6.2 Chapter 6.2 Water Resources –Hydrogeology and Groundwater

6.2.1 Introduction and Current Planning Situation

Across the footprint of the integrated waste management facility (IWMF) site, quarrying operations within Site A2 has resulted in the phased and systematic excavation of overburden and sand and gravel reserves to the underlying London Clay; and the subsequent restoration operations has resulted in the placement of overburden materials within the IWMF site. Quarrying operations have confirmed that perched groundwater is encountered within the hollows (or natural low points) that result from natural variations in the interface between the sand and gravel and London Clay.

The hydrogeological information presented within Chapter 6 of the Site A2 and Site A3 and A4 Environmental Impact Assessment(s) (EIA(s)) have been reviewed to supplement the original baseline and hydrogeological assessment of 2008.

The geological setting, site boundary and planning application area remain unchanged from that originally assessed and approved.

Within the Section 73 application and submission of details in July 2015, Honace provided its document "S2 – IWMF EIA update" now submitted with this Regulation 22 submission to the Planning Inspectorate within Appendix A2.

In addition to the Section 73 application, in 2015, an up to date assessment was undertaken of all groundwater baseline conditions and IWMF-related foreseeable developments within the detailed design of the IWMF under planning conditions 23 and 24, which are stated as follows:-

> ***Condition 24:*** *"No excavation shall commence until a scheme of ground water monitoring for the site has been submitted to and approved in writing by the Waste Planning Authority. The scheme shall identify the locations for the installation of boreholes to monitor groundwater and the frequency of monitoring. The scheme shall be implemented in accordance with the details approved prior to the commencement of excavations on the site."*

The detailed design submissions for Conditions 24 are contained herein immediately following this Chapter 6.2 within Appendix 6B (for Condition 24 Ground water). Within the submission for Condition 24, document C24.1 "Groundwater Monitoring Scheme" confirms the proposals to monitor the existing groundwater monitoring wells within Bradwell Quarry (Pz01, Pz02, Pz07, Pz09a, Pz11, Pz16a, Pz18, Pz19 and Pz21) and boreholes BH 10, BH 11 and BH 19 on a monthly basis during the construction of the IWMF.

6.2.2 Hydrogeological Setting and Groundwater Conditions

The hydrogeological setting surrounding the site remains unchanged. The principal aquifer in the region is the Upper Chalk which has been exploited for industrial, public and agricultural use. The chalk aquifer is confined beneath the London Clay and groundwater flow is essentially towards the south. Due to the presence of the thick London Clay (~70 m) the sand and gravel deposits are not in direct contact with the Chalk.

In terms of the local hydrogeology, the sand and gravel deposits beneath the Site contain minor amounts of water, with the pattern of groundwater flow in and around the Site being substantially influenced by the topography of the surface of the underlying London Clay. Hollows in the underlying London Clay surface typically contain amounts of groundwater. The cohesive and relative impermeable nature of the Boulder Clay overburden typically restricts the recharge to the sands and gravels.

Detailed testing and analysis carried out by Golder Associates (UK) Ltd for a Public Inquiry (held in 1995) into the then proposed quarry and landfill, determined the 'mean' permeability of the sand and gravel stratum as $2x10^{-4}$ m/second, and an anticipated groundwater flow rate of approximately 120 m^3 per day through the base of the sand and gravel across the wide area of the former airfield.

It is important to note that quarrying operations within the footprint of the IWMF site, and the surrounding mineral extraction areas of Site R and A2, reaffirmed that quantities of perched groundwater are encountered as the quarrying operations progressed in a planned and systematic manner across hollows (or natural low points) resulting from natural variations in the interface between the sand and gravel and London Clay.

The interface level of the underlying London Clay across the footprint of the IWMF is generally at or around 35 m AOD. The minor modifications and design changes that have been made to the IWMF within the July 2015 Section 73 application and submissions of details fit within the envelope of the original hydrogeological assessment.

