Homes England

West of Ifield Development Groundwater Initial Feasibility and Hydrogeological Risk Assessment

April 2024

Report for

Homes England

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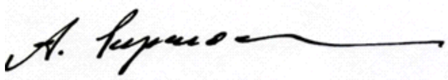

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Document revisions

No.	Details	Date
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Executive summary

Purpose of this report

Homes England is promoting a strategic development of 3,000 homes plus employment area to the West of Ifield, near Crawley in West Sussex. The site is located entirely within the Sussex North Water Resource Zone (SNWRZ) and to satisfy Natural England's position statement on water neutrality, the Proposed Development must demonstrate that water neutrality will be achieved. The evolving water neutrality strategy[1] has identified that it may be possible for water supply requirements to be provided from groundwater using a borehole, or boreholes, capable of sustaining an uninterrupted (i.e., through dry summer periods) supply of approximately 500 m^3/day. The site is underlain by the Weald Clay Formation (WCF) which overlies the Tunbridge Wells Sand Formation (TWSF), the upper part of which is the Upper Tunbridge Wells Sand Member (UTWSM). The WCF is unlikely to provide sufficient yield and therefore the UTWSM is the likely target aquifer from which abstraction would take place.

This report has been produced as a Phase 1 desk study for the purpose of providing an initial assessment of the feasibility of, and potential impacts from, the development of a groundwater supply through a hydrogeological risk assessment. The assessment investigates whether a borehole will likely be able to supply the required volume of water in perpetuity for the development and its likely impacts and will support the Environmental Impact Assessment (EIA) for the housing development. The work has involved the collection of baseline data, including engagement with the Environment Agency (EA) and the Local Authorities (LAs). A 5 km buffer around the Proposed Development site boundary has been used for data searches. It is assumed that all information provided to WSP through data requests in connection with the preparation of this report are accurate and complete at the time of the request. A hydrogeological conceptual model for the area of the proposed drilling location/s has been developed. Potential receptors that may be adversely impacted by any borehole water supply have been identified and a risk assessment undertaken. The list of potential receptors will form the basis of any future water features survey undertaken for the project. As a result of the feasibility study and risk assessment recommendations for further investigation/ work are made.

Conclusions

The feasibility study based on currently available data indicates that a borehole within the UTWSM at depth of approximately 200 m below the Proposed Development site has the potential to supply the required yield of 500 m^3/d at least initially. However, the sustainability of any supply is uncertain, i.e., it may not be possible to maintain the initial yield in the long term. There is also uncertainty regarding the quality of groundwater, although it is likely to require treatment to reduce the fluoride and boron levels to below the required standard. Also elevated sodium and alkalinity may impose noticeable aesthetic (taste, odour, feel) character to the water that affect water wholesomeness and therefore may also require treatment before domestic use. Other determinands will have to be tested during testing to confirm that they meet the Drinking Water Standards (DWS).

The preliminary hydrogeological feasibility study has, therefore, identified significant uncertainties regarding both water quantity and quality which can only be resolved through collection of specific additional on-site data. Further information on yields and water quality beneath the site can only be acquired through the drilling and testing of exploration boreholes and recommendations are made on this basis.

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[1] WSP 10 January 2024 Draft Water Neutrality Strategy

The risk assessment based on the desk study has not identified any significant residual risks to surface water and groundwater resources or quality that may result from the proposed shallow workings/ excavations and the construction, operation or decommissioning of installed abstraction borehole/s at the Proposed Development site. Any monitoring requirements appropriate for the construction and operation phases will be identified in consultation with the EA.

Contents

1. Introduction

1.1 Overview

WSP UK Limited were asked by Homes England to undertake a Phase 1 desk study for the purpose of providing an initial assessment of the feasibility of, and potential impacts from, development of a groundwater supply for a strategic development of 3,000 homes plus employment area to the West of Ifield, near Crawley in West Sussex. The site is located entirely within the Sussex North Water Supply Zone (SNWRZ) and to satisfy Natural England's position statement on water neutrality, the Proposed Development must demonstrate that water neutrality will be achieved. The evolving water neutrality strategy has identified that it may be possible for some of the water supply requirements to be provided from groundwater using a borehole, or boreholes, capable of sustaining an uninterrupted (i.e., through dry summer periods) supply of approximately 500 m^3/day. The site is underlain by the Weald Clay Formation (WCF) which overlies the Tonbridge Wells Sand Formation (TWSF), the upper part of which is the Upper Tonbridge Wells Sand Member (UTWSM) and has aquifer properties that may provide sufficient water for the proposed supply. The WCF is unlikely to provide sufficient yield and therefore the UTWSM is the likely target aquifer from which groundwater abstraction would take place.

This report has been produced for the purpose of providing a preliminary, desk-based hydrogeological assessment (Phase 1) of the feasibility of a new borehole to supply the required volume of potable water in perpetuity at the Proposed Development site. The purpose of the preliminary desk study is to establish if there is groundwater resource availability and information on whether a new abstraction borehole would be practicable. In addition, potential receptors that may be adversely impacted by the development and any borehole water supply have been identified and a hydrogeological risk assessment undertaken that will support the EIA for the housing development. The list of potential receptors will form the basis of any future water features survey undertaken for the project. Following the feasibility study and hydrogeological risk assessment recommendations for further investigation/ work are made. The assessment of water resource availability, likely water quality and the regulatory position will be used to determine whether to recommend progressing to Phase 2 (such as further investigation through the drilling and testing of an investigation borehole).

1.2 Scope

The scope of works is a desk study consisting of the following tasks:

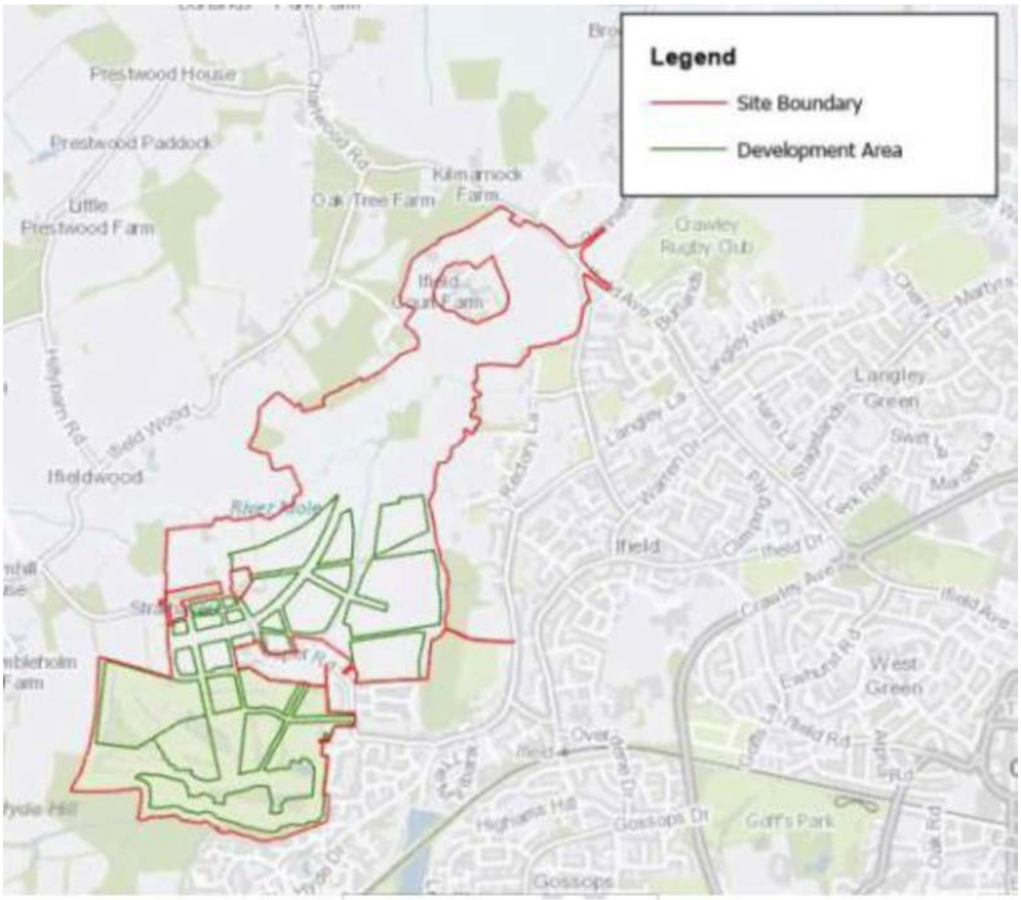
- Data collection using online data sources and data held by the Environment Agency (EA) and Local Authorities;
- Initial engagement with the EA;
- Development of a hydrogeological conceptual model to assess borehole yield and likely water quality;
- Identification of potential receptors that may be adversely impacted by the water supply;
- A water environment hydrogeological risk assessment; and
- Recommendations for further investigation.

The hydrogeological risk assessment covers the development construction works, including proposed borehole installation and future abstraction from the borehole. Any potential environmental impacts from water treatment processes and discharges are considered within the Environmental Impact Assessment (EIA) for the Proposed Development.

1.3 Geographical Scope and Study Area

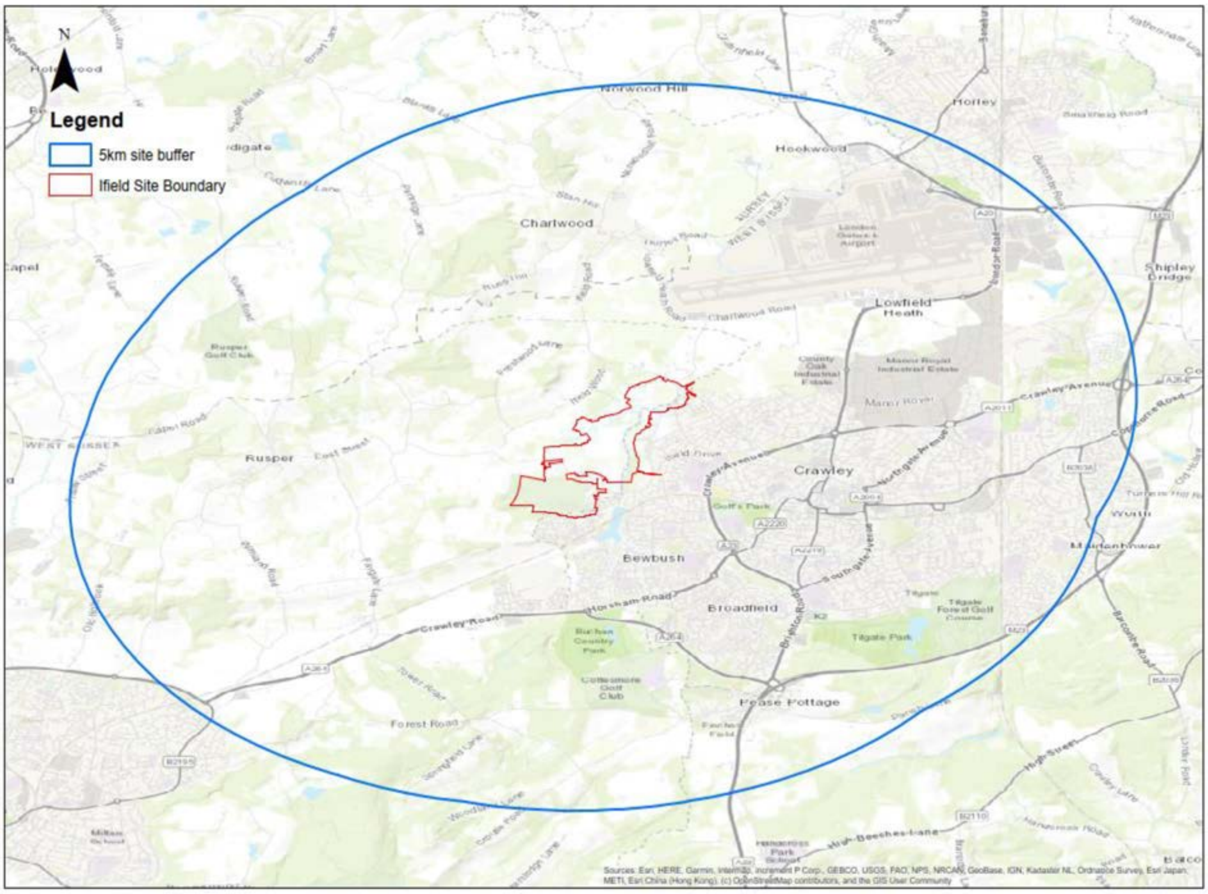
The site is located to the west of Ifield, a suburb of the town of Crawley in West Sussex. The site boundary is shown in **Figure 1-1**. The site is approximately 203 hectares in size and lies to the north of the Horsham-Crawley railway line. The existing residential areas of Ifield and Langley Green, associated with the town of Crawley, are located to the east. Ifield West and woodland are located to the south, with the River Mole and further woodland present to the west. The site is currently occupied by Ifield Court Farm in the north and the Ifield Golf and Country Club to the south.

Figure 1-1 Site Boundary



The study area has been focussed on the proposed site and an area beyond the site. This study area has been defined by a 5 km radius around the site (**Figure 1-2**). The study area comprises a wide area east of Crawley to the M23; to Horley and Norwood Hill in the northeast and north respectively (including Gatwick airport); to the edge of Horsham in the southwest and south of Pease Cottage in the south. The 5 km radius study area surrounding the site was considered to be of sufficient extent to allow the collection of appropriate data for a baseline assessment.

Figure 1-2 Study Area



1.4 Key assumptions/ limitations

Key assumptions and limitations of the for the Phase 1 study include the following:

- A site visit was not required/ not undertaken and all data was collected via desk study;
- The conceptual model presented here will be updated as more information becomes available, such as any future intrusive site investigations; and
- No digital geological modelling or software was used whilst undertaking the risk assessment.

1.5 Data Requests

The EA was sent a freedom of information request on the 17th January 2024 and this was answered within the reply Reference: NR343008[2] on the 20th February 2024 and included information from the EA areas, Kent and South London; and Solent and South Downs.

A freedom of information request was sent to the Crawley Borough Council (CBC); Horsham District Council (HDC), Surrey County Council (SCC); and West Sussex County Council (WSCC) requesting data on surface and groundwater private water supplies (PWSs) within the study area.

[2] E-mail reply to a Freedom of Information request - communication from Simon Guy (National Requests Team) to WSP UK Ltd on the 20th February 2024; Ref NR343008

1.6 Consultation

An initial email to the EA[3] requesting early engagement was sent on the 8th Feb 2024, and a meeting was held on the 11th March 2024 with technical specialists from the EA from the Kent South London and East Sussex division to discuss the proposed abstraction borehole enquiry. No ongoing consultation with other third parties (such as Southern Water) is required at this stage.

1.7 Methodology - Data Collection

The data and other sources of information collected for this assessment are listed in **Table 1.1**.

Table 1.1 Desk study data sources

Type	Data	Source
Topography	Mapping	Ordnance Survey (OS) mapping at 1:50,000 and 1:25,000 scales.
Climate	Rainfall	Meteorological Office (Met Office) Rainfall data, climate averages and locations of stations https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcx57w9fb
Hydrology	Main rivers	EA Statutory Main River Map
	River flows	Centre for Ecology and Hydrology, (2022). National River Flow Archive (NRFA) at https://nrfa.ceh.ac.uk/data/search
	Ponds and lakes	OS mapping at 1:50,000 and 1:25,000 scales.
	Flood risk	EA Flood Map for Planning map, at: https://flood-map-for-planning.service.gov.uk/ EA Flood Risk from Surface Water map, at: https://flood-warning-information.service.gov.uk/long-term-flood-risk/
	Surface water abstractions	Licensed abstraction/discharge data request to EA Private water supply data request to CBC; HDC; SCC; and WSCC.
	Discharges to surface water	Register of Environmental Permits (https://environment.data.gov.uk/public-register/view/search-water-discharge-consents)
	Surface water resource availability	EA Catchment Abstraction Management Strategy (CAMS); Mole Abstraction licensing strategy (ALS) (EA, February 2013)
	Surface water quality	EA River Basin Management Plan (2016 cycle 2) information, via the EA Catchment Data Explorer accessed 24/09/21 at: http://environment.data.gov.uk/catchment-planning/ Water Framework Directive (WFD) water body status assessments.

[3] An e-mail was sent to the EA - Groundwater Support Team at Kent, South London and East Sussex (ksl.gwh@environment-agency.gov.uk).

Type	Data	Source
		DEFRA Data Services surface water quality at the River: EA Water Quality Archive - WIMS data at: https://environment.data.gov.uk/water-quality/view/explore?search=&area=10-38&samplingPointType.group=&samplingPointStatus%5B%5D=open&loc=&_limit=500
Conservation sites	Statutory and non-statutory	Defra MAGIC database, at: http://magic.defra.gov.uk/ Wetland Site of Special Scientific Interest (SSSIs), County Wildlife Sites (CWS) and Local Nature Reserves (LNR).
Heritage	Heritage assets/sites	Defra MAGIC website, at: http://magic.defra.gov.uk/
Land Use	Historical Mapping	National Library of Scotland - Side by side georeferenced maps viewer (https://maps.nls.uk/geo/explore/side-by-side/)
Geology	Bedrock and superficial geology maps	Geological Survey of England and Wales, New Series 1:63 360/1:50 000 geological map series British Geological Surey (BGS) (1990) 1:50,000 Series England and Wales Sheet 302 Horsham (1972) at: https://webapps.bgs.ac.uk/data/MapsPortal/series.html?collection=PMAP&series=E50k BGS Memoirs at: https://webapps.bgs.ac.uk/Memoirs/docs/B01684.html Solid and Drift https://largeimages.bgs.ac.uk/iip/mapsportal.html?id=1001492 Online BGS GeoIndex geology mapping https://www.bgs.ac.uk/map-viewers/geoindex-onshore/ Online BGS Lexicon of Named Rock Units http://www.bgs.ac.uk/lexicon
	Borehole logs	Digital geological and construction logs from the BGS Onshore GeoIndex https://www.bgs.ac.uk/map-viewers/geoindex-onshore/ https://ukogl.org.uk/ - onshore wells
Hydrogeology	Aquifer status	Defra MAGIC website, at: http://magic.defra.gov.uