	Ground water	398,236
L3	18/54/020/G/050	Bristol City Council	ST 55537852	01/04 to 31/10	3900	Agriculture	Ground water	836,482
L4	17/53/001/S/449	Henbury Golf Club	ST 564776	01/10 to 31/03	4925	Industrial	Surface Water	1,000

¹¹ Contact with Bristol City Council on 14th August 2009
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Groundwater Quality

- 9.51 Groundwater Quality monitoring has been undertaken from boreholes drilled in June 2009 on three occasions (3rd July 2009, 24th July 2009 and 5th August 2009) to determine baseline groundwater quality at the site.
- 9.52 Three boreholes monitoring groundwater at the base of the Alluvium; BHC01, BHC03 and BHC04 and a number of shallow boreholes: BH01, BH02, BH03, BH05, BH06, BH07, BH12, BH13, HP7a and HP7b were monitored.
- 9.53 A summary of the results along with selected time series plots is presented in Appendix 9-3. Full review of groundwater quality is reported in the Hydrogeological Factual Report¹². Monitoring locations are presented on Drawing 9-3.
- 9.54 A review of the data from the *Shallow boreholes* (BH01, BH02, BH03, BH05, BH06, and BH13) shows:
- groundwater quality within the shallow boreholes was of reasonably good quality with the majority of List II determinands recorded at concentrations below their relevant UK Drinking Water Standard (DWS);
 - elevated concentrations of ammoniacal nitrogen and a number of metals, above the relevant DWS were observed;
 - chloride concentrations were consistently below the DWS of 250mg/l in all borehole;
 - the majority of List I substances were recorded at concentrations below the laboratory reporting limit, with the exception of BH07, reviewed below under 'contaminated boreholes'; and
 - PAHs were recorded in BH01, BH02, BH06, BH12 and BH13.
- 9.55 Review of the monitoring data shows that groundwater within the shallow boreholes is commonly contaminated with PAH determinands, ammoniacal nitrogen and selected heavy metals.
- 9.56 A review of the data from the *Deep boreholes* (BHC01, BHC02, BHC03 and BHC04) shows:
- groundwater quality within BHC01, BHC03 and BHC04 was of reasonably good quality with the majority of concentrations recorded below their relevant UK Drinking Water Standard (DWS);
 - elevated concentrations of ammoniacal nitrogen were recorded in all boreholes on all three monitoring occasions with a maximum of 7.4mg/l recorded in BHC01;
 - elevated concentrations of manganese and sodium were consistently recorded, along with some metals;

¹² SLR Consulting. Severn Road Resource Recovery Centre – Avonmouth, Hydrogeological Factual and Interpretative Report, SLR Ref.: 402.0036.00451/04 September 2009
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- significantly elevated concentration of chloride were observed in BHC01; with a maximum concentrations of 900mg/l, concentrations in other boreholes were below the DWS of 250mg/l;
 - the majority of List I determinands were recorded below laboratory reporting limit;
 - List I Substance cadmium was detected within BHC03 on all three occasions with a maximum of 0.00044mg/l, which is below the DWS of 0.005mg/l;
 - PAHs were detected within BHC01 and BHC03;
- 9.57 Review of the monitoring data shows that significantly elevated concentration of ammoniacal nitrogen and chloride are recorded in BHC01. Review of land uses in the area show that a landfill lies to the north of the site adjacent to BHC01 which may attribute to the elevated concentrations.
- 9.58 A review of the data from the *Contaminated boreholes* (BH7, BH12, HP7a and HP7b) shows:
- free phase hydrocarbon was encountered in BH07 during drilling and presented elevated concentration of:
 - 15 of the 16 Poly Aromatic Hydrocarbons (PAHs) with a maximum concentration of 2.8mg/l (naphthalene);
 - 5 semi-volatile substances with a maximum concentration of 0.57mg/l (Carbazole);
 - BTEX determinands (benzene toluene, ethylbenzene and xylene), with a maximum concentration of 0.059mg/l (toluene);
 - 1,2,4-Trimethylbenzene and 1,3,5-Trimethylbenzene with concentrations of 0.010mg/l and 0.006mg/l respectively;

Hydrology

- 9.59 In considering the hydrological baseline regime this section is structured as follows: local hydrology, discharge consents, abstraction licences, surface water quality and finally flood risk.

Local Hydrology

- 9.60 The site is located approximately 850m to the east of the Severn Estuary flood defence embankment.
- 9.61 The low lying land east of the Severn Estuary, within the vicinity of the site is drained by a system of land drains and rhines which ultimately outfall to the Severn Estuary.
- 9.62 An unnamed drain runs around the eastern boundary of the site adjacent to Albeton Lane and the southern boundary adjacent to Severn Road, continuing west before draining south-westerly, eventually outfalling to Stupill Rhine, 290m south-west of the site. The Stupill Rhine outfall to the Severn Estuary is tidally influenced, with backflows restricted by a flap valve arrangement.

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- 9.63 Further unnamed drains outfall via the northern site boundary to nearby Monks Well Rhine, then northwards to its confluence with Red Rhine. The Red Rhine outfall to the Severn Estuary to the north of Seabank Power Station at New Pill Gout, is tidally influenced, with backflows restricted by a flap valve arrangement.
- 9.64 A large lagoon, 4 concrete lined settlement tanks, an overflow tank and a single tank for storage of water prior to offsite discharge are located in the eastern portion of the site. Two surface water tanks are also located in the north western area of the site adjacent to the former Medium Thermal Plant. Treatment of surface water is understood to comprise the settlement of fines (primarily carbon black) prior to re-use within the production plant or offsite discharge.
- 9.65 The existing site is drained by a private surface water sewer network and runoff tends to shed off to the local Rhine networks to both the north, south, and east of the site via the pipework during nominal storm events, and by overland flood flow routes under more extreme conditions.

Abstraction Licences

- 9.66 Details of licensed abstractions have been set out in Section 9.53 and details presented in Table 9-5.

Discharge Consents

- 9.67 The EA have confirmed there are 4 licensed discharge consents within a 2.5km radius of the site, with 3 being within 1km. Details are presented in Table 9-6 and their locations presented on Drawing 9-2.

**Table 9-6
Summary of Licensed Discharge Consents within 2.5km of the Site**

Ref	Consent No.	Licence Holder	NGR	Distance From site	Discharge Type	Receiving Water
D1a	102226	D Hales Limited	353950, 181760	2m	Trade Effluent Discharge and Site Drainage	Tributary of the Stuppill Rhine
D1b	102226	D Hales Limited	353980, 181690	7m	Sewage Discharge – Final/treated effluent (not water company)	Tributary of the Stup Pill Rhine
D2a	102159	Hire Hill Plc	353570, 181790	45m	Trade Discharge, Site Drainage (contaminated Surface Water) and sewage discharge	Stup Pill Rhine
D2b	102159	Hire Hill Plc	353580, 181810	50m	Trade Effluent	Stup Pill Rhine
D2c	102159	Hire Hill Plc	353550, 181790	60m	Sewage Discharge – Final/treated effluent (not water company)	Stup Pill Rhine
D2d	102159	Hire Hill Plc	353530, 181840	110m	Trade Discharge, Site Drainage (contaminated)	Stup Pill Rhine

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					Surface Water) and sewage discharge	
D3	070295	Halstock Village Hall	353650, 182100	200m	Sewage Discharge – Final/treated effluent (not water company)	Soakaway
D4	103664	Bristol & Avon Waste Management	353381, 181594	250m	Trade Effluent Discharge, Site Drainage	Stup Pill Rhine

Surface Water Quality

- 9.68 The existing treatment of surface water onsite is understood to comprise settlement tanks and surface water lagoons.
- 9.69 No surface water quality data is available for any of the drainage ditches on or adjacent to the site itself.
- 9.70 The EA have provided inland surface water data for the Water Framework Directive (WFD) monitoring sites within a 5km radius of the site which are currently undergoing WFD classification. The draft classifications of the three WFD water bodies located within the search area are provided within Table 9-7 however these classifications are currently based on a limited data set and are subject to change.

**Table 9-7
Summary of Water Framework Directive Monitoring Sites within 5km
Radius of the Site**

Water Body	Reference	Overall Ecological Classification (Draft)	Elements used for Classification
Redwick Common Rhine – source to confluence with The Pill	GB109054026640	Poor	Diatoms
River Trym – source to confluence with River Avon (Bristol)	GB109053027530	Moderate	Invertebrates & Physio-chemistry
The Pill – source to confluence with Redwick Common Rhine	GB10905426650	Not yet assessed	N/A

- 9.71 The EA carry out Dangerous Substance monitoring in the Severn Estuary to assess the impact of various industrial discharges. The EA have provided surface water quality data for six sample locations, four of which were within 3km of site. The closest sample point is at Stup Pill located 900m west of the site. The Stup Pill sample data is summarised within Table 9-8 below. Sample data from the other 3 sample points within 3km of the site is summarised within Appendix 9

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Table 9-8
Summary of Surface Water Quality Data from Sampling Point B0010301 - NGR
ST5272382171 (between 01-JAN-2001 and 01-MAY-2009)

Determinand	Count	Min	Mean	Max	Environment al Quality Standard EQS (saltwater)	UK Drinking Water Standard (DWS)
Lead Filtered µg/l	230	0.04	1.98	14.6	25	25
Mercury Filtered µg/l	9	0.01	0.01	0.01	0.3	1
Cadmium Filtered µg/l	10	0.25	0.25	0.25	2.5	5
Cyanide Filtered µg/l	60	5	5.04	7	-	50
Zinc Filtered µg/l	230	3.09	8.03	30	-	5000
Chromium Filtered µg/l	230	0.5	0.52	1.5	15	50
Nickel Filtered µg/l	170	3	3.01	5.1	30	20

Flooding

- 9.72 A detailed Flood Risk Assessment and Surface Water Management Plan have been prepared for the site and are presented in Appendix 9-4. The flood risk assessment has been completed in accordance with guidance presented in PPS25 – Development and Flood Risk (2006) and supplementary PPS25 Practice Guide (2008).
- 9.73 The principal sources of flooding identified within the flood risk assessment were:
- tidal flooding as a result of overtopping of the flood defences;
 - tidal flooding as a result of breach of the flood defences; and
 - fluvial flooding, as a result of overtopping of the adjacent surface water drainage channels, which could be exacerbated by tide locking of drainage outfalls.
- 9.74 Based upon the EA's Flood Zone Maps the entire site is located within Flood Zone 3 which represents an annual probability of greater than 0.5% (1:200yr) of a tidal flood occurring in any one year and an annual probability of greater than 1% (1:100 yr) of a fluvial flood occurring in any one year.
- 9.75 The site benefits from the presence of the formal flood defences which are located adjacent to the Severn Estuary. The EA have confirmed that the defences adjacent to the Severn Estuary within the vicinity of the site comprise raised earth embankments with crest heights ranging between 9.1 and 10.8mAOD which provide between a 100 year and 200 year standard of protection to land adjacent to the defences.
- 9.76 The Lower Severn Internal Drainage Board (LSIDB) and EA do not consider¹³ any area behind the flood defences on the River Severn to be

¹³ Discussions with James Thomas from the LSIDB on 14/04/2009
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designated as functional floodplain. The site is therefore located within Flood Zone 3a.

PROPOSED DEVELOPMENT

9.77 A detailed description of the proposed development and operations is provided in Chapter 3. For the purposes of this section, a review of the development proposals which may impact the baseline hydrology and hydrogeology of the site is provided below:

- demolition of the redundant plant, equipment and ancillary buildings at the site;
- construction and operation of an Energy from Waste (EfW) facility and associated infrastructure including ancillary buildings, offices and parking facilities etc). The plant would have an annual throughput of approximately 350,000 tonnes per annum.
- redistribution of surface deposits (alluvium) to allow construction of the EfW plant and landscaping of the surrounding area.
- infilling of the current surface water lagoons and removal of settlement tanks in the eastern portion of the site;
- creation of attenuation pond(s) and water features on site.
- construction and operation of a onsite incinerator bottom ash (IBA) treatment and recycling facility;
- improved access from Severn Road; and
- construction and operation of a Materials Recycling Facility (MRF) which will accept up to 150,000 tonnes per annum of commercial and industrial waste.

ASSESSMENT OF POTENTIAL IMPACTS

9.78 This section identifies the potential impacts of the proposed development on the geological, hydrogeological and hydrological environments. It also assesses the likelihood of occurrence of each identified impact. The results of this assessment are summarised in Table 9-9. It should be noted that the magnitude of the impact has been assessed as described in Table 9-2.

Geology

9.79 During the construction phase it is envisaged that the main impact on the geology will be removal and redistribution of in-situ geological deposits during excavation of the proposed storage bunker and creation of the various development plateaux. The stratum (Alluvium and limited amount of Mercia Mudstone) to be extracted does not, however, have any particular geological rarity value and does not display any significant features which cannot be observed elsewhere.

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- 9.80 Appropriate Geotechnical Stability Assessments¹⁴ have been undertaken to assess any issues associated with the removal of the Alluvium during construction and not considered further in this section.
- 9.81 It is concluded that the proposed development will not have a significant impact on the geology of the area.

Hydrogeology

- 9.82 The proposed developments have the potential to impact groundwater in terms of both groundwater levels and flows, and groundwater quality. These factors are considered separately below.

Groundwater Levels and Flows

- 9.83 The development of the site by the construction of impermeable buildings, weighbridges and covering parts of the site with hard standing has the potential to reduce the amount of recharge to groundwater potentially affecting groundwater levels.
- 9.84 The probability of this occurring, without mitigation, is considered to be low due to the site currently being developed at this time with a high proportion of hard standing present and the Alluvium being a Non-aquifer. The magnitude of impact is considered 'mild', as groundwater levels are high and show limited fluctuation due to reasonably low permeability and the heterogeneity nature of the Alluvium. The overall risk is therefore assessed as 'low' and does not require mitigation.
- 9.85 The construction of the refuse bunker below the water table will require temporary dewatering and may disrupt groundwater levels and resources within the local area. The probability of this occurring is 'medium', due to the heterogeneity of the Alluvium with groundwater existing in more permeable horizons only, with less permeable units acting as aquicludes. The magnitude of impact is considered 'mild' due to any impact being localised and the nearest groundwater abstraction being over 1.5km away. The overall risk would therefore be 'low' and no further mitigation is required. However it is noted that over-pumping to the Rhines (via settlement/attenuation ponds) will be required temporary during the construction phase due to dewatering and a consent to discharge would be required.
- 9.86 The refuse bunker being situated below the water table will potentially disrupt groundwater flow within the Alluvium on a long term basis (it is understood that the bunker will not extend into the Mercia Mudstone). The probability that the bunker will act as a barrier and groundwater flow within the alluvium will 'back up' behind the bunker, raising water levels and increasing the risk of flooding by groundwater up-gradient of the site without mitigation is 'low owing to the heterogenic nature and non-aquifer status of the Alluvium' with

¹⁴ SLR Consulting Limited. Severn Road Resource Recovery Centre, Avonmouth, Geotechnical Factual and Interpretative Report. SLR Ref.: 402.0036.00451/002, August 2009
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the magnitude of impact 'Severe'. It is therefore considered that the overall significance of an impact would be 'Medium' and mitigation measures are necessary to reduce impacts to an acceptable level.

Groundwater Quality

- 9.87 During the development and operation of the site, there is a risk of contaminated runoff being generated from the following potential sources and entering the groundwater system:
- accidental spillage of fuels and lubricants, required over the short term by construction plant and over the longer term, from operation of the facility and from the vehicles moving around the site;
 - increase in suspended solids during the construction phase resulting from the proposed earthworks;
 - contaminated run-off from the temporary storage of bottom ash and change in land (weighbridges and vehicle movement areas); and
 - washout of pollutants by water used to put out a fire onsite.
- 9.88 It is considered that, without mitigation, the probability of occurrence of spillage of fuels, lubricants and other potentially contaminative liquids during construction phase would be 'medium' owing to the area of the site and number of vehicles that would be using the site. The magnitude of impact would be 'moderate' given the likely small volumes of contaminative liquids and the absence of sensitive water in the immediate vicinity of the site (Estuarine Alluvium classed as non-aquifer). However, the relevant Pollution Prevention Guidelines listed in Section 9.7 will be adhered to, to ensure construction works are undertaken in an environmentally responsible manner. It is concluded that site management in accordance with the relevant Pollution Prevention Guidelines will reduce the risk of groundwater quality impacts from 'Medium' to 'Low'. Further mitigation measures are therefore not required.
- 9.89 It is considered that, without mitigation, the probability of occurrence of contaminated runoff from spillage of fuel, lubricants and other potentially contaminative liquids entering groundwater in the long term (during the operation of the site) would be 'low' owing to the fact that the proposed site design is predominately hard standing and the relatively low number of vehicles that would be using the site. It is assumed that the above will be effectively managed by site best practice techniques in accordance with the relevant Pollution Prevention Guidelines. Any environmentally hazardous material used during the operational phase of the site will be kept in dedicated stores and fuel storage tanks will have appropriate secondary bunding. The magnitude of impact would be 'mild' given the likely small volumes of contaminative liquids. Therefore the overall risk during operation of the site is assessed to be 'low'. Mitigation measures are therefore not required.
- 9.90 During the demolition of the former carbon black production plants, redundant power plants, product warehouse and pipe network there is a potential for runoff contaminated with carbon black and/or solidified feedstock

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oil to contaminate the underlying aquifer. The probability of this occurring is considered to be 'medium' due to high groundwater level but the non-aquifer status of the Alluvium and the magnitude of the impact 'moderate'. Therefore the overall risk is assessed to be 'high' and hence mitigation is required.

- 9.91 During the operation of the incinerator bottom ash treatment and recycling facility, bottom ash storage areas and MRF, there is the potential for the leaching of contaminated water high in metals to cause contamination of the underlying aquifer. The probability of this occurring is considered to be 'low' due to the majority of the proposed site being hard standing and the magnitude of the impact 'moderate' given the likely nature of the bottom ash. This gives an overall 'low' risk of impact and hence no mitigation is required.
- 9.92 Without mitigation, it is considered that the storage of waste prior to processing could result in an impact on groundwater quality if leachate is allowed to form and escape to ground. The probability of this occurring is considered to be 'medium', as it is proposed that the majority of the site will be hard standing and the magnitude of the impact 'moderate' given the nature of the wastes. Therefore the overall risk during operation of the site is assessed to be 'medium'. Mitigation measures are therefore required.
- 9.93 In the event of a fire, it is considered that, without mitigation, firewater could potentially washout pollutants from the site leading to contamination of the underlying aquifer. The probability of occurrence of washout of pollutants is considered to be 'low' to 'medium' given the unlikely but potential risk of a fire occurring due to the presence of an incinerator. The magnitude of impact would be 'mild' given the aquifer characteristics and the proposed site design (predominately hard standing areas), and the presence of carefully designed 'firewater' ponds that not only supply water for fire suppression, but would have the facility for shutting off their outfall arrangements to provide some available capacity for temporary storage of potentially polluted runoff, thereby acting as a buffer to protect the wider off-site watercourse network and underlying groundwater. Therefore, the overall risk is 'low'. No further mitigation is required but inherent mitigation will be provided to further reduce the significance of impact.

Hydrology

- 9.94 Potential impacts on the surface water environment can be considered as two distinct groups; impacts on the hydraulic regime in the area and the impact on surface water quality. Accordingly, this assessment considers the two areas in turn.

Surface Water Regime

- 9.95 The development of the application site has the potential to alter the hydrological regime of the area. In the long term (after construction) the site will predominately be covered with hardstanding, consisting of low permeability material which has the potential to increase the surface runoff generated from the post-development site. The increased runoff could cause

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flooding to neighbouring properties or increased run-off to the Rhines adjacent to the site if not adequately controlled.

- 9.96 In the absence of mitigation the likelihood of occurrence is considered 'high', and the magnitude of the effect considered 'mild' to 'moderate' due to the limited uplift in impermeable area coverage when comparing the proposed development site with the baseline heavy industrial site. Impacts are also limited due to the lack of nearby vulnerable development, and the close proximity of the surface water features to their tidal outfall. Therefore the overall risk would be 'medium' to 'high' and would require mitigation to reduce impacts to an acceptable level.

Flood Risk

- 9.97 The proposals include the provision of Waste Treatment Facilities (non-hazardous), General Industry, Offices and Welfare facilities.
- 9.98 Table D.2 of Planning Policy Statement 25: Development and Flood Risk (PPS25) sets out that all of the above uses are designated as 'Less Vulnerable' uses and are appropriate in Flood Zones 1, 2 and 3a. The site is located within Flood Zone 3a, therefore the proposed development is deemed to be appropriate in terms of flood risk providing adequate mitigation is provided, subject to ratification by the Local Planning Authority.
- 9.99 There is a potential impact associated with increasing the population of site users within a higher flood risk area. The probability of occurrence is considered to be 'high'. The magnitude of impact is deemed to be 'mild' given the similar nature and vulnerability of the former land use, the limited number of site occupants at any one time, and the lack of any habitable accommodation on-site. This gives an overall 'Medium' risk of impact. Therefore mitigation is required to reduce the impact to an acceptable level.
- 9.100 There is a potential impact associated with the rapid inundation of floodwater into the development site from tidal sources following a breach of the tidal defences coincident with a significant tidal event. The probability of rapid inundation is considered to be negligible given the unlikely probability of a breach of the defence coinciding with a significant tidal event. The magnitude of impact is deemed to be 'severe' giving an overall 'Low' risk of impact. Although no mitigation is required, inherent mitigation will be provided to further reduce the risk of impact, in the form of hydrostatic resistance built into the fabric of the building structure.
- 9.101 There is a potential impact associated with the rapid inundation of floodwater into the development site from fluvial sources during a significant fluvial event. The probability of rapid inundation is considered to be low given the low probability of a significant fluvial event occurring. The magnitude of impact is deemed to be 'moderate' giving an overall 'Low' risk of impact. Although no mitigation is required, inherent mitigation will be provided to further reduce the risk of impact.
- 9.102 The proposals could potentially displace 'tidal' flood storage during a tidal flooding event. The probability of tidal flood storage being displaced is

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considered to be 'medium' as the site is defended to a high standard, therefore, only volumes of tidal floodwater generated by overtopping would be displaced over the lifetime of the development. The magnitude of the impact is deemed to be 'negligible' to 'mild' given the vast area of low lying land adjacent to the River Severn providing a large storage volume so that any loss in 'tidal' flood storage as a result of the proposals will pose a negligible risk to offsite areas. This gives an overall 'Near Zero' to 'Low' risk of impact and hence no mitigation is required.

- 9.103 Nominal volumes of fluvial flood storage could potentially be displaced as a result of the proposals. Impacts will be assessed as part of a fluvial flood modelling analyses to be undertaken by the Lower Severn Internal Drainage Board, and mitigation measures provided as part of a holistic surface water and fluvial flood risk management strategy to be formulated in partnership with the LSIDB. Without mitigation, the probability of this occurring is considered to be Medium and the magnitude is deemed to be 'mild' to 'moderate'. This gives an overall 'Low' to 'Medium' risk of impact. Mitigation is therefore required to reduce the impact to an acceptable level.

Surface Water Quality

- 9.104 During the demolition of the former carbon black production plants, redundant power plants, product warehouse and pipe network there is a potential for runoff contaminated with carbon black and/or solidified feedstock oil to contaminate surrounding surface water features. The probability of this occurring is considered to be 'high' and the magnitude of the impact 'moderate'. This gives an overall 'High' risk of impact and hence mitigation is required.
- 9.105 During the development and operation of the site, there is a risk of contaminated runoff being generated from the following potential sources and entering the local water courses:
- accidental spillage of fuels and lubricants, required over the short term by construction plant and over the longer term, from operation of the facility and from the vehicles moving around the site;
 - increase in suspended solids during the construction phase resulting from the proposed earthworks;
 - contaminated run-off from the temporary storage of bottom ash and change in land (weighbridges and vehicle movement areas); and
 - washout of pollutants by water used to put out a fire onsite.
- 9.106 It is considered that, without mitigation, the probability of occurrence of spillage of fuels, lubricants and other potentially contaminative liquids during the construction phase would be 'medium' owing to the area of the site and number of vehicles that would be using the site. It is assumed that the above will be effectively managed by site best practice techniques in accordance with the relevant Pollution Prevention Guidelines. These will be adhered to, to ensure construction works are undertaken in an environmentally responsible manner. The magnitude of impact would therefore be 'mild'. As

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a result the overall risk during construction without mitigation is assessed to be 'low'. No mitigation measures are therefore required.

- 9.107 It is considered that, without mitigation, the probability of occurrence of spillage of fuels, lubricants and other potentially contaminative liquids during the operation of the facility would be 'medium' owing to the area of the site and number of vehicles that would be using the site. It is assumed that the above will be effectively managed by site best practice techniques in accordance with the relevant Pollution Prevention Guidelines. Any environmentally hazardous material used during the operational phase of the site will be kept in dedicated stores and fuel storage tanks will have appropriate secondary bunding. The magnitude of impact would therefore be 'mild'. As a result the overall risk during construction without mitigation is assessed to be 'low'. No mitigation measures are therefore required.
- 9.108 It is considered that, without mitigation in the form of appropriately considered management, the probability of occurrence of sediment erosion causing high sediment loading to surface water courses (Rhines) in the vicinity of the site during all earthworks at the site is considered to be 'high'. The magnitude of impact is deemed to be 'mild' to 'moderate'. Therefore the overall risk is assessed to be 'medium' to 'high'. Mitigation measures are therefore required, which will be assessed and implemented in conjunction with the LSIDB.
- 9.109 During the operation of the incinerator bottom ash treatment and recycling facility, bottom ash storage areas and MRF, there is the potential for the leaching of contaminated water high in metals to cause contamination of the surrounding surface water features. The probability of this occurring is considered to be 'medium' and the magnitude of the impact 'moderate' given the likely nature of the bottom ash. This gives an overall 'Medium' risk of impact and hence mitigation is required.
- 9.110 Without mitigation, it is considered that the storage of waste prior to processing could result in an impact on surface water quality if leachate is allowed to form and escape. The probability of this occurring is considered to be 'medium', as it is proposed that the majority of the site will be hard standing and the magnitude of the impact 'moderate' given the nature of the wastes. Therefore the overall risk during operation of the site is assessed to be 'Medium'.
- 9.111 In the event of a fire, it is considered that, without mitigation, firewater could potentially washout pollutants from the site leading to contamination of the local watercourse network. The probability of occurrence of washout of pollutants is considered to be 'low' to 'medium' given the unlikely but potential risk of a fire occurring due to the presence of an incinerator. The magnitude of impact would be 'mild' given the watercourse characteristics and the presence of carefully designed 'firewater' ponds that not only supply water for fire suppression, but would have the facility for shutting off their outfall arrangements to provide some available capacity for temporary storage of potentially polluted runoff, thereby acting as a buffer to protect the wider off-site watercourse network and underlying groundwater. Therefore, the overall

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risk is 'low'. No further mitigation is required but inherent mitigation will be provided to further reduce the significance of impact.

- 9.112 Due to the implementation of an improved drainage system and pollution control measures on-site compared to that of the baseline situation (heavy industrial site with ageing drainage system), it is considered that, without further mitigation, there will be an improvement to the existing 'baseline' regime in terms of a reduction in the risk of pollutant / contaminant washout from roofs, highways and other external hardstanding areas being released to local watercourses. The probability of pollutants being released post-development is considered to be 'low' and the magnitude is deemed to be 'mild' giving an overall risk of 'Low'. Therefore no further mitigation is required.

**Table 9-9
Summary of Unmitigated Potential Impacts**

Potential Impact	Spatial and Temporary impact	Probability of Occurrence	Magnitude of Impact	Significance of Impact	Mitigation Required
Hydrogeology					
Groundwater Level and Flow					
Reduction in water levels due to loss of recharge	Local, Long Term	Low	Mild	Low	No
Disruption of Groundwater levels and flow through dewatering during construction of the bunker	Local, Short Term	Medium	Mild	Low	No
Disruption of Groundwater levels and flow by bunker causing a barrier to groundwater flow	Local, Long Term	Low	Severe	Medium	Yes
Groundwater Quality					
Leakage of fuels etc to groundwater during construction	Local, Short Term	Medium	Moderate	Medium	Yes
Leakage of fuels etc to groundwater during site operation	Local, Long Term	Low	Mild	Low	No
Storage of waste prior to processing – generation of leachate	Local, Long Term	Medium	Moderate	Medium	Yes
Leachate contamination due to 'bottom ash' during site operation	Local, Long Term	Low	Moderate	Low	No
Contamination from demolition of the former carbon black production plants	Local, Long Term	Medium	Moderate	Medium	Yes

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Fire Water polluting underlying aquifer	Local, Short and Long Term	Low to Medium	Mild	Low	No (But inherent mitigation will be provided)
Hydrology					
Surface Water Regime					
Increase in Surface Water Runoff due to development	Local, Long Term	High	Moderate	High	Yes
Flood Risk					
Increase in population within a flood risk zone	Local, Long Term	High	Mild	Medium	Yes
Risk of rapid inundation of floodwater from tidal sources	Local, Short Term	Negligible	Severe	Low	No (But inherent mitigation will be provided)
Risk of rapid inundation of floodwater from fluvial sources	Local, Short Term	Low	Moderate	Low	No (But inherent mitigation will be provided)
Displacement of tidal flood storage	Local, Long Term	Medium	Negligible to Mild	Near Zero to Low	No
Displacement of fluvial flood storage	Local, Long Term	Medium	Mild to Moderate	Low to Medium	Yes
Surface Water Quality					
Contamination from demolition of the former carbon black production plants	Local, Long Term	High	Moderate	High	Yes
Leakage of fuels etc to Local Water Courses	Local, Short and Long Term	Medium	Mild	Low	No
High Sediment Loading to local water courses	Local, Short Term	High	Mild to Moderate	Medium to High	Yes
Leachate contamination due to 'bottom ash' during site operation	Local, Short and Long Term	Medium	Moderate	Medium	Yes
Storage of waste prior to processing – generation of leachate	Local, Short and Long Term	Medium	Moderate	Medium	Yes
Fire Water polluting local water courses	Local, Short and Long Term	Low to Medium	Mild	Low	No (But inherent mitigation will be provided)
Release of pollutants from roof, highways and other external	Local, Short and Long	Low	Mild	Low	No (But inherent mitigation

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areas to local watercourses					will be provided)
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PROPOSED MITIGATION

9.113 The assessment has identified that mitigation is required to address the following potential impacts:

- Groundwater Levels
- Groundwater and Surface Water Quality.
- Flood Risk.

9.114 Details of the proposed mitigation are given below.

Hydrogeology

Groundwater Levels and Flows

9.115 Although no mitigation is required for the dewatering during construction with regards to groundwater levels and flow, the following should be noted. Dewatering for engineering purposes triggers a requirement of the water abstraction licensing regime, whereby an abstraction licence will be required for dewatering. The potential impacts and mitigation of dewatering will be addressed further when a licence application is made.

9.116 In order to minimise the impact on groundwater flow by the underground bunker, groundwater drainage will be developed. It is proposed that groundwater intercepted by the drains around the facility will be over-pumped to the surface water attenuation lagoons (via settlement tanks if appropriate) and discharged to the Rhines thus mitigating any impact on flows in the local drainage network. Groundwater is in continuity with the Rhines so, in any case, the overall impact upon the off-site watercourse network is negligible.

Groundwater Water Quality

9.117 In order to minimise the potential for accidental spills of potentially contaminating material during the construction phase of the project, the relevant Pollution Prevention Guidelines listed in Section 9.7 will be adhered to, to ensure construction works are undertaken in an environmentally responsible manner. Any environmentally hazardous material used during the operational phase of the site will be kept in dedicated stores and storage tanks will have appropriate secondary bunding. It is concluded that site management in accordance with the relevant Pollution Prevention Guidelines reduce the risk of surface water and groundwater quality impacts from the development being reduced from 'Medium' to 'Low'.

9.118 The demolition of the redundant plant and equipment at the site will include the need to safely remove and dispose of potential pollutants such as solidified feedstock oil and carbon black. It is concluded that the safe removal of potential pollutants will reduce the risk of groundwater quality

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impacts arising from contaminated runoff generation during demolition from 'High' to 'Low'.

- 9.119 The potential for leachate generation and discharge to groundwater from the waste reception and bottom ash recycling facility will be minimised by the design of the facility. The waste would be delivered to a dedicated handling area using bulk transfer and street refuse collection vehicles (RCV's). All vehicles delivering residual waste will be weighed when entering the site and proceed to a vehicle delivery and tipping hall where they would back up and discharge the waste directly into a pit or storage hopper. This will minimise the potential for the generation and discharge of leachate. It is concluded that the site design inherently reduces the risk of groundwater quality impacts arising from leachate generation at the development being reduced from 'Medium' to 'Low'.

Hydrology

Flood Risk

- 9.120 A number of measures have been taken into account during evolution of the development proposals in order to manage flood risks at the site, these are set out below.
- 9.121 There will be no habitable sleeping accommodation on-site and the proposals shall not include any basement areas used by site personnel.
- 9.122 Elevation of the development platform and finished floor levels shall provide an enhanced degree of flood protection from both fluvial and tidal sources, and will seek to ensure that critical site infrastructure will remain operational during flood conditions.
- 9.123 In order to ensure that the site users and workers will have sufficient warning and advance notice prior to any flood event inundating the site, it is proposed that Viridor sign up to the Environment Agency Flood Warnings Direct Service and that an Evacuation Plan is formulated and implemented prior to site occupation. Further details are provided within the FRA in Appendix 9-4
- 9.124 In the unlikely event that advance flood warnings are not heeded, or a breach (failure) of the tidal defences were to occur, safe refuge will be afforded to site users within both the MRF and EfW facilities, with internal access being provided to welfare facilities and offices situated on upper floors.
- 9.125 Elevation of the development platform will minimise potential impacts associated with rapid inundation of floodwater into the development site from tidal sources following a breach of the tidal defences coincident with a significant tidal event. Inherent mitigation will be built into the fabric of the main building structure, in the form of hydrostatic resistant design techniques, to further reduce the impact.
- 9.126 It is concluded that the above mitigation measures will reduce the impact on flood risk arising from an increase in population within a flood risk zone from

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'Medium' to 'Low'. It is concluded that the above mitigation measures will reduce the flood risk impact associated with the risk of rapid inundation of floodwater from tidal or fluvial sources from 'Low' to 'Near Zero'.

- 9.127 The site falls within Lower Severn Internal Drainage Board (LSIDB) jurisdiction in terms of the planning consultation process on flood risk and surface water management. Impacts of any displaced fluvial flood storage, and of any excess surface water runoff generated as a result of the proposals, will be assessed as part of a fluvial flood modelling analyses to be undertaken by the LSIDB, and mitigation measures provided as part of a holistic surface water and fluvial flood risk management strategy to be formulated in partnership with the LSIDB.
- 9.128 Any 'fluvial' flood storage displaced as a result of the proposals will be adequately compensated for on a like-for-like (volumetric) or level-for-level basis for up to and including the 1 in 100 year fluvial flood event incorporating an appropriate allowance for climate change, as part of a holistic strategy to be formulated in partnership with the LSIDB. It is concluded that the impact on flood risk arising from the displacement of fluvial flood storage will therefore be reduced from 'Low to Medium' to 'Near Zero'.

Surface Water Regime - Drainage

- 9.129 In order to manage the predicted increase in surface water runoff being generated as a result of the proposed development, two potential mitigation approaches have been put forward. A combination of the following approaches will be implemented as part of this scheme, namely:
- On-site attenuation provision
 - Off-line wet storage and overflow storage
- 9.130 The site falls within Lower Severn Internal Drainage Board (LSIDB) jurisdiction in terms of the planning consultation process on flood risk and surface water management. Surface water runoff will be managed on-site to provide a permanent supply of fire suppressant water and, where practical, to limit off-site runoff rates to those generated by the 'pre-developed' site, or less, for up to and including the critical 1% annual probability storm event taking into account the impacts of climate change in accordance with paragraph F10 of PPS25.
- 9.131 Impacts of any displaced fluvial flood storage, and of any excess surface water runoff generated as a result of the proposals, will be assessed as part of a fluvial flood modelling analyses to be undertaken by the LSIDB, and mitigation measures provided as part of a holistic surface water and fluvial flood risk management strategy to be formulated in partnership with the LSIDB.
- 9.132 On-site surface water attenuation storage has been maximised within the constraints and limitations imposed by the development proposals. Attenuation storage may take the form of:

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- Surface water attenuation ponds;
 - 'Fire' ponds;
 - Creation of new Rhines within the site boundary, linked to the off-site Rhine network;
 - 'Floodable' on-site areas, created by careful profiling of on-site car parking, hardstanding and landscape areas to promote the above-ground detention of excess floodwater;
 - Underground storage tanks or over-sized pipes;
- 9.133 In combination with the proposed on-site surface water attenuation scheme, the LSIDB have advised that supplementary attenuation may be provided in the form of off-line 'wet' storage comprising Rhines / wet ponds. Surface water could be discharged freely from the site to a Rhine for events up to and including the 1:5 year storm. Surface water would overflow from the Rhine to the off-line storage area from the proposed connection point for events exceeding the 1:5 year storm. Where it is not possible to connect the site drainage to the nearest LSIDB managed Rhine, the LSIDB would permit the construction of new Rhines to allow a connection to be achieved.
- 9.134 The proposed combination of the two surface water drainage options above will reduce the overall risk to the hydrological regime from 'High' to 'Near Zero'. Further details of surface water drainage mitigation are provided within the FRA in Appendix 9-4.

Surface Water Quality

- 9.135 An improved drainage system will be implemented as part of the proposed development and the inclusion of SuDS mitigation in the form of proprietary petrol interceptors, silt traps, reed beds and detention ponds will ensure that the quality of the surface water drained from roofs, highways and other external hardstanding areas is controlled prior to offsite discharge. Therefore, there will be an improvement to the existing regime in terms of reducing the risk of pollutant / contaminant washout from the site. Further details of the proposed surface water management measures are presented in the FRA in Appendix 9-4.
- 9.136 The demolition of the redundant plant and equipment at the site will include the need to safely remove and dispose of potential pollutants such as solidified feedstock oil and carbon black. It is concluded that the safe removal of potential pollutants will reduce the risk of surface water quality impacts arising from contaminated runoff generation during demolition from 'High' to 'Low', and reduce risk to 'Low' over the lifetime of the development.
- 9.137 The potential for sediment erosion causing high sediment loading to surface watercourses (Rhines) in the vicinity of the site during all earthworks will be managed by the implementation of surface water management measures such as trapped gullies, silt traps, and temporary settlement tanks prior to the commencement of earthworks onsite. It is concluded that surface water management will reduce the risk of surface water quality impacts from 'Medium to High' to 'Low'.

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9.138 The potential for leachate generation and discharge to surface water from the waste reception and bottom ash recycling facility will be minimised by the design of the facility. The waste would be delivered to a dedicated handling area using bulk transfer and street refuse collection vehicles (RCV's). All vehicles delivering residual waste will be weighed when entering the site and proceed to a vehicle delivery and tipping hall where they would back up and discharge the waste directly into a pit or storage hopper. This will minimise the potential for the generation and discharge of leachate. It is concluded that the site design inherently reduces the risk of surface water quality impacts arising from leachate generation at the development being reduced from 'Medium' to 'Low'.

ASSESSMENT OF RESIDUAL IMPACTS

9.139 It is considered that the residual impacts associated with the development on the geological, hydrogeological and hydrological regime are low or near zero after the incorporation of mitigation measures detailed above. A summary of these residual impacts is provided in Table 9-10.

**Table 9-10
Summary of Residual Impacts**

Potential Impact	Spatial and Temporary impact	Probability of Occurrence	Magnitude of Impact	Significance of Impact	Mitigation Required	Residual Impacts
Hydrogeology						
Groundwater Level and Flow						
Reduction in water levels due to loss of recharge	Local, Long Term	Low	Mild	Low	No	Low
Disruption of Groundwater levels and flow through dewatering during construction of the bunker	Local, Short Term	Medium	Mild	Low	No	Low
Disruption of Groundwater levels and flow by bunker causing a barrier to groundwater flow	Local, Long Term	Low	Severe	Medium	Yes	Low
Groundwater Quality						
Leakage of fuels etc to groundwater during construction	Local, Short Term	Medium	Moderate	Medium	Yes	Low

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Leakage of fuels etc to groundwater during site operation	Local, Long Term	Low	Mild	Low	No	Low
Storage of waste prior to processing – generation of leachate	Local, Long Term	Medium	Moderate	Medium	Yes	Low
Leachate contamination due to 'bottom ash' during site operation	Local, Long Term	Low	Moderate	Low	No	Low
Contamination from demolition of the former carbon black production plants	Local, Long Term	Medium	Moderate	Medium	Yes	Low
Fire Water polluting underlying aquifer	Local, Short and Long Term	Low to Medium	Mild	Low	No	Low
Hydrology						
Surface Water Regime						
Increase in Surface Water Runoff due to development	Local, Long Term	High	Moderate	High	Yes	Near Zero
Flood Risk						
Increase in population within a flood risk zone	Local, Long Term	High	Mild	Medium	Yes	Low
Risk of rapid inundation of floodwater from tidal sources	Local, Short Term	Negligible	Severe	Low	No (But Inherent Mitigation will be provided)	Near Zero
Risk of rapid inundation of floodwater from fluvial sources	Local, Short Term	Low	Moderate	Low	No (But Inherent Mitigation will be provided)	Near Zero
Displacement of tidal flood storage	Local, Long Term	Medium	Negligible to Mild	Near Zero to Low	No	Low to Near Zero
Displacement of fluvial flood storage	Local, Long Term	Medium	Mild to Moderate	Low to Medium	Yes	Near Zero
Surface Water Quality						
Contamination	Local,	High	Moderate	High	Yes	Low

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from demolition of the former carbon black production plants	Long Term					
Leakage of fuels etc to Local Water Courses	Local, Short and Long Term	Medium	Mild	Low	No	Low
High Sediment Loading to local water courses	Local, Short Term	High	Mild to Moderate	Medium to High	Yes	Low
Leachate contamination due to 'bottom ash' during site operation	Local, Short and Long Term	Medium	Moderate	Medium	Yes	Low
Storage of waste prior to processing – generation of leachate	Local, Short and Long Term	Medium	Moderate	Medium	Yes	Low
Fire Water polluting local water courses	Local, Short and Long Term	Low to Medium	Mild	Low	No (But Inherent Mitigation will be provided)	Low µg/l to near Zero
Release of pollutants from roof, highways and other external areas to local watercourses	Local, Short and Long	Low	Mild	Low	No (But inherent mitigation will be provided)	Near Zero

SUMMARY AND CONCLUSIONS

- 9.140 The potential impacts of the proposed development upon the baseline hydrogeological and hydrological environments have been identified and assessed, and where appropriate, mitigation measures have been accommodated into the design of the development.
- 9.141 All aspects of the construction and operation of the site would be in µg/l accordance with best practice guidance.
- 9.142 A flood risk assessment has been undertaken for the development. The FRA concluded that the site is presented as being deliverable and sustainable in flood risk terms with proposed mitigation measures in place, and that key requirements set out within PPS25 may be adequately satisfied.

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- 9.143 Overall, it is concluded that, with respect to geology, groundwater and surface water, there would be no significant residual impacts of the development with the proposed mitigation measures in place.