The recent Section 73 revisions that have been made to the IWMF's design, and that have a positive effect on the water resources, have resulted in:

- A combination of excavated and soil nailed walls replacing the originally proposed vertical concrete retaining walls to deliver the IWMF within the footprint of the existing quarry, leading to a positive effect in respect of the earth and water retention around existing trees next to the proposed wall; and
- Modification of the proposed ground formation levels at the front of the building following the excavation of the sand and gravel as part of the on-going quarrying operations. Ground levels at the front of the IWMF are now proposed to be at top of London Clay level, rather than retaining an unexcavated and permeable layer of sand and gravel as had previously been shown in the original design.

The reduced footprint of the IWMF and minor modifications to its floor level have a negligible effect on the findings and mitigation measures set out within the original Environmental Statement(s), and quarrying operations within the footprint of the IWMF site have affirmed the hydrogeological setting.

The submission of details drawing (Lagan Consulting Drawing No GA/C/111/A submitted as "C24.8 Drainage Construction Details" within Appendix 6B) indicates the proposals for the drainage system at the bottom of the retaining walls. Only a small (150 mm diameter) perforated pipe is required as a means of collection of any residual groundwater that might be retained in the remaining sands and gravel seam on the eastern, southeastern and southwestern sides of the IWMF. Following the quarrying operations only small (residual) quantities of groundwater are anticipated – as a result of dewater operations as quarrying progressed across Site A2,

6.2.3 Aquifer Classification and Groundwater Vulnerability

The Environment Agency maps that identify the vulnerability of groundwater to contamination define Principal Aquifers, Secondary Aquifers and Unproductive Strata based on geological information, and use information on the overlying soils to determine the protection afforded to the geology to assess the overall vulnerability. Secondary Aquifers are subdivided into types A and B, where type A comprise 'permeable layers capable of supporting water supplies at a local and in some cases forming an important source of base flow to rivers'. Type B aquifers comprise 'lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering'.

The IWMF site (and Site A2, A3 and A4) are covered by Groundwater Vulnerability Map Sheet 32. This map, and the Environment Agency website, indicates that the Lowestoft Formation and the London Clay Formation (part of the Thames Group) are classified as Unproductive Strata. These are described by the Environment Agency as '*rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow*'. This is supported by the British Geological Survey (BGS) dataset, which indicates the rocks in the area have 'essentially no groundwater'. There is no vulnerability class assigned to the soils overlying the Lowestoft Formation.

The Kesgrave Formation, where still remaining between the Lowestoft Formation and the London Clay Formation, are classified as a Secondary Aquifer (undifferentiated).

6.2.4 Hydrogeological Source Protection Zones

The Environment Agency defines Source Protection Zones (SPZs) for groundwater sources (e.g. wells, boreholes and springs) used for public drinking water supply. These zones show the risk of contamination from activities that might cause pollution in the area; the closer the activity to the source the greater the risk. The maps show three main zones (inner, outer and total catchment) and a fourth zone of special interest, which the Environment Agency occasionally applies to a groundwater source. The IWMF site (and Sites A2, A3 and A4) are not located in an area defined as an SPZ.

6.2.5 Updated Hydrogeological Conditions - 2015

The original IWMF EIA (Chapter 6) noted that the saturated thickness of the sands and gravels varied from approximately 1 m to 3.5 m. It concluded that this variability is related to hollows in the surface of the London Clay; with the greatest saturated aquifer thickness corresponding to the hollows. Blackwater Aggregates' ongoing quarrying operations across Site R and Site A2 have confirmed that perched groundwater is encountered within the hollows (or natural low points) that result from natural variations in the interface between the sand and gravel and London Clay, so this conclusion is still supported.

Monthly groundwater level data has been provided Essex County Council's Minerals Planning Authority for the period January 2008 to August 2015 as part of the Site A2 quarrying operations. The locations of the groundwater monitoring points are shown on Drawing 213033-SOD-24 (included within Appendix 6B Document 24.2). A drawing plot of groundwater levels over time is presented within Appendix 6B (Document C24.6 Appendix A – Groundwater Monitoring" submitted with details under Condition 24). A summary of the groundwater level information for that period is presented in Table 6.2.1.

Table 6.2.1: Summary of Groundwater Level Data (January 2008 to July 2015)

Borehole	Groundwater Level			
	Minimum	Mean	Maximum	Range
PZ01^	33.88	34.38	34.93	1.05
PZ02	33.44	33.72	34.07	0.63
PZ04*	34.50	34.70	34.80	0.30
PZ07	33.54	34.02	34.89	1.35
PZ09A	32.86	33.23	33.96	1.1
PZ11	31.82	32.21	34.42	2.6
PZ16A	35.00	35.40	35.97	0.97
PZ18	37.21	37.69	38.59	1.38
PZ19	38.65	39.28	39.75	1.10
PZ20+	38.22	38.83	39.20	0.98
PZ21	31.77	33.12	34.54	2.77

^ Not monitored in summer months due to bees. ** Location stopped being monitoring in early 2009.* *+ Dry since December 2012.*

The monitoring data presented in Table 6.2.1 shows that groundwater elevations in the Kesgrave Formation sand and gravel are highest in the southwest and lowest in the northeast, suggesting groundwater flow in this deposit is likely to be towards the northeast and the River Blackwater.

Groundwater elevations do not appear to vary much over the monitoring period and do not show any clear seasonal variation. Groundwater elevations do tend to be slightly higher towards the end of the winter and spring months, but this is not always the case. This limited seasonality may be due to restricted recharge through the overlying, low hydraulic conductivity, Lowestoft Formation.

From all available information (and experience from quarrying operations in and around the IWMF site), the Kesgrave Formation sand and gravel deposits beneath the Site contain minor amounts of water, with the pattern of groundwater flow in and around the Site being influenced to some degree by the River Blackwater, and also by the topography of the surface of the underlying London Clay. Hollows in the underlying London Clay surface typically contain groundwater. The cohesive and relative impermeable nature of the Lowestoft Formation overburden typically restricts the recharge to the Kesgrave Formation.

The interface level of the underlying London Clay across the footprint of the IWMF is generally at or around 35 m AOD.

6.2.6 2014 Ground Investigation & Piezometer Installations

Twenty exploratory holes were carried out between 21 July 2014 and 22 August 2014 by CC Ground Investigation Limited in accordance with BS5930, Amendment 2 (2010). The location of the boreholes are indicated on Drawing 213033-150 (submitted with submission of details in July 2015 for Condition 24 and presented within Appendix 6B as document 24.5 Dwg No 213033-150 "As-Built Borehole Locations".).

Piezometers were installed within BH 10, BH 11 and BH 19 with a response zone within the sand and gravel. Each installation comprises a 50 mm ID HDPE slotted tube set in a filter response zone of Limestone free gravel. The installation was sealed above and below with a bentonite seal and accessed via a valve assembly. The piezometers are protected at the surface by a lockable galvanised steel borehole helmet set in concrete. Installation details are presented on the borehole logs (submitted with submission of details in July 2015 for Condition 24 and presented within Appendix 6B as document 24.7 "Appendix B – Borehole Logs").

On installation BH 10, BH 11 and BH 19 were dry (confirmed by quarrying operations within Site A2). As a contained low point within the operational quarry, this area of Site A2 has been used as a drainage lagoon and soak away for water pumped from the operational areas of the quarry. Groundwater monitoring of BH 10 and BH 11 have recorded water levels coincidental to water levels within the lagoon, BH 19 remains dry.

6.2.7 Groundwater Monitoring Proposals

It is proposed that the groundwater levels in the Sands and Gravels will continue to be monitored monthly throughout the extraction and construction phases of the IWMF. It is proposed that the existing groundwater monitoring wells within Bradwell Quarry (Pz01, Pz02, Pz07, Pz09a, Pz11, Pz16a, Pz18, Pz19 and Pz21) and boreholes BH 10, BH 11 and BH 19 are monitored on a monthly basis during the construction of the IWMF.

6.2.8 Updated Groundwater Quality Baseline 2015

In 2013 and 2014, as part of the Site A2 quarry operations, the groundwater quality in and around the IWMF site was tested. The suite of determinands and results are presented in Table 6.2.2

Field parameter measurements for pH, temperature, electrical conductivity and dissolved oxygen were taken in August 2013 and February 2014. Results were recorded at seven monitoring points (Pz02, Pz07, Pz09A, Pz11, Pz16A, Pz19 and Pz21) in August 2013 and eight monitoring locations (Pz02, Pz07, Pz09A, Pz11, Pz16A, Pz18, Pz19 and Pz21) in February 2014. Groundwater samples were also taken for laboratory analysis at the same locations.

Table 6.2.2: Summary of August 2013 and February 2014 Groundwater Quality Data

Parameter	Unit	WQS	Number of Samples	Number of Samples >LOD	Concentrations		
					Minimum	Mean	Maximum
Temperature*	Degrees Celsius	-	15	15	10.1	11.75	13.6
Dissolved Oxygen*	mg/L	-	15	15	4.98	9.72	16.75
Electrical Conductivity*	µS/cm	2500	15	15	537	815	1193
pH*	pH units	<6.5 and >10.0	15	15	7.13	7.45	8.12
Boron^	µg/L	1000	15	10	<12	19.4	87
Cadmium^	µg/L	5	15	1	<0.03	0.1	0.07
Calcium^	mg/L	250	15	15	115.2	149.2	196.6
Total Chromium^	µg/L	50	15	1	<0.2	0.4	0.4
Copper^	µg/L	2000	15	7	<7	4.8	14
Total Iron^	µg/L	2000	15	1	<4.7	8.5	40.3
Lead^	µg/L	200	15	8	<5	3.2	5.1
Magnesium^	mg/L	50	15	15	2.3	5.6	11.1
Manganese^	µg/L	50	15	5	<1.5	2.5	19
Nickel^	µg/L	20	15	10	<2	3.1	11.5
Potassium^	mg/L	12	15	14	<0.1	3.2	24.3
Sodium^	mg/L	200	15	15	9.5	26.5	107.5
Zinc^	µg/L	5000	15	14	<3	12.5	28
Sulphate	mg/L	250	15	15	50.65	112.4	261.99
Chloride	mg/L	250	15	15	10.1	38.2	57.6
Nitrate (as NO3)	mg/L	50	15	15	0.4	36.8	73.8
Ammoniacal Nitrogen (as N)	mg/L	0.39	15	6	<0.03	0.03	0.09
Total Alkalinity (as CaCO3)	mg/L	-	15	15	210	277	354
Bicarbonate Alkalinity (as CaCO3)	mg/L	-	15	15	210	277	354
BOD (Settled)	mg/L	-	15	2	<1	0.6	2
COD (Settled)	mg/L	-	15	5	<7	5.8	18
Total Organic Carbon	mg/L	-	15	1	<2	1.5	8

* Field parameter

^ Dissolved concentrations

No hydrocarbons, volatile organic compounds, arsenic, mercury, selenium or nitrate were detected at concentrations greater that the laboratory limit of detection.

An initial screening against the UK DWS (Water Supply (Water Quality) regulations 200, SI2000/3184) indicates that the groundwater quality is generally within the standards for potable supply. The exceptions to this are nitrates across much of the area, which might be expected in an agricultural setting, sulphate at Pz11 in August 2013 and potassium in Pz11 in February 2014.

6.2.9 Updated Groundwater Assessment - 2015

The baseline conditions indicate that the Site has been subject to historical land use activities that may have the potential to lead to groundwater and ground contamination. For example, there are areas on Site where aircraft would have been stored and/or re-fuelled with resultant localised spillages or leakage of fuel, lubricants or de-greasing products. To date, no widespread ground or groundwater contamination has been observed on adjacent areas that were also part of the former airfield. Furthermore, the original IWMF assessment noted that Braintree District Council had confirmed that there are no known contaminated land sites at or in the vicinity of Rivenhall Airfield.

Whilst there is no existing evidence of ground contamination arising as a consequence of historical activities, the development of the IWMF could lead to the disturbance of previously unidentified contamination. Any previously unidentified contamination is considered to have the potential to result in a slight, adverse impact on groundwater conditions in the sands and gravels. Such impacts are likely to be medium to long term, but could be reversible.

Due to the thickness of London Clay overlying the Chalk, the impact on groundwater in the Chalk from previously unidentified contamination is considered to be negligible.

Operational activities also have the potential to effect groundwater quality, primarily through the following:

- Spills or leaks of fuels, oils or lubricants; and
- Run-off from the Site (e.g. increase in suspended solids).

The removal of previously placed restoration soils and the remaining overburden and mineral from the IWMF site has the potential to reduce the available attenuating properties of organic material and clays resulting in greater potential for pollution of groundwater. Any contamination of ground or groundwater arising from construction activities has the potential to result in a slight, adverse impact on groundwater quality at the Site. Such impacts may be medium to long term, but could be reversible.

6.2.10 Updated Mitigation Measures - 2015

Many of the potential impacts to groundwater in relation to previously unidentified contamination can be managed and mitigated through following industry guidance. For example, in the unlikely event suspected contamination is identified during excavation works, works should cease and the need for further assessment (e.g. through site investigation) should be considered. Such decisions will be undertaken in agreement with the local planning authority and the Environment Agency. In the event that soils or groundwater are found to be contaminated, then appropriate risk assessment and remediation will be employed.

During the IWMF construction phase, pollution prevention techniques, operational good practice and appropriate waste disposal methods will be used to mitigate the potential effects of accidental spills or leaks of fuel, oil or lubricants. These may include the following:

- Any vehicles and plant used during the operational phase will be maintained and inspected regularly for leaks of fuel, lubricants and oil, and equipment will be made available on site to deal with minor spills;
- All fuels will be stored according to good practice guidelines, including bunding of tanks with a minimum storage volume of 110% of the tank capacity;
- All materials that represent a risk to the environment being labelled, stored, handled and used in an appropriate manner, including the use of sheeting, bunds, and drip trays;
- Effluent from any plant and temporary wheel washing will be collected and recycled, where possible, rather than being discharged to ground. Disposal to ground will not take place without appropriate treatment and obtaining necessary consent from the Environment Agency;
- Appropriate storage will be provided for any waste generated during the operational phase to reduce run off from potentially contaminating materials. All spoil and waste arising during the operational phase will be classified and disposed of to a licensed facility in accordance with the relevant legislation; and
- Remaining areas of topsoil and overburden (including existing restoration soils) from excavation areas will be stripped and stored separately. Careful removal and storage of soils during preparatory construction works will reduce the potential effects of run-off and enable soils to be used in landscaping of the development.

Whilst there is no existing evidence of ground contamination arising as a consequence of historical activities, the removal of remnants of the former airfield could lead to the disturbance of previously unidentified contamination. To address this issue a 'watching brief' will be maintained during site clearance works to determine the presence of previously unidentified zones of soils or groundwater contamination.

The 'watching brief' will implement a series of actions as follows:

- General removal of topsoil and subsoils should be undertaken in a manner that limits exposure of soil to surface water runoff and allows visual and olfactory observation of all materials by a competent, designated clerk of works or equivalent;
- In the event that visual or olfactory evidence indicates a potential area of concern, then all excavation works will cease to ensure that potentially unknown sources of contamination from the ground or groundwater are not mobilised further;
- The clerk of works will contact Gent Fairhead & Co Limited, to determine what steps can be taken to isolate the material pending further investigation. This may include, but not be limited to, excavation and storage of small volumes of soils in a designated quarantine area. The Environment Agency and Local Planning Authority will be informed and an appropriate course of action will be agreed;
- The potential area of concern will be appropriately assessed, primarily through sampling and laboratory analysis, and any requirement for remedial works will be identified. The scope of any proposed remedial works will be agreed with the Environment Agency and Local Planning Authority prior to works commencing. This may include the need for additional investigation and/or risk assessment to support the works; and
- Records shall be maintained of all areas investigated and actions taken to remediate these, including appropriate verification / validation reports. These will need to be submitted to the Environment Agency and Local Planning Authority for approval.

Additional reference should be made to Appendix 5A which presents the submission of details issued to Essex County Council in July 2015 for Condition 25.

The IWMF development works will also be carried out with due reference to relevant Environment Agency Pollution Prevention Guidelines (PPGs) to reduce or avoid the potential risks presented to the groundwater environment. The relevant PPGs are considered to be as follows:

- **PPG1:** General Guide To The Prevention Of Pollution;
- **PPG 2:** Above Ground Oil Storage Tanks;
- **PPG 3:** The Use And Design Of Oil Separators in Surface water drainage systems;
- **PPG 4:** Treatment and disposal of sewage where no foul sewer is available;
- **PPG 5:** Works or maintenance in or near water;
- **PPG 6:** Working At Construction And Demolition Sites;
- **PPG 8:** Safe Storage And Disposal Of Used Oils;
- **PPG 13:** Vehicle Washing and Cleaning; and
- **PPG 26:** Storage and Handling of Drums and Intermediate Bulk Containers.

Procedures will also be put into place to ensure that any spills of materials that do occur are dealt with appropriately and expediently, including any resulting from emergency responses. These will be developed with reference to the following PPGs:

- **PPG 18:** Managing fire **water** and major spillages; and
- **PPG 21:** Pollution incident response planning.

6.2.11 Cumulative Groundwater Assessment

The planning application boundaries of the former Site A2 and existing Site A3 and A4 quarrying operations included the IWMF site to ensure that the 'Site Specific Issues to be Addressed' set out within Essex County Council's emerging Replacement Minerals Local Plan and adopted 2014 Minerals Local Plan were addressed, namely:

> *"Careful consideration must be given to the final low-level restoration contours to ensure the final landform blends with the surrounding topography and could blend with the levels and planting of the strategic waste management development (Ref ESS/37/08/BTE) if implemented."*

Furthermore, the 'preferred' Site A5 and 'reserve' Site A6 and A7 within the 2014 Minerals Local Plan are near the IWMF site. Therefore, there is a need to consider the cumulative impacts associated with the coincidental development of these schemes on the Site's groundwater setting.

The plan for all minerals excavation is for work to be phased with rolling restoration, so the total excavation area at any one time will be considerably less than the total resource area. Based on this, the nature of the schemes and the low sensitivity of the groundwater environment, the cumulative impacts on groundwater levels, flow and quality are considered to be slight to negligible.

The proposed mitigation works, including appropriate monitoring and pollution prevention methods, are relevant to both schemes and will reduce any potential quality effects to negligible.

Increasing the area of restored land from just Site R and A2, to include Site A3 and A4, and then potentially sites A5 through A7, along with the IWMF, will result in the replacement of

relatively high hydraulic conductivity sands and gravels with lower hydraulic conductivity soils. This could have a cumulative impact on recharge to the sand and gravel aquifer (and therefore groundwater levels) and on local groundwater flow directions.

Recharge to the sand and gravel aquifer could be reduced or slowed. Infiltration into the restoration soils will still occur, but there could be more surface water run-off as a result of the change in restoration profile reducing the amount of water available for infiltration. Recharge to the surrounding remaining sands and gravels may also be slower due to the likely lower hydraulic conductivity of the restoration materials. However, the footprint of the IWMF and the total area of 'preferred' and 'reserve' minerals areas across Bradwell Quarry identified in the Minerals Local Plan is small in relation to the total area of remaining sands and gravels in the surrounding area. Direct recharge through the overburden and into these sands and gravels will not be affected by the proposed development. Therefore, on a wider scale, the cumulative change in recharge to the sands and gravels (and therefore levels) as a result of the IWMF's development alongside the whole 'preferred' and 'reserve' minerals area is likely to be negligible.

Further consideration has been given to the hydrogeological impacts associated with the installation of the proposed electricity cable and water abstraction and discharge pipelines within a shallow trench. As the construction process takes place in shallow trenches at the ground surface, due to the thickness of the Boulder Clay overlying the sands and gravels, and the London Clay overlying the Chalk, the potential impact on groundwater in the Sands and Gravels or the Chalk is considered to be negligible.

It is concluded that from a groundwater assessment perspective the cumulative EIA for the IWMF proposal and the wider foreseeable developments in and around the site have been considered and assessed, and no significant cumulative issues have been identified.