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# INTRODUCTION

6.1 This chapter of the ES details the local hydrology and hydrogeology of the application site and the surrounding area. It also identifies possible hydrogeological and hydrological impacts associated with the proposed development, details of which have been set out in Chapter 3 above.

6.2 The assessment is based on the hydrological and hydrogeological regimes and the specific mitigation measures which have been incorporated into the design of the scheme.

# ASSESSMENT METHODOLOGY

## Approach

6.3 The assessment has involved the following:

- detailed desk study to establish current baseline hydrological and hydrogeological conditions;
- identification of possible measures to avoid and mitigate any adverse impacts resulting from the proposed development; and
- evaluation of the residual significance of these impacts by consideration of the sensitivity of the baseline features of the application site and the potential magnitude, following mitigation.

6.4 The desk top study was undertaken in order to:

- describe the geological and hydrogeological setting;
- describe surface water hydrology within and adjacent to the application site boundary;
- identify flooding risks; and
- identify sensitive hydrogeological and hydrological features which may potentially be impacted by the proposed development.

6.5 The extent of the desk top study was based on professional judgment.

## Policy Context

6.6 The proposals for the development of the application site have had regard to technical guidance, relevant Pollution Prevention Guidelines and other codes of best practice in order to limit the potential for contamination of ground and surface waters, the potential for flooding to be caused by the development, and other potential impacts on the water environment. The development of the application site would therefore be in accordance with the following:

### *European Legislation*

6.7 The key piece of European Legislation that protects the UK's water environment is the Water Framework Directive (2000/60/EC). This Directive

protects all elements of the water cycle and seeks to enhance the quality of groundwaters, surface waters, estuaries and coastal waters.

### *National Legislation and Policy*

6.8 Key national legislation and policy relevant to this proposed development includes:

- Environmental Permitting (England and Wales) Regulations 2010;
- Environment Act 1995;
- the Environment Agency's (EA) statutory obligations over the management and control of pollution into water;
- the Environment Agency's Groundwater Protection: Principles and Practice (GP3), EA, 2012;
- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003 in England and Wales;
- Flood and Water Management Act, 2010;
- National Planning Policy Framework, Published by Department for Communities and Local Government, March 2012; and
- National Planning Policy Framework, Technical Guidance Note Published by Department for Communities and Local Government, March 2012.

### *Local Planning Policy and Strategy*

6.9 As noted from Chapter 4 above, the main local planning policy documents include:

- Hertfordshire County Council (2007). Hertfordshire Minerals Local Plan Review 2002- 2016; and
- Hertfordshire County Council (2012). Hertfordshire Waste Development Framework: Waste Core Strategy & Development Management Policies Development Plan Document 2011-2026.

6.10 Details of the relevant planning policies that relate to the water environment are set out in Chapter 4.

## Good Practice Guidance

6.11 Relevant UK guidance on good practice for construction projects is detailed in the following documents:

- Control of Water Pollution from Construction Sites - Guide to Good Practice, CIRIA 2002; and
- Environmental Good Practice on Site C650, CIRIA 2005.

6.12 The Pollution Prevention Guidelines identified below are the principal guidance documents for preventing water pollution and erosion from construction activities and are jointly produced by the Environment Agency, Scottish Environment Protection Agency and the Environment and Heritage

Service in Northern Ireland and are available via the Environment Agency's website (www.environment-agency.gov.uk):

- PPG1 General Guide to the Prevention of Pollution (PPG1, July 2013)
- PPG2 Above Ground Oil Storage Tanks (PPG2, August 2011)
- PPG3 Use and Design of Oil Separators in Surface Water Drainage Systems (PPG3, April 2006)
- PPG4 Treatment and disposal of sewage where no foul sewer is available (PPG4, July 2006)
- PPG5 Works and maintenance in or near water (PPG5, October 2007)
- PPG6 Working at Construction and Demolition Sites (PPG6, May 2012)
- PPG21 Pollution Incident Response Planning (PPG 21, March 2009)
- PPG22 Incident Response – dealing with spills (PPG22, March 2011)

6.13 Guidelines for surface water management and flood risk assessment are as follows:

- The SuDS Manual (Report C697). CIRIA, 2007; and
- Planning Policy Guidance, Department for Communities and Local Government (2014)

## Information Sources

6.14 The following sources of information have been consulted in order to characterise the geology, hydrogeology and hydrology of the area within and surrounding the application site:

- BGS online maps (www.bgs.ac.uk/data/mapViewers/home.html) for details of geology and borehole logs;
- British Geological Survey / Environment Agency (1997) The Physical Properties of Major Aquifers in England and Wales, Technical Report WD/97/34;
- Environment Agency Website (www.environment-agency.gov.uk) for details on aquifer classification, source protection zones, groundwater vulnerability, flood risk and Water Framework Directive classifications for groundwater and rivers;
- Institute of Hydrology Flood Estimation Handbook CD ROM Version 3, 2009;
- Ordnance Survey website for 1:25,000 scale explorer map (https://www. ordnancesurvey.co.uk);
- Emap Groundsure reports of application site (October 2015) including Floodinsight, Geoinsight and Enviroinsight reports;
- C Fitzpatrick, 2010, The Hydrogeology of Bromate Contamination in the Hertfordshire Chalk: Double-Porosity Effects on Catchment-Scale Evolution;
- SLR Consulting (November 2014) Hatfield Aerodrome Mineral Development Site - Site Investigation, Ref 406.01009.00064; and

- SLR Consulting (April 2015), Hatfield Aerodrome Mineral Development Site Phase 3, Quarter 2 Project Update.

## Scoping and Consultations

6.15 As noted from Chapter 1 above, a scoping opinion was requested from the MPA and issued on the 19 November 2015. Discussions have been held with the Environment Agency (EA) over a period of 5 years to help develop a working plan that would be acceptable to the EA.

## Significance Criteria

6.16 A qualitative risk assessment methodology has been used to assess the significance of the potential effects associated with the proposed development. Two factors have been considered using this approach: the sensitivity of the receiving environment and the potential magnitude of impact, should that potential impact occur.

6.17 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 scheme. This approach also allows effort to be focused on reducing risk where the greatest benefit may result.

6.18 Criteria for determining the significance of effects are provided in Table 6-1, Table 6-2 and Table 6-3 below. Effects of 'major' and 'moderate' significance are considered to be 'significant' in terms of the EIA Regulations.

6.19 The sensitivity of the receiving environment (i.e. the baseline quality of the receiving environment as well as its ability to absorb the impact without perceptible change) is defined in Table 6-1.

**Table 6-1**
**Sensitivity Criteria for Water Environment Receptors**

| Sensitivity | Definition |
|---|---|
| Very High | • International importance.<br>• Receptor with a high quality and rarity, regional or national scale and limited potential for substitution / replacement. |
| High | • National importance.<br>• Receptor with a high quality, local scale and limited potential for substitution / replacement; or<br>• Receptor with a medium quality and rarity, regional or national scale and limited potential for substitution / replacement. |
| Medium | • Regional importance.<br>• Receptor with a medium quality and rarity, local scale and limited potential for substitution / replacement; or<br>• Receptor with a low quality and rarity, regional or national scale and limited potential for substitution / replacement. |
| Low | • Local importance.<br>• Receptor with a low quality and rarity, local scale.<br>• Environmental equilibrium is stable and is resilient to changes that are greater than natural fluctuations, without detriment to its present character. |

6.20 The criteria that have been used to assess the magnitude of the impacts are defined in Table 6-2.

**Table 6-2**
**Magnitude of Impact Criteria and Definitions**

| Magnitude | Criteria | Definition |
|---|---|---|
| **Major** | Results in loss of attribute. | Fundamental (long term or permanent) changes to hydrology, hydrogeology and water quality, such as:<br>• Wholesale changes to watercourse channel, route, hydrology or hydrodynamics.<br>• Changes to the application site resulting in an increase in runoff with flood potential and also significant changes to erosion and sedimentation patterns.<br>• Major changes to the water chemistry or hydro-ecology.<br>• Major changes to groundwater levels, flow regime and risk of groundwater flooding. |
| **Moderate** | Results in impact on integrity of attribute or loss of part of attribute. | Material but non-fundamental and short to medium term changes to hydrology, hydrogeology and water quality, such as:<br>• Some fundamental changes to watercourses, hydrology or hydrodynamics. Changes to application site resulting in an increase in runoff within system capacity.<br>• Moderate changes to erosion and sedimentation patterns.<br>• Moderate changes to the water chemistry of surface runoff and groundwater.<br>• Moderate changes to groundwater levels, flow regime and risk of groundwater flooding. |
| **Minor** | Results in minor impact on attribute. | Detectable but non-material and transitory changes to hydrology, hydrogeology and water quality, such as:<br>• Minor or slight changes to the watercourse, hydrology or hydrodynamics.<br>• Changes to application site resulting in slight increase in runoff well within the drainage system capacity.<br>• Minor changes to erosion and sedimentation patterns.<br>• Minor changes to the water chemistry of surface runoff and groundwater.<br>• Minor changes to groundwater levels, flow regime and risk of groundwater flooding. |
| **Negligible** | Results in an impact on attribute but of insufficient magnitude to affect the use/integrity. | No perceptible changes to geology, hydrology, hydrogeology and water quality, such as:<br>• No impact or alteration to existing important geological environs.<br>• No alteration or very minor changes with no impact to watercourses, hydrology, hydrodynamics, erosion and sedimentation patterns.<br>• No pollution or change in water chemistry to either groundwater or surface water.<br>• No alteration to groundwater recharge or flow mechanisms. |

6.21 The sensitivity of the receiving environment together with the magnitude of the impact defines the significance of the potential effect, as identified within Table 6-3.

**Table 6-3**
**Significance of Potential Effect**

| Magnitude of Impact | Sensitivity | | | |
|---|---|---|---|---|
| | Very High | High | Medium | Low |
| Major | Major | Major | Moderate | Minor |
| Moderate | Moderate | Moderate | Moderate | Minor |
| Minor | Minor | Minor | Minor | Negligible |
| Negligible | Negligible | Negligible | Negligible | Negligible |

6.22 The characteristics of the impacts are described in terms of direct/indirect, temporary (reversible)/permanent (irreversible), together with timescales (short, medium, long term). These terms are defined within Chapter 1 of this Volume.

## BASELINE CONDITIONS

6.23 The following hydrogeological and hydrological regime is considered below:

- regional geology;
- local geology;
- aquifer characteristics;
- recharge mechanisms;
- groundwater levels and flow,
- water abstraction and use;
- groundwater quality;
- catchment overview;
- surface water flows;
- surface water quality; and
- flood risk.

6.24 The hydrogeological and hydrological data have been used to develop a conceptual site model.

## Geology

### *Regional Geology*

6.25 The solid geology beneath the application site comprises undifferentiated Lewes Nodular Chalk Formation and Seaford Chalk Formation. This dips to the south-east and is underlain by undifferentiated Holywell Nodular Chalk Formation and New Pit Chalk Formation.

6.26 The application site lays within the Vale of St Alban's, a broad northeast to southwest orientated plain between higher land to the north-west and south-east. The chalk on the higher land to the west is overlain by superficial drift Clay with Flints deposits. In contrast the chalk on the higher land to south-east is overlain by the Lambeth Group and London Clay, as well as other variable drift deposits.

6.27 The Vale of St Albans corresponds with the route of a pre-glacial water course (Proto-Thames) that is understood to have flowed northeast into East Anglia. Overlying the chalk in this area and at the site is the Lowestoft Formation, comprising a sequence of glacial deposits including boulder clays and sands and gravels. A thin tract of alluvium associated with the former alignment of a surface water course known as the Nast also crosses the site.

6.28 Extracts of the geological maps are shown on Drawing HQ 6/1 and Drawing HQ 6/2, whilst a geological cross section across the application site is shown on Drawing HQ 6/3.

## *Local geology*

6.29 A number of site investigations and studies identified four broad superficial drift units comprising an upper and lower granular formation (sands, gravels known as the Upper Mineral Horizon and Lower Mineral Horizon respectively) separated by boulder clay and all overlain by a gravelly clay overburden. This corresponds to the Lowestoft Formation described in the regional geology of the area. The geology beneath the application site has been confirmed in a number of site boreholes, the results from which are summarised in Table 6-4. A detailed geological cross section from the application site and nearby boreholes is shown on Drawing HQ 6/3. The locations of the borehole are shown on Drawing HQ 6/5. Borehole logs are presented in Appendix 6/1.

**Table 6-4**
**Application Site Geology**

| Drift/Solid | Depth (m) | Geological Unit | Description |
|---|---|---|---|
| Superficial Drift | 0.1 – 5.7 | Overburden – Clay, Sand, Gravel | Variable mixture of clay, sand and gravel, sometimes in discrete lenses |
| | 2.2 – 11.8 | Upper Mineral Horizon (UMH) | Slightly gravelly sand. |
| | 6.2 – 14.2 | Interburden - Boulder Clay (BC) | Stiff grey or orange brown clay with occasional gravel |
| | 8 – 18.3 | Lower Mineral Horizon (LMH) | Sand and sandy gravels |
| Solid Geology | | White Chalk Sub-Group | White chalk with flints |

6.30 Previous sand and gravel quarries in the Hatfield area have generally been restored via landfill and there are landfills to the immediate north of the application site. All landfills within a 2km radius of the application site are shown on Drawing HQ 6/4.

## Hydrogeology

### *Aquifer Characteristics*

6.31 The Glacial Drift Deposits of sand, gravel and clay, (Overburden, Upper Mineral Horizon (UMH) and Lower Mineral Horizon (LMH)) are classified by the Environment Agency[1] as Secondary (undifferentiated) Aquifers.

6.32 This classification combines Secondary A and Secondary B Aquifers which cannot be distinguished due to the variable characteristics of the geology. Secondary A Aquifers are described as *"permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers."* and Secondary B Aquifers are described as *"lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering."*

6.33 The small band of alluvium associated with the Nast, which correlates to the current route of the Nast including a culverted section, is classified by the Environment Agency as a Secondary A Aquifer.

6.34 The Chalk is classified as a Principal Aquifer; it is a laterally continuous water body and an important regional supply of potable water as well as supporting base flow in rivers. The aquifer is generally unconfined where the chalk outcrops to the northwest of the application site although where valleys cut into the chalk the aquifer can be locally confined beneath infilling of low permeability superficial drift deposits.

6.35 The Chalk has high matrix porosity but low matrix permeability, with flow mainly occurring through fractures and fissures (secondary permeability), often associated with traceable hard bands.

6.36 Groundwater in the Chalk and the Lower Mineral Horizon (LMH) is regionally extensive and in hydraulically continuity. It is possible that weathering of the upper parts of the chalk have reduced the hydraulic conductivity of the strata.

6.37 The Upper Mineral Horizon (UMH) groundwater is perched on the Interburden (boulder clay) which separates the two mineral horizons and is laterally continuous across the application site. The Overburden consists of clay, silt, sand and gravels and covers the majority of the application site.

[1] Environment Agency Website (Accessed October 2015) *http://www.environment-agency.gov.uk/homeandleisure/117020.aspx*

6.38 In situ permeability tests were completed in January 2015 within the Chalk, LMH and UMH groundwater monitoring boreholes installed at the application site (BH101, BH104, BH106, BH107, BH108, BH201s and BH201d, as shown in Drawing HQ 6/5). These are summarised in Table 6-5 below.

**Table 6-5**
**Hydraulic Conductivity Determined from Falling & Rising Head Tests (m/d)**

| BH | Rising/Falling | UMH | LMH | CHALK |
|---|---|---|---|---|
| 101 | Falling | - | 0.10 | 0.71 |
| | Rising | 0.70 | 0.21 | 0.66 |
| 104 | Falling | - | - | 0.40 |
| | Rising | 1.2 | - | 0.51 |
| 106 | Falling | - | - | 0.14 |
| | Rising | 7.55 | - | 0.11 |
| 107 | Falling | - | 4.33 | 5.76 |
| | Rising | 2.47 | 3.02 | 7.50 |
| 108 | Falling | - | 1.61 | 0.18 |
| | Rising | 6.55 | 1.76 | 0.08 |
| 201 (s)[1] | Falling | - | 0.35 | - |
| | Rising | - | 0.73 | - |
| 201 (d)[1] | Falling | - | 1.71 | - |
| | Rising | - | 1.71 | - |
| **Minimum** | | **0.70** | **0.10** | **0.08** |
| **Mean** | | **3.69** | **1.55** | **1.61** |
| **Maximum** | | **7.55** | **4.33** | **7.50** |

*Notes: 1. s & d shallow and deep piezometers respectively*

6.39 The data indicates that the Upper Mineral Horizon is more permeable than the Lower Mineral Horizon and Chalk which have similar properties. This is surprising given that the LMH is a cleaner gravel deposit and may be an erroneous result.

6.40 The Chalk shows the greatest variation in hydraulic conductivity with a maximum value of 7.5m/d. This is not particularly high for the Chalk based on literature, but most monitoring wells are installed in the upper weathered section of chalk which may have a lower hydraulic conductivity than the unweathered Chalk.

6.41 Literature values of hydraulic conductivity are provided in in Table 6-6. Taking these into account together with the on-site testing it is considered that the following range of values is representative of the hydraulic conductivity of the strata.

- Upper Mineral Horizon 4 – 20m/day
- Lower Mineral Horizon and Chalk 10 – 20m/day

6.42 The application site is located within the Total Catchment Zone (SPZ3) and Outer Source Protection Zone (SPZ2) of two public water supply wells (Hatfield and Colney Heath) located 1,500m south-east and 2,200m south

south-east from the application site, respectively. The SPZ2 zone is defined as the 400 day travel time but must have a minimum radius of 250 or 500m around the source depending on abstraction volume.

6.43 The hydrogeological characteristics of the geological strata at the application site and surrounding areas are summarised in Table 6-6 below.

## Table 6-6
## Hydrogeological Characteristics of Geological Units at the Application Site

| Period | Geological Unit | Hydrogeological Characteristics | Groundwater Vulnerability and Aquifer Productivity |
|---|---|---|---|
| Quaternary | Overburden | Comprises clay, silt, sand and gravel deposits with limited thickness. Lithology is mixed and also in discrete lenses therefore permeability is variable depending on grain size and sorting. | Secondary Aquifer (Undifferentiated) |
| | Upper Mineral Horizon (UMH) | Variable lithology (clays, sands and gravels) but largely sands with occasional gravel and clay lenses. Typical hydraulic conductivity 1 x $10^{-5}$ to 1 x $10^{-2}$m/sec[2] | Secondary Aquifer (Undifferentiated) |
| | Interburden (Boulder Clay) | Glacial Boulder Clay thought to be laterally extensive and is typical over-consolidated glacial boulder clay. The top of the boulder clay dips eastwards across the application site and laboratory tests have provided a permeability of 5x$10^{-11}$m/s. | Secondary Aquifer (Undifferentiated) |
| | Lower Mineral Horizon (LMH) | Predominantly sandy gravel with lenses of sand and occasional lenses of clay. Typical hydraulic conductivity 1 x $10^{-4}$ to 1 x $10^{0}$m/sec[2] | Secondary Aquifer (Undifferentiated) |
| Cretaceous | Lewes Nodular Chalk Formation (Base of the Upper Chalk) | White chalk with flints.<br>Groundwater storage and flow is associated with secondary porosity and permeability due to fractures and karstic features.<br>Literature gives transmissivity values for the Colne valley in the range of 1,500-3,000m$^2$/day[3], however, it is noted that repeated freezing and thawing during periglaciation shattered the chalk in the wider valleys and produced a thick soft weathered layer of chalk. The weathered chalk hydraulic conductivities are estimated to be between $10^{-4}$ to $10^{-2}$ m/day[4] with vertical hydraulic conductivities likely to be around 10% of the horizontal values.<br>Weathered soft chalk has been recorded on site and whilst the Chalk and LMH are thought to be in hydraulic continuity, the presence of the weathered chalk causes a lower permeability layer at the interface. | Principal Aquifer |

[2] Freeze A and Cherry J. A (1979) Groundwater pp604
[3] BGS 1997, The Physical Properties of Major Aquifers in England and Wales. WD/97/34
[4] C Fitzpatrick, 2010, The Hydrogeology of Bromate Contamination in the Hertfordshire Chalk: Double-Porosity Effects on Catchment-Scale Evolution

## Recharge Mechanisms

6.44 The Environment Agency has provided rainfall data (2010-2012) for a rainfall gauge at Mill Green, approximately 4km east-east-north of the application site. These data indicate that annual rainfall ranges between 456mm and 811mm, with an annual average of approximately 616mm.

6.45 The Institute of Hydrology (FEH CD ROM) reports that the Seasonally Adjusted Average Annual Rainfall (SAAR) at the application site is 662mm.

6.46 Groundwater recharge to the Chalk strata occurs where bedrock is exposed at or just below the surface, which occurs approximately 1.5km to the north west of the application site.

6.47 Recharge to the Upper Mineral Horizon is thought to be incidental rainfall and infiltration from the Boggymead Spring to the west of the application site.

## Groundwater Levels and Flow

6.48 The Environment Agency has provided groundwater elevations for three chalk boreholes in the region, the locations of the borehole close to the application site are shown on Drawing HQ 6/4. The data are summarised in Table 6-7 and a hydrograph is included in Appendix 6/2.

**Table 6-7**
**Regional Chalk Groundwater Elevations**

| Borehole | Period | Groundwater Elevation (mAOD) | | | | Range (m) | Distance from Site (km) |
|---|---|---|---|---|---|---|---|
| | | Count | Min | Mean | Max | | |
| Orchard Garage | Jan 1988 – Jan 2011 | 260 | 73.97 | 77.05 | 81.60 | 7.63 | 2.5 NW |
| North Mymms Park | Mar 1986 – Feb 2015 | 271 | 58.76 | 61.44 | 66.51 | 7.75 | 3.7 SW |
| Shaws Corner | Mar 1986 – Jan 2015 | 301 | 75.96 | 77.09 | 78.73 | 2.77 | 7.6 N |

6.49 A review of the data shows that, over the monitoring period, the highest groundwater levels in all three boreholes were recorded in 2001 over the monitoring period, however, North Mymm and Shaws Corner boreholes show similarly high groundwater elevations in 2014.

6.50 Groundwater levels within the Upper Mineral Horizon (UMH), Lower Mineral Horizon (LMH) and Chalk are routinely recorded within monitoring boreholes within and next to the application site, locations are shown on Drawing HQ 6/5. Hydrographs are included in Appendix 6/3 and are summarised in Table 6-8.

**Table 6-8**
**Groundwater Elevations in the Proximity of the Application Site (Aug 2013 – Oct 2015)**

| Horizon | Borehole | Groundwater Elevation (mAOD) | | | | Range (m) |
|---|---|---|---|---|---|---|
| | | Count | Min | Mean | Max | |
| Upper Mineral Horizon (UMH) | BH101U | 19 | 73.03 | 74.13 | 75.84 | 2.81 |
| | BH102U | 19 | 74.70 | 75.63 | 77.28 | 2.58 |
| | BH103U | 19 | 73.41 | 74.73 | 76.77 | 3.36 |
| | BH104U | 19 | 72.19 | 73.01 | 74.61 | 2.43 |
| | BH105U | 19 | 71.61 | 72.21 | 72.42 | 0.81 |
| | BH105UX | 9 | 71.69 | 71.96 | 72.18 | 0.49 |
| | BH106U | 19 | 71.85 | 72.63 | 73.90 | 2.04 |
| | BH107U | 9 | 73.74 | 74.66 | 76.33 | 2.59 |
| | BH108U | 9 | 71.93 | 72.20 | 72.41 | 0.48 |
| | FT101 | 17 | 73.63 | 74.83 | 76.42 | 2.79 |
| | FT102 | 18 | 73.59 | 74.91 | 76.86 | 3.27 |
| | FT103 | 17 | 73.68 | 74.94 | 76.83 | 3.16 |
| | BHAU | 17 | 72.03 | 72.84 | 73.87 | 1.84 |
| | BHCU | 14 | 71.66 | 72.12 | 72.66 | 1.00 |
| | BHDU | 12 | 71.93 | 72.38 | 72.87 | 0.93 |
| | BHEU | 13 | 71.99 | 72.74 | 73.64 | 1.65 |
| | BHFU | 12 | 74.04 | 75.49 | 77.64 | 3.60 |
| | BHHU | 11 | 73.48 | 74.92 | 76.71 | 3.23 |
| | BHIU | 2 | 72.98 | 73.14 | 73.30 | 0.32 |
| | BHJU | 12 | 72.01 | 72.59 | 73.16 | 1.16 |
| | BHKU | 11 | 73.38 | 74.38 | 75.17 | 1.79 |
| Lower Mineral Horizon (LMH) | BH101L | 19 | 66.08 | 67.01 | 68.36 | 2.28 |
| | BH102L | 19 | 68.53 | 69.82 | 71.55 | 3.02 |
| | BH103L | 19 | 68.93 | 70.08 | 71.68 | 2.76 |
| | BH104L | 19 | 67.55 | 68.64 | 70.26 | 2.71 |
| | BH105L | 19 | 67.04 | 68.02 | 69.42 | 2.38 |
| | BH106L | 19 | 64.40 | 65.20 | 66.53 | 2.13 |
| | BH107L | 9 | 67.79 | 68.29 | 69.07 | 1.27 |
| | BH108L | 9 | 68.03 | 68.47 | 69.24 | 1.21 |
| | BH201S | 9 | 66.85 | 67.78 | 68.69 | 1.84 |
| | BH201D | 9 | 66.74 | 67.72 | 68.61 | 1.87 |
| | BHBL | 15 | 64.28 | 65.21 | 66.67 | 2.40 |
| | BHGL | 13 | 68.85 | 70.30 | 71.63 | 2.78 |
| Chalk | BH101C | 19 | 66.05 | 66.97 | 68.36 | 2.30 |
| | BH102C | 19 | 68.54 | 69.71 | 71.50 | 2.97 |
| | BH103C | 19 | 69.10 | 70.25 | 71.87 | 2.77 |
| | BH104C | 19 | 67.49 | 68.58 | 70.20 | 2.71 |
| | BH105C | 19 | 67.17 | 68.13 | 69.39 | 2.22 |
| | BH106C | 19 | 64.38 | 65.18 | 66.54 | 2.16 |
| | BH107C | 9 | 67.81 | 68.30 | 69.10 | 1.29 |
| | BH108C | 9 | 67.69 | 68.43 | 69.30 | 1.60 |

*Note: BH101-BH108 are nested wells and the letter suffix indicates the monitored horizon.*

6.51 A review of the groundwater level data indicates the following with regard to groundwater levels and flow at the application site:

- Highest recorded groundwater elevation:
  - UMH – 77.64mAOD (BHF in west of application site);
  - LMH – 71.68mAOD (BH103L in north west of application site); and
  - Chalk – 71.87mAOD (BH103C in north west of application site).
- Lowest recoded groundwater elevation:
  - UMH – 71.61mAOD (BH105U to the north east of application site);
  - LMH – 64.28mAOD (BHB to the east of application site); and
  - Chalk – 64.38mAOD (BH106C in south east of application site).
- Greatest seasonal variation recorded:
  - UMH – 3.60m (BHF in west of application site);
  - LMH – 3.02m (BH102L in south west of application site); and
  - Chalk – 2.97m (BH102C in south west of application site).

6.52 Groundwater levels in the LMH and the Chalk in the nested wells are at the same elevation and closely correlate; indicating that the LMH and Chalk are in hydraulical continuity.

6.53 The highest recorded groundwater levels in all aquifers during the monitoring period occurred in March 2014. Groundwater contours for UMH and LMH from this date are shown on Drawings HQ 6/6 and HQ 6/7.

6.54 Groundwater flow within the UMH is west south west to north east across the application site. The hydraulic gradient ranges between 0.0004 and 0.01. Groundwater flow within the LMH and Chalk is north-west to south east across the application, the hydraulic gradient is approximately 0.001.

6.55 The UMH due to the occasional absence of overburden and the groundwater seasonal fluctuations is predominantly unconfined for the majority of the year. It is noted that the highest groundwater levels recorded in the UMH in March 2014 were close to ground level.

6.56 The LMH and Chalk aquifer alternates between confined and unconfined conditions both spatially and temporally. This is due to:

- seasonal fluctuation of piezometric water levels;
- non uniform elevation of the interburden horizon (confining unit); and
- variations in abstraction rates from the Chalk groundwater plus distance from the Hatfield abstraction boreholes to the south of the application site.

6.57 A review of groundwater levels indicates that the LMH/Chalk aquifer becomes confined during high water level periods in the southern and western areas of the application site, but there are periods (between approximately July to December) when the water level falls and the aquifer becomes unconfined.

## *Water Abstractions and Use*

6.58 The Groundsure report (Appendix 6/4) has confirmed that there are eight active licensed groundwater abstractions and no active licensed surface water abstractions within 2km of the application site. The abstraction licenses are summarised in Table 6-9 below and locations are shown on Drawing HQ 6/4

**Table 6-9**
**Abstractions within a 2km radius of the Application Site**

| Drawing ID | Name of Holder | Licence Number | Grid Ref | Distance From Site (m) | Purpose | Permitted Annual Yield ($m^3$/year) |
|---|---|---|---|---|---|---|
| G1 | Barba | 28/39/28/0 477 | 519400 207900 | 213 SW | Horticultural Watering | 15,000 |
| G2 | Barker | 28/39/28/0 206 | 519400 207800 | 266 SW | Spray Irrigation | 6,819 |
| G3 | Glinwell Plc | 28/39/28/0 023 | 519460 207420 | 439 SW | Horticultural Watering | 90,290 |
| G4 | | | 519580 207250 | 535 S | | |
| G5 | Cemex UK Materials Ltd | 28/39/28/0 598/RO1 | 518791 208946 | 449 W | Quarry Process Water<br>Mineral Washing | 610,000 |
| G6 | Arlington Business Parks GP Ltd | 28/39/28/0 015 | 521350 209790 | 1524 NE 1524 | Make-up or Top up Water<br>Spray Irrigation - Direct | 83,000 |
| G7 | Affinity Water Limited | 29/38/01/0 061 | 522012 207729 | 1576 SE | Potable Water | 33,18649 |
| G8 | | TH/38/000 1/001 | 522015 207731 and 522012 207729 | 1577 SE | General Use | 33,17850 |

6.59 East Hertfordshire District Council and St Albans City and District Council have confirmed that there are a total of 11 private water supplies within 3km of the application site boundaries. The locations of the private water supplies are shown on Drawing HQ 6/4.

## *Groundwater Quality*

6.60 Regionally the Environment Agency are monitoring a bromate plume in the Chalk, the main route of the plume is approximately 1km to the north and northeast of the application site. A review of the extent of the plume is given in Appendix 6/4.

6.61 The historical release of bromate into the Chalk aquifer at Sandridge 4km north-west of the application site has migrated laterally east south-east from the source with groundwater flow. Although the bromate originally impacted the Chalk at its source, the chalk aquifer piezometric surface crosses the chalk/LMH geological boundary 1 km east of the source, meaning the LMH also contains bromate at this location.

6.62 The axis of the bromate plume extends west to east towards the northern end of the Aerodrome with the southern margin extending onto the edge of the proposed mineral extraction area as defined by SLR boreholes 104, 201 and pre-existing borehole BHB (Drawing HQ 6/5 for borehole locations). This southern plume edge coincides with the applicant's proposed mineral extraction area.

6.63 Groundwater quality has been monitored on and next to the application site since August 2013. The groundwater monitoring locations are shown on Drawing HQ 6/5.

6.64 Chemographs of key characteristics from water quality analyses for monitoring boreholes screened within the UMH, LMH and Chalk are included within Appendix 6/5. A summary of the main features of the full set of results is given below:

Boreholes within the application site:

- ammoniacal nitrogen concentrations are generally below the UK Drinking Water Standard (DWS) of 0.39mg/l across the application site. Single exceedances are recorded at BH101, in both Chalk (2.1mg/l) and UMH (0.51mg/l) and BH102 in both LMH (1.7mg/l) and Chalk (0.76mg/l). BH103 often exceeds the DWS in the LMH and Chalk. Maximum concentrations recorded are 11mg/l and 0.7mg/l respectively;
- metal concentrations are typically low across the application site;
- nickel has exceeded the UK DWS of 0.02mg/l more than once in LMH and Chalk boreholes BH102L, BH103L and BH103C with a maximum concentration of 0.083mg/l in BH103L;
- arsenic has been detected twice above the UK DWS of 0.01mg/l once in BH101L and once in BH102L with a concentration of 0.012mg/l in both boreholes. The UMH and Chalk boreholes have both occasionally detected arsenic but at concentrations lower than the UK DWS;
- cadmium has also been detected occasionally in UMH, LMH and Chalk boreholes but at concentrations lower than the UK DWS;
- within the UMH the groundwater quality is typically good with a few single exceedances of certain metals across the boreholes; and

- groundwater in the LMH and Chalk is also typically good although quality within BH103 tends to have higher concentrations than the other boreholes.

Boreholes outside of the application site:

- bromate has been detected over the UK DWS of 0.01mg/l in boreholes BHB, BH201, BH105 and BH108 within the LMH and Chalk (where screened). There have been multiple detections in all these boreholes which are situated to the northwest of the application site. The maximum recorded concentration is 0.33mg/l in BH105L which is the furthest north west borehole to the site;
- trichloroethene has been detected within the LMH in BH201, BH108L and BH105L. Trichloroethene has also been detected within the UMH and Chalk within BH105. The maximum concentration recorded is 0.17mg/l in BH105C;
- vinyl chloride has been detected at elevated concentrations in BH108L, BH105L and BH105C with a maximum concentration of 0.0048mg/l in BH105C; and
- 1,2 Dichloroethene has been detected at elevated concentrations in BH105 across all three horizons with a maximum concentrations of 0.22mg/l in BH105C.

6.65 The boreholes within the LMH and Chalk which have some elevated concentrations are noted to be down-gradient of historic landfills situated off site.

6.66 An assessment of the potential for contaminated land within the proposed extraction boundary has been made and is presented in Appendix 6/4. This has not identified any significant contamination that could be affecting groundwater quality.

6.67 The Water Framework Directives River Basin Management Plan (2009) summarises the regional qualitative and quantitative quality of the groundwater within the Chalk (Waterbody ID – GB40601G601200). The groundwater in the vicinity of Hatfield is classified as:

- Current Quantitative Quality: Poor
- 2015 Predicted Quantitative Quality: Poor
- Current Chemical Quality: Poor
- 2015 Predicted Chemical Quality: Poor

6.68 Further details are included within the Water Framework Directive Compliance Assessment, included within Appendix 6/6.

## Hydrology

### *Catchment Overview*

6.69 The application site and surrounding area are shown on Drawing HQ 6/4 and 6/5. The general topography shows the western boundary of the application site at an elevation of c. 79-78mAOD and the ground falls slightly to the north, east and south with the lowest point at the south eastern corner next to the A1057 at around 74mAOD.

6.70 However, demolition of the former aerodrome runway which ran south west to north east across the majority of the central part of the application site and crossed the eastern site boundary, causes localised high ground associated with this feature up to 83m AOD.

6.71 The application site and immediate area is situated within the headwaters of the River Colne catchment. The River Lea catchment is to the north east and east of the application site.

6.72 The River Colne flows east to west and is approximately 1.8km to the south of the application site at its closest point. The River Lea flows north-west to east and is approximately 3.3km to the north east of the application site at its closest point.

6.73 The nearest watercourse to the application site is the Nast. It originates within the application site close to the north western boundary and is understood to receive surface water over-flows from ponds to the immediate north of the application site, outside of the site boundary. The Nast flows as an open channel in a general south easterly direction through the northern part of the application site.

6.74 There is an unnamed drain which is also ephemeral and originates close to the ponds north of the application site; this is referred to as the Home Covert ditch in this application. When containing water it flows south east along the north eastern boundary of the application site where it merges with the Nast and is then culverted under the eastern part of the application site.

6.75 The Ellenbrook is located to the east of the site and is culverted under the University of Hertfordshire De Havilland Campus. A tributary of the Ellenbrook flows southwards approximately 200m east of the application site that is mostly fed by storm water lagoons associated with the nearby housing. The Ellenbrook and its tributary form a confluence and are culverted under the A1057 roundabout. The Ellenbrook then meanders to the River Colne in a general southwest direction in an open channel once it is clear of the urban area.

6.76 Other water bodies in the area comprise of lagoons from previous mineral workings to the immediate north of the site and a small stream called Boggymead Spring approximately 0.5km to the south west of the application site at its closest point. Boggymead Spring flows south to the River Colne via the Ellenbrook.

## Surface Water Levels

6.77 The Environment Agency website shows no surface water monitoring points within a 2km radius of the application site.

6.78 Surface water monitoring has been undertaken by SLR since August 2013, the locations are shown on Drawing HQ 6/5. Water levels have been taken monthly for the first year followed by quarterly although no flow data have been gathered. Results are summarised in Table 6-10 below and shown in full in Appendix 6/7.

**Table 6-10**
**Surface Water Elevations (August 2013 – October 2015)**

| Monitoring Location | Water Elevation (mAOD) | | | | | |
|---|---|---|---|---|---|---|
| | Count | Dry Visits | Min | Mean | Max | Range (m) |
| SW1 | 18 | 12 | 75.29 | 75.38 | 75.48 | 0.18 |
| SW2 | 18 | 0 | 71.98 | 72.44 | >72.74 | >0.76 |
| SW3 | 18 | 8 | 74.27 | 74.69 | 74.99 | 0.72 |
| SW4 | 18 | 0 | 73.66 | 73.85 | 74.04 | 0.38 |
| SW5 | 18 | 0 | 73.20 | 73.34 | 73.50 | 0.30 |
| SW6 | 18 | 0 | 71.36 | 71.45 | 71.57 | 0.21 |
| SW7A | 18 | 13 | 71.83 | 71.88 | 71.93 | 0.10 |
| SW7B | 18 | 15 | 71.90 | 71.91 | 71.91 | 0.01 |
| SW8 | 18 | 0 | 77.24 | 77.41 | >77.60 | >0.36 |
| SW9 | 18 | 13 | 73.81 | 73.93 | 74.30 | 0.49 |
| SW10 | 9 | 8 | No Datum | | | |

6.79 A review of the data shows the Nast is predominantly dry throughout the monitoring period whilst the surface water management pond for the Ellenbrook Park appears to be providing a small amount of baseflow into Ellenbrook. The greatest ranges of water level fluctuation occur within an onsite pond and the upstream Ellenbrook tributary.

## Surface Water Quality

6.80 The Water Framework Directives River Basin Management Plan indicates that the 2009 ecological status of the Ellenbrook (Waterbody ID GB106039029930) was 'moderate' with a predicted 2015 ecological status as 'moderate'. The watercourse is considered to be at risk. It is noted that the Environment Agency designate only the culverted arm of the Ellenbrook and not the Ellenbrook tributary.

6.81 The chemical quality of the Ellenbrook has not been officially assessed by the Environment Agency; however it is noted that ammonia, phosphate and pH are listed as 'High' whilst dissolved oxygen is listed as 'Bad'.

6.82 The Nast is not assessed in the Water Framework Directives River Basin Management Plan. However it is noted the Environment Agency classify the Nast within the culvert on the application site as a main river and extend this

main river up the Home Covert ditch. The two Ellenbrook sources are not considered to be main rivers prior to the A1057 roundabout.

6.83 Surface water monitoring data for the period August 2013 to October 2015 are summarised within Table 6-11. Monitoring locations are shown on Drawing HQ 6/5. Results and chemographs for selected determinands are included within Appendix 6/8.

**Table 6-11**
**Surface Water Quality – Key Characteristics and Determinands over Environmental Quality Standards**

| Location | | Ammoniacal Nitrogen (mg) | Chloride (mg/l) | Sodium (mg/l) | Total Alkalinity (mg/l) | Total Iron (mg/l) | Cadmium (ug/l) |
|---|---|---|---|---|---|---|---|
| Freshwater EQS/DWS | | 0.39 | 250 | 200 | - | 0.2 | 0.25 |
| SW1 – Upstream Nast | Count | 2 | 2 | 2 | 2 | 2 | 2 |
| | Min | 0.33 | 12 | 9 | 230 | 0.12 | <0.03 |
| | Mean | **1.42** | 15.5 | 10.5 | 245 | **1.26** | - |
| | Max | **2.5** | 19 | 12 | 260 | **2.4** | 0.19 |
| SW2 – Pond onsite | Count | 4 | 4 | 3 | 3 | 3 | 4 |
| | Min | 0.033 | 6.2 | 3.5 | 110 | 0.073 | <0.03 |
| | Mean | 0.086 | 8.18 | 5.7 | 130 | **0.23** | - |
| | Max | 0.16 | 11 | 8.7 | 150 | **0.34** | 0.15 |
| SW3 – Upstream Ellenbrook | Count | 3 | 3 | 3 | 3 | 3 | 3 |
| | Min | 0.049 | 24 | 16 | 140 | 0.074 | <0.03 |
| | Mean | 0.059 | 38.3 | 22 | 193 | 0.15 | - |
| | Max | 0.07 | 62 | 34 | 230 | **0.28** | 0.14 |
| SW4 – SUDs Pond offsite | Count | 4 | 4 | 3 | 3 | 4 | 4 |
| | Min | 0.11 | 34 | 29 | 87 | 0.023 | <0.03 |
| | Mean | 0.29 | 57.5 | 35.3 | 87.7 | 0.1 | - |
| | Max | 0.37 | 96 | 43 | 89 | 0.15 | <0.03 |
| SW5 – Midstream Ellenbrook Tributary | Count | 3 | 4 | 3 | 3 | 3 | 3 |
| | Min | 0.076 | 26 | 27 | 89 | 0.12 | <0.03 |
| | Mean | 0.23 | 34.5 | 30 | 102.7 | **0.37** | - |
| | Max | 0.31 | 40 | 32 | 120 | **0.68** | <0.03 |
| SW6 – Downstream Ellenbrook Tributary | Count | 3 | 4 | 3 | 3 | 3 | 3 |
| | Min | 0.069 | 27 | 20 | 82 | 0.11 | <0.03 |
| | Mean | 0.15 | 34.8 | 26.3 | 113 | **0.31** | - |
| | Max | 0.23 | 41 | 30 | 170 | **0.7** | <0.03 |
| SW7A – Pipe Outfall into ditch next to A1057 | Count | 1 | 1 | 1 | 1 | 1 | 1 |
| | Max | 0.19 | 17 | 11 | 180 | **0.7** | <0.03 |

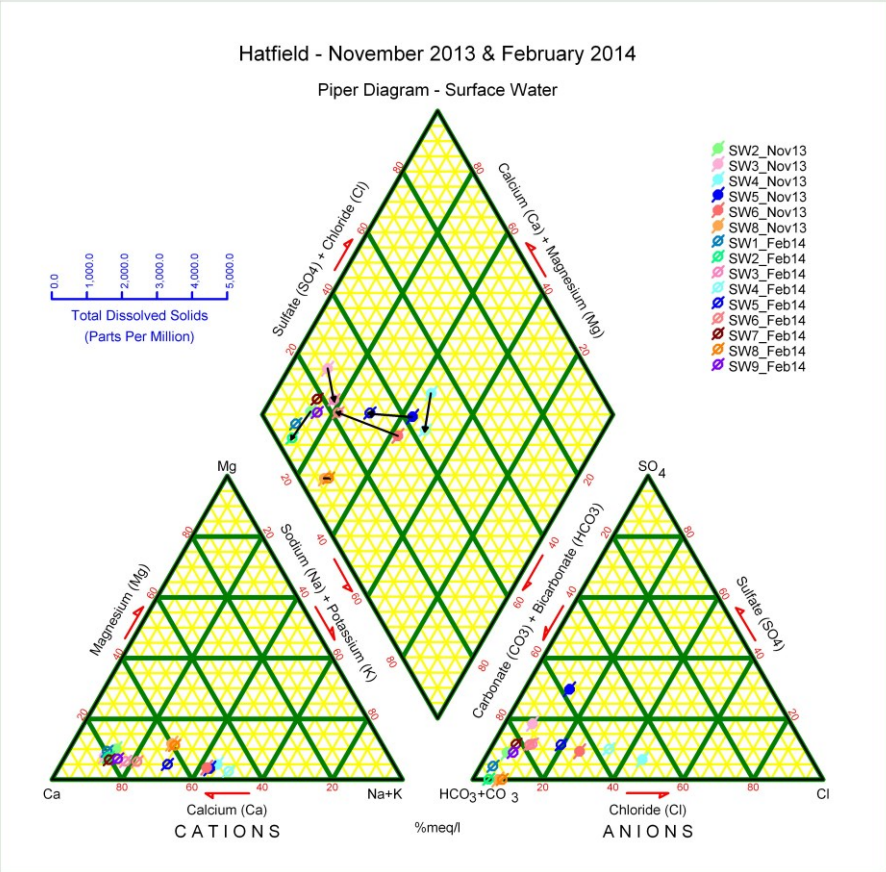
| Location | | Ammoniacal Nitrogen (mg) | Chloride (mg/l) | Sodium (mg/l) | Total Alkalinity (mg/l) | Total Iron (mg/l) | Cadmium (ug/l) |
|---|---|---|---|---|---|---|---|
| SW8 – Pond offsite | Count | 4 | 4 | 3 | 3 | 3 | 4 |
| | Min | **1.16** | 8.9 | 4.7 | 66 | **0.41** | <0.03 |
| | Mean | **3.07** | 9.4 | 5 | 83.3 | **0.48** | - |
| | Max | **4.3** | 9.6 | 5.4 | 97 | **0.55** | <0.5 |
| SW9 – Midstream Nast | Count | 1 | 1 | 1 | 1 | 1 | 1 |
| | Max | 0.21 | 17 | 11 | 170 | 0.071 | <0.03 |

*Notes:* *Environmental Quality Standards (EQS)*
*UK Drinking Water Standards (DWS)*
*Figures in bold exceed relevant standards.*
*SW7B and SW10 were dry during sampling events.*

6.84 A review of the data shows that:

- ammoniacal nitrogen concentrations that are elevated above the relevant UK Drinking Water Standards (DWS) of 0.39mg/l are recorded in the upstream Nast (SW1 – maximum 2.5mg/l) and an offsite pond (SW8 – maximum 4.3mg/l);
- total iron is elevated above the UK DWS of 0.2mg/l at most monitoring locations both up and downstream with the highest concentrations seen in the upstream Nast (SW1) with a maximum concentration of 2.4mg/l;
- cadmium has been detected at trace amounts below the relevant EQS in the upstream Nast (SW1), a pond onsite (SW2) and upstream Ellenbrook (SW3); and
- arsenic has also been detected at trace amounts below the relevant EQS in the majority of monitoring locations including both upstream and downstream Nast and Ellenbrook.

**Figure 6-1**
**Piper Diagram of Surface Water Quality in and around Hatfield Aerodrome**




6.85 The surface water quality monitoring data to date indicate that the overall quality of watercourses around the application site is good, with most locations recording a calcium-bicarbonate type water typical of chalk areas, as demonstrated in Figure 6-1.

6.86 The piper diagram demonstrates that SW4 and to some extent SW5 indicate a different hydrochemistry and are recorded as sodium-chloride to calcium-bicarbonate water type. SW4 is the surface water management pond for the nearby housing estate and receives water from this area, it feeds into the Ellenbrook and SW5 is located downstream of this on the Ellenbrook.

6.87 Despite the above the majority of the water quality results are comparable upstream and downstream, although it is noted the water quality in the ponds varies slightly from the watercourses.

6.88 The Groundsure report lists one active licensed discharge within 1km of the application site boundary the details of which are in Table 6-12.

**Table 6-12**
**Licensed Discharges within a 1km radius of the application site**

| Drawing ID | Consent Number | Location | Grid Reference | Purpose | Distance from Site (m) |
|---|---|---|---|---|---|
| D1 | CTWC.3104 | Beech Farm, Coopers Green | 519030 208920 | Sewage Discharges – Final/Treated | 433 NW |

## *Flood Risk*

6.89 All potential sources of flooding to the application site have been considered and assessed in detail within the FRA provided in Appendix 6/9.

6.90 The primary flood risk associated with the proposed development is from fluvial flooding, from the Nast, and overland flow, conveyed from the slightly higher ground adjacent to the north and east of the Site.

6.91 However, no works are proposed within the area shown to be at risk of fluvial flooding. The proposed works are therefore considered to lie in Flood Zone 1. Moreover, based upon the low vulnerability of the proposed development land uses, any localised and shallow ponding of surface water towards the fringes of the application site poses minimal impact upon the function of the application site.

6.92 A summary of the potential sources of flooding and a review of the potential risk posed by each source at the Site is presented in Table 6-13 below.

**Table 6-13**
**Potential Sources of Flood Risk**

| Potential Source | Potential Flood Risk at the Site | Reason |
|---|---|---|
| Fluvial flooding | Yes | Application site located partly in within Flood Zone 2. |
| Tidal flooding | No | Inland location. |
| Overland flow flooding | Yes | Potential higher ground adjacent to the west and north west of the application site |
| Flooding from rising / high groundwater | No | Elevated terrain and lack of historic evidence suggest that groundwater emergence poses no flood risk to the Site. |
| Flooding from artificial drainage systems | No | Floodwater from surcharging sewers in the vicinity of the application site is likely to follow the general topography and drain towards the Ellenbrook. Therefore, flows would not accumulate to a sufficient depth to give rise to a flood risk. |

| Potential Source | Potential Flood Risk at the Site | Reason |
|---|---|---|
| Flooding due to infrastructure failure | No | The Site is not reliant upon any flood defence infrastructure; therefore, no flood risk is posed by failure of infrastructure. Moreover, EA mapping confirms that the Site is not located in an area identified at risk of flooding from a reservoir. |

## Designated Ecological Site

6.93 Details of the ecology of the site and including the location of sites designated for their ecological value (SSSI's, SPA's etc.) are given in the ecology chapter of the ES (Chapter 11). There are five water dependant designated ecological sites within 2km of the site; one Local Nature Reserve and four Local Wildlife Sites. A summary of the sites is given in Table 6-15.

**Table 6-14**
**Water Dependant Ecological Sites**

| Reference | National Grid Ref. | Name | Direction and Distance from Site Boundary (km) | Description of Water Dependant Habitat |
|---|---|---|---|---|
| 68/040 | TL 176 096 | Jersey Farm Estate Houses Lane | 1.6 NW | Pond |
| 68/015 | TL 185 081 | Oaklands Gravel Pit | 0.7 SW | Flooded gravel pit with wetland |
| 68/003 | TL 193 068 | Smallford Pit | 0.6 S | Seasonal wet hollows |
| 69/003 | TL 202 064 | Sleapshyde Gravel Pit | 1.1 S | Open water and wet neutral grassland |
| 69/001 | TL 201 058 | Colney Heath* | 1.8 S | Marshy grassland |

Note: * Also designated as Local Nature Reserve.

6.94 In addition to these sites an ecological survey undertaken as part of the baseline assessment has identified five ponds (P1, P3, P5, P6 and P9) that support a great crested newt population, four of which are within the application site boundary. Further details and plans showing the locations of ecological features can be found in the ecology chapter of the ES.

## PROPOSED DEVELOPMENT

6.95 The proposed development is described in detail in Chapter 3 of this volume and summarised below:

- building of processing plant and excavation/construction of infiltration lagoons;
- excavation of mineral from 7 phases;
- infilling of inert materials; and
- restoration to recreational/conservation land.

6.96 The proposals would involve the winning and working of some 8Mt of sand and gravel over a period of around 30 years (based on an annual output of around 250,000tpa). In parallel with the extraction of minerals would be the importation of low permeability inert material to infill the mineral workings to facilitate the restoration of the site. The imported material would typically comprise excavation wastes from construction and engineering projects (soils, overburden, clays etc.) within the region.

6.97 Phasing and restoration drawings (including cross sections) are shown on Drawings HQ 3/6 to 3/12. The quarry would be worked on a phased basis to allow for progressive restoration. Sand and gravel would be worked from the two discrete horizons described above. The UMH is overlain by a clayey material (referred to as *'overburden'),* above which is the soil horizon. The two mineral horizons are separated by a laterally continuous layer of boulder clay (referred to as '*interburden'*): the overburden and interburden would be used to control groundwater ingress and to infill the base of the workings to provide a suitable low permeability geological barrier on which the imported material would be placed.

6.98 Two infiltration lagoons would be constructed; one into the UMH and a second into the LMH. These would be used to manage the dewatering discharge during the operation of the application site. Groundwater from the LMH would be discharged only to the LMH lagoon. UMH groundwater would predominantly be discharged to the UMH lagoon, but the LMH lagoon may be used if additional capacity is required.

6.99 The minerals would then be extracted and the phase backfilled using a staged approach. Each phase would be isolated from the UMH by the construction of perimeter bunds before the UMH is worked. This would involve local dewatering of the UMH to allow the bund to be constructed in a dry excavation. A back-drain would be installed behind the bund to reduce the maximum historically recorded groundwater level by 1m in order to maintain the stability of the bund prior to restoration.

6.100 When the bund is complete the UMH would be dewatered and worked dry and the interburden would be used as a working platform to wet dig the LMH. Limited de-watering of the LMH would be required in certain phases, only when and where the water level in the LMH is above the base of the interburden. This would allow the interburden to be worked dry.

6.101 Once the minerals have been excavated the phases would be progressively restored. The excavation into the LMH would be backfilled with site derived materials and an engineered geological barrier with a minimum thickness of 1m would be formed from site derived clay and keyed into the remaining overburden/ phase perimeter bunds. The remaining void adjacent to the

interburden and LMH with be restored with imported material typically comprising excavation wastes from construction and engineering projects (soils, overburden, clays etc.) within the region

6.102 Each phase would take approximately 4 years to work and phases would be worked progressively, moving east to west (see Drawing HQ 3/1).

6.103 Details of the restored landform are shown on Drawing HQ 3/11. Restoration would include the sealing of the LMH infiltration lagoon with low permeability backfill and enlargement of the UMH infiltration lagoon to help manage water from the restored phase of the site. It is proposed to retain the back-drain to phases E and G as a 500mm deep open channel to intercept groundwater levels exceeding that monitored in February 2014 and extended as shown on Drawing No. HQ 3/10. This drain would discharge to swales on site and then to the recharge lagoons in the UMH. This would prevent groundwater levels from rising above historical levels.

6.104 The working of the site would involve the management of groundwater and surface water. Estimates of the volumes that would need to be managed and the capacity of the recharge lagoons are presented in Appendix 6/10 and summarised in Table 6-15.

**Table 6-15**
**Likely Potential Volumes of Water to be Managed**

| Source of Water | Likely Potential Volume ($m^3$/day) | Discharge Location |
|---|---|---|
| Dewater for bund construction | 59 – 299 | UMH Lagoon (LMH if required) |
| Backflow Drain | 28 – 133 | UMH Lagoon (LMH if required) |
| Groundwater and rainfall within each phase | 125 -147 | UMH Lagoon (LMH if required) |
| LMH groundwater if above interburden base | 155 – 811 | LMH Lagoon |
| Back-drain discharge from restored site | 134 – 269 | UMH Lagoon |

## ASSESSMENT OF POTENTIAL IMPACTS

6.105 This sub-section identifies the potential impacts of the proposed development on the hydrogeological and hydrological environments prior to mitigation. It also assesses the likelihood of occurrence of each identified impact. The results of this assessment are summarised in Table 6-16. It should be noted that the significance of the impact has been assessed as described in Table 6-2.

6.106 The proposed design and operation of the application site would incorporate measures to mitigate potential impacts on the water environment. These measures are not included in the initial assessment of impacts so that they can be explicitly stated in the mitigation section of this chapter of the ES.

6.107 In this assessment the sensitivity of the potential receptors is designated as follows:

- UMH Groundwater – **Medium** sensitivity as it is of local to regional importance only.
- LMH and Chalk Groundwater – **High** sensitivity as it is of national importance for water supply.
- Surface Water (Nast and Ellenbrook) – **Medium** sensitivity as it is of local to regional importance only, is frequently culverted and is urban in character.

## Groundwater

### *Groundwater Quality*

6.108 During construction, operation and restoration of the proposed mineral extraction work there is the potential for adverse impacts on the groundwater quality within the UMH and LMH/Chalk aquifers, unless mitigation measures are adopted.

6.109 Construction and operation carries the risk of impact to groundwater quality via direct emission into one or both aquifers from accidental spillage of raw materials, uncontrolled surface water run-off entering the active phase, fuels and lubricants from the vehicles moving around the application site. The magnitude of the potential impact is considered to be '**moderate**' for both the UMH and LMH/Chalk and therefore the significance of potential effect would be '**moderate**' for both aquifers.

6.110 There is a potential for the groundwater of the UMH and the LMH/Chalk aquifers to mix during construction. The groundwater quality of the UMH beneath the site is typically better than the LMH/Chalk. In addition, the LMH/Chalk to the north east of the site is impacted by bromate. Therefore the magnitude of the impact for the UMH groundwater to enter the LMH/Chalk aquifer is considered to be '**minor**'. This gives a potential effect of '**minor**' significance. The magnitude of impact of the LMH/Chalk groundwater entering the UMH aquifer is considered to be '**very high**' due to the risk of bromate contamination (although the risk of occurrence is considered to be low) therefore the potential effect would be of '**moderate**' significance.

6.111 There would be some limited dewatering of the LMH/Chalk aquifer to allow the interburden to be excavated. This dewatering has the potential to intercept bromate contaminated water from the plume to the north east of the excavation. The magnitude of this potential impact is considered to be '**major**' and therefore the potential effect of the impact would be of '**major**' significance.

6.112 The application site would be restored with imported inert wastes. Although inert waste should not produce a leachate it is recognised that percolating water could be affected, which if leakage occurs could impair groundwater quality. The potential magnitude of any impact is considered to be '**moderate'** and hence the significance of any effect on groundwater quality in the UMH and LMH/Chalk is rated as '**moderate**'.

### *Groundwater Levels and Flow*

6.113 During construction and operation of the site there is the potential to impact on the groundwater levels and flow direction within the UMH and LMH/Chalk.

6.114 Construction and operational phases of the development would require temporary dewatering of the UMH and also limited dewatering of the LMH/ Chalk at various stages and times of the year, including:

- construction of the recharge lagoons;
- installation of phase perimeter bunds in the UMH;
- installation of back-drain to reduce maximum water levels behind the bund;
- dewatering of the UMH so it can be worked dry; and
- limited dewatering of the LMH to facilitate the excavation of the interburden.

6.115 The impact of dewatering activities on water resources in the UMH and LMH/Chalk is considered to be '**moderate**' and therefore the significance of the effect is **'moderate'** for both aquifers.

6.116 During operation the UMH perimeter bunds would create a barrier to groundwater flow within the UMH that could cause groundwater levels to rise and locally alter the flow direction. During certain seasons, groundwater within the UMH is close to the ground surface and the barrier effect could result in local groundwater flooding. The magnitude of the impact of increased water levels in the UMH is considered to be '**moderate**' giving a significance of effect of '**moderate**' so mitigation would be required.

6.117 After the removal of the mineral from the LMH the void would be backfilled with onsite material from the overburden and interburden. This is likely to be of a lower hydraulic conductivity than the mineral and could locally alter groundwater levels and flow directions in the LMH. Given that at least 1m of unworked LMH would be left in place and the underlying Chalk is in hydraulic connection with the Chalk aquifer, the impact on water levels and flow directions in the LMH/ Chalk would be negligible and the overall significance of any effect is also '**negligible'**.

## Surface Water

### *Surface Water Quality*

6.118 Without the incorporation of mitigation measures the proposed mineral extraction works, including processing plant, and restoration works have the potential to impact on the quality of surface water from the following potential runoff sources:

- accidental spillage of raw materials, fuels and lubricants, from the processing plant and from the vehicles moving around the application site, including the accidental spillage of potentially polluting liquids;
- increase in suspended solids;

- the change in land use may result in contaminated runoff from the weighbridges and vehicle movement areas; and
- contaminated runoff from the management and handling of waste materials.

6.119 During the construction and operational phases of the development, in the short term, hydrocarbon pollution from untreated runoff associated with roads and car parking areas could cause issues for surface water quality without suitable mitigation. Accidental spillage of raw materials, fuels, other liquids and runoff from the operation of the processing/recycling facility has the potential to cause pollution of surface water. The magnitude of impact is considered to be '**moderate**' due to ground disturbance associated with construction or hydrocarbon pollution from vehicles over a relatively short timeframe. The potential effect significance is therefore considered to be '**moderate**' and further mitigation is required.

6.120 There is potential for surface water to entrain suspended solids during construction and landscaping activities associated with the restoration scheme owing to surface runoff from working areas and soil stockpiles. The magnitude of impact is '**moderate**' during the short and the potential significance of the effect is therefore considered to be '**moderate**'.

## *Surface Water Flow Regime*

6.121 The restoration scheme would involve the infilling of the mineral void with inert materials (being clayey in nature) and covering with restoration soils, thereby potentially increasing the rate and volume of surface water as a consequence of the proposed development.

6.122 In the absence of mitigation, the magnitude of impact due to a potential change in the flow regime and potential increase in flood risk, both within and outside the application site boundary, is considered to be '**major**'. This assessment reflects the area of the application site occupied by the capped waste. The potential effects are considered to be '**moderate**' and further mitigation is required.

6.123 The Nast would be diverted along the northern perimeter of the working areas to enable construction of the proposed processing plant. It is proposed that flow in the Nast would discharge into the proposed back-drain during the operational phase. As the diverted reach is relative short, flow conveyed along the Nast is expected to be low and the magnitude of impact is considered '**negligible**' resulting in an overall significance of '**negligible**'.

6.124 Table 6-15 presents a summary of potential impacts associated with the proposed development and identifies where mitigation measures are required to reduce potential impacts to acceptable levels.

## Ecological Sites

6.125 The nearest water dependent designated ecological sites are between 0.7 and 1.8km from the site boundary and, given the limited dewatering proposed in the UMH (see details below) they are unlikely to be significantly affected by the proposals. There are ponds within and close to the development site which are undesignated but support a population of great crested newts. These are ephemeral ponds that dry in the summer period when water levels in the UMH fall. However, pumping from the UMH will only take place in the summer months on a limited scale to allow the installation of clay bunds and any water pumped will be recharged back into the aquifer. The clay bunds would prevent the drawdown of groundwater levels outside of the extraction area during the excavation of sands and gravels from the UMH. Given the above it is considered that the magnitude of impact on water dependant ecological features would be '**minor**' resulting in an overall '**minor**' significance.

**Table 6-16**
**Summary of Unmitigated Potential Impacts**

| Potential Impact | Spatial and Temporal Impact | Magnitude of Impact | Sensitivity of Receptor | Potential Effect | Mitigation Required? |
|---|---|---|---|---|---|
| **Groundwater Quality** | | | | | |
| **UMH Aquifer** | | | | | |
| Spillage of pollutants, oils, fuels etc. and uncontrolled surface water | Local, Short Term (Adverse) | Moderate | Medium | Moderate | Yes |
| Mixing of LMH/Chalk groundwater and UMH groundwater | Local, Short Term (Adverse) | Major | Medium | Moderate | Yes |
| Potential contamination from restoration landfill | Local, Long Term (Adverse) | Moderate | Medium | Moderate | Yes |
| **LMH/Chalk Aquifer** | | | | | |
| Spillage of pollutants, oils, fuels etc. | Local, Short Term (Adverse) | Moderate | High | Moderate | Yes |
| Mixing of UMH groundwater with LMH/Chalk groundwater | Local, Short Term (Adverse) | Minor | High | Minor | No |
| Interception of bromate contaminated groundwater | Regional, Short Term (Adverse) | Major | High | Major | Yes |
| Potential | Regional, | Moderate | High | Moderate | Yes |

| Potential Impact | Spatial and Temporal Impact | Magnitude of Impact | Sensitivity of Receptor | Potential Effect | Mitigation Required? |
|---|---|---|---|---|---|
| contamination from restoration landfill | Long Term (Adverse) | | | | |
| **Groundwater Levels and Flow** | | | | | |
| **UMH Aquifer** | | | | | |
| Dewatering reduce groundwater levels and change flows | Local, Short Term (Adverse) | Moderate | Medium | Moderate | Yes |
| Barrier to groundwater | Local, Short Term (Adverse) | Moderate | Medium | Moderate | Yes |
| **LMH/Chalk Aquifer** | | | | | |
| Dewatering reduce groundwater levels and change flows | Local, Short Term (Adverse) | Moderate | High | Moderate | Yes |
| Barrier to groundwater | Local, Long Term (Adverse) | Negligible | High | Negligible | No |
| **Surface Water Quality** | | | | | |
| Contaminated runoff entering surface waters during construction phase | Regional, Short Term (Adverse) | Moderate | Medium | Moderate | Yes |
| Suspended solids entering surface water | Regional, Short and Long Term (Adverse) | Moderate | Medium | Moderate | Yes |
| **Surface Water Flow Regime** | | | | | |
| Flooding from increased runoff | Local, Short, and Long Term (Adverse) | Major | Medium | Moderate | Yes |
| Diversion of the Nast | Local, Short, and Long Term (Adverse) | Negligible | Medium | Negligible | No |
| **Water Dependant Ecological Sites** | | | | | |
| Reduction in water levels | Local, Short, Term (Adverse) | Minor | Medium | Minor | No |

## PROPOSED MITIGATION MEASURES

6.126 Mitigation measures to address potential impacts detailed in Table 6-15 are described below. These measures either reduce the likelihood of an event occurring, or reduce the magnitude of the consequences if the event does occur. The reduction in likelihood is reflected in the overall rating of significance. It should be noted that several of the mitigation measures proposed below would have a positive effect on more than one potential impact.

6.127 A number of operational mitigation measures and best available techniques have been incorporated into the scheme design, which would reduce the potential risks identified to ground and surface water.

## Groundwater and Surface Water Quality

### *Spillages and Contaminated Runoff*

6.128 The operation and restoration of the quarry would be undertaken using current technical guidance, relevant Pollution Prevention Guidelines, other codes of best practice and consents, to limit the potential for contamination of both ground and surface waters.

6.129 Best practice techniques would be incorporated within the management procedures for construction and operation activities onsite in order to protect the water environment from pollution incidents. The mitigation measures can be summarised as follows:

- during construction there would be heavy plant and machinery required on site and as a result it is appropriate to adopt best working practices and measures to protect the water environment, including those set out in the Environment Agency's Pollution Prevention Guidance (PPG1);
- in accordance with PPG2 all above ground on-site fuel and chemical storage would be bunded;
- an emergency spill response kit would be maintained on site;
- a vehicle management system / road markings would be put in place wherever possible to reduce the potential conflicts between vehicles and thereby reduce the risk of collision;
- a speed limit would be imposed on site to reduce the likelihood and significance of any collisions;
- the proposed restoration scheme would also be subject to an Environmental Permit, the application for which would include appropriate measures to avoid unacceptable impact on the environment including water;
- surface water runoff would be contained within the excavation areas and all water would be discharged to a recharge lagoon, this would reduce the risk of suspended solids entering surface waters; and
- a detailed water management plan would be prepared and agreed with the Environment Agency prior to work commencing at the site.

6.130 The above measures would significantly reduce the likelihood of pollutants, including suspended solids, being discharged from the application site, such that the magnitude of impact is reduced to '**minor**' and the potential effect is '**minor**' for both surface and groundwaters.

## *Mixing of Aquifer Waters*

6.131 As the UMH and LMH would be worked concurrently there is a risk that waters from the LMH could enter the UMH impairing its quality. Two separate recharge lagoons would be provided; one for the UMH groundwater and one for the LMH groundwater. LMH groundwater would only be discharged to the LMH recharge lagoon. UMH groundwater may be discharged to both lagoons subject to capacity requirements. Groundwater levels would be controlled in the LMH to ensure they do not rise above the level of the interburden and flow into the UMH. Discharge of LMH groundwater in the LMH lagoon would only be required in certain phases and during high water table conditions.

6.132 The significance of impact would be reduced to '**minor'** by the proposed methods

## *Contamination from Restoration Operations*

6.133 The restoration operations would be operated under an Environmental Permit that would ensure activities do not pollute the water environment. The phases would be lined with a minimum thickness of 1m of clay with a maximum hydraulic conductivity of 1 x $10^{-7}$m/s. A hydrogeological risk assessment[5] has been undertaken as part of the application for an Environmental Permit to demonstrate that essential and technical precautions and requisite surveillance would be undertaken to ensure the installation complies with the Environmental Permitting Regulations 2010. Mitigation would reduce the significance of any effect to '**negligible'.**

## *Interception of Bromate Contaminated Water*

6.134 Groundwater in the LMH/Chalk to the north and east of the site is contaminated with bromate from an historical spill. There is a risk that pumping groundwater from the LMH site would intercept the bromate plume potentially causing the plume to spread. The significance of this potential effect is mitigated to a '**minor**' significance by the following factors, design and operational measures:

- the groundwater in the LMH in the proposed mineral extraction area is not impacted by bromate;
- groundwater pumping would be kept to a minimum and only when required to reduce water levels to the base of the interburden.

[5] SLR (October 2015) Hatfield Quarry Inert Landfill Environmental Permit Application Hydrogeological Risk Assessment. Ref. 427-01009-00140/HRA.

- the LMH would then be worked wet with no requirement for groundwater pumping
- the direction of migration of the plume is parallel to rather than towards the excavation areas. Pumping of LMH groundwater would tend to preferentially induce flow from a hydraulically up gradient location rather than lateral to the excavation, hence groundwater quality should be unimpacted;
- Phases A and B, located between the plume and the site, would be worked first, would not require groundwater lowering;
- Infilling of the LMH in Phase A and B with low permeability material would provide a barrier to flow from the eastern side of the site further reducing any inducement of flow from the bromate plume;
- Pumped groundwater from the LMH and potentially from the UMH would be recharged into the LMH/Chalk via a recharge lagoon located between Phases A and B, and the bromate impacted groundwater located further to the east. This process would create a hydraulic barrier to flow from the plume entering the site; and
- a water management plan would be agreed with the Environment Agency prior to works commencing and this would include a monitoring programme to confirm the mitigation measures described above are effective and to agree contingency actions as necessary.

## Groundwater and Surface Water Flow

### *Groundwater Flow*

6.135 All groundwater pumped from the UMH and LMH/Chalk would be recharged back into the aquifer so that there would be no significant loss of resource. The recharge area is relatively close to the points of abstraction and it is not envisaged that there would be a significant impact on water resources in either aquifer. Estimates have been made of the volumes of water that would be extracted and of the recharge capacity of the two proposed lagoons. These estimates are presented in Appendix 6/10 and they demonstrate that groundwater can be managed at the site. The significance of the effect given this mitigation is reduced to '**minor**'.

6.136 Restoration of the void with imported inert material would make a barrier to groundwater flow within the UMH. A back-drain is therefore included in the design to ensure groundwater levels do not increase above historically high elevations. Groundwater from the back-drain would be discharged to the UMH lagoon reducing the significance of the impact to '**minor**'.

6.137 On completion of the site the back-drain in phases E and G would be maintained as an open channel to manage groundwater levels in the long term. The drain would be modified to be an open channel and would be linked into the surface water swales and ponds ultimately discharging to the recharge lagoon.

### *Surface Water Flooding*

6.138 A flood risk assessment has been prepared and is presented in Appendix 6/9. With reference to Section 3, following extraction works the application site would be infilled to approximately 76.0m AOD with a slope in a general north-easterly direction towards the infiltration lagoon. The infill would potentially increase surface water runoff rates.

6.139 It is therefore proposed that surface water runoff would be discharged offsite using a 2-tier approach. Surface water runoff would be intercepted by a network of lined swales and ponds before discharging to the infiltration lagoon in the east of the site.

6.140 However, if the water level within the infiltration lagoon reaches 74.5m AOD, it is proposed that an overflow arrangement be provided into the Nast at the south east boundary of the application site, albeit attenuated to the 100% AEP greenfield runoff rate of 117.5l/s for the application site (some 85.94ha). This would be achieved through the use of a flow control device (orifice plate, hydrobrake or similar). It should be noted that this would only be in an exceptional event as calculations indicate that the lagoon would have the capacity to recharge the expected volumes.

6.141 The above measures would significantly reduce the likelihood of surface water flooding, such that the magnitude of impact is reduced to '**minor**' and the potential significance of any impact to '**minor**' also.

## RESIDUAL EFFECT

6.142 A summary of the potential impact of the development after consideration of mitigation measures is given in Table 6-17. This demonstrates that the implementation of appropriate preventive measures and mitigation significantly and appropriately limits the identified hazards to surface water and groundwater from the proposed site activities to acceptable levels.

6.143 Overall, it is concluded that, with respect to groundwater and surface water, there would be no significant residual effects of the proposed development after inclusion of the identified mitigation measures.

**Table 6-17**
**Summary of Mitigated Impacts and Residual Effects**

| Potential Impact | Spatial and Temporal Impact | Magnitude of Impact | Significance of Impact | Mitigated Magnitude of Impact | Mitigated Significance of Impact |
|---|---|---|---|---|---|
| | | | *Groundwater Quality* | | |
| Spillage of pollutants, oils, fuels etc, and uncontrolled surface water runoff to UMH | Local, Short Term (Adverse) | Moderate | Moderate | Minor | Minor |
| Mixing of LMH/Chalk groundwater and UMH groundwater | Local, Short Term (Adverse) | Major | Moderate | Minor | Minor |
| Potential contamination of UMH and LMH from landfilling | Local, Long Term (Adverse) | Moderate | Moderate | Negligible | Negligible |
| Interception of bromate contaminated water | Regional, Short Term (Adverse) | Major | Major | Minor | Minor |
| Spillage of pollutants, oils, fuels etc., and uncontrolled surface water runoff to LMH/ Chalk | Local, Short Term (Adverse) | Moderate | Moderate | Minor | Minor |
| | | | | | |
| | | | *Groundwater Levels and Flow* | | |
| Dewatering reduce groundwater levels and change flows in UMH and LMH | Local, Short Term (Adverse) | Moderate | Moderate | Minor | Minor |
| Barrier to groundwater in UMH | Local, Short Term (Adverse) | Moderate | Moderate | Minor | Minor |
| | | | | | |

| Potential Impact | Spatial and Temporal Impact | Magnitude of Impact | Significance of Impact | Mitigated Magnitude of Impact | Mitigated Significance of Impact |
|---|---|---|---|---|---|
| *Surface Water Quality and Flow* | | | | | |
| Contaminated runoff entering surface waters during construction phase | Regional, Short Term (Adverse) | Moderate | Moderate | Minor | Minor |
| Suspended solids entering surface water | Regional, Short Term (Adverse) | Moderate | Moderate | Minor | Minor |
| Flooding from increased runoff | Local, Short and Long Term | Major | Moderate | Minor | Minor |

## CONCLUSIONS

6.144 The groundwater and surface water regimes at the application site have been assessed with reference to information held by the BGS, the Environment Agency, Local Authority and others, and by the consideration of site specific investigations and reports for the application site.

6.145 The potential impacts of the proposed development upon the hydrogeological and hydrological environments have been identified and assessed, and where appropriate, mitigation measures have been accommodated into the design of the proposed development.

6.146 The operation and restoration of the application site would be undertaken using current technical guidance, relevant Pollution Prevention Guidelines, other codes of best practice and consents, to limit the potential for contamination of both ground and surface waters. Best practice techniques would be incorporated within the management procedures for construction and operation activities onsite in order to protect the water environment from pollution incidents.

6.147 Groundwater encountered during the works would be disposed of back into the aquifer via two recharge lagoons. Two separate recharge lagoons would be provided; one for the UMH groundwater and one for the LMH groundwater in order to prevent the mixing of waters from different aquifers.

6.148 A hydrogeological risk assessment has been completed to assess the proposed restoration of the site with imported inert wastes[5]. The risk assessment has confirmed that the proposed development of the quarry (and in particular the backfilling of the void) would not have a significant effect on the water environment. No additional mitigation measures are therefore required over and above the technical precautions that are proposed for the construction and management of the site.

6.149 Groundwater in the LMH/Chalk to the north and east of the site is contaminated with bromate from an historical spill. There is a risk that pumping groundwater from the LMH site would intercept the bromate plume potentially causing the plume to spread. Measures are incorporated into the design and operation of the site so that this risk would not be significant.

6.150 All groundwater pumped from the UMH and LMH/Chalk would be recharged back into the aquifer so that there would be no significant loss of resource. The recharge area is relatively close to the points of abstraction and it is not envisaged that there would be a significant impact on water resources in either aquifer.

6.151 There is a risk that the development could cause groundwater levels to rise as the restoration of the void with imported inert material would make a barrier to groundwater flow. A drain is therefore included in the design to ensure groundwater levels do not increase above historically high elevations, both during the operational and restored phases of the site.

6.152 A flood risk assessment has been prepared to assess the risk that the development itself would be affected by flooding or would exacerbate flood risk elsewhere. Mitigation measures are presented to ensure flood risk is not significantly increased. This includes the recharge of water encountered during the development, both during the operational and the restored phases, back into the aquifer to minimise off-site disposal.

6.153 A Water Framework Directive compliance assessment has been undertaken and is included as an appendix to the ES. This concludes that the proposals would not have a significant impact on the objectives of the WFD.

6.154 Overall, it is concluded that, with respect to groundwater and surface water, there would be no significant residual effects of the proposed development after inclusion of the identified mitigation measures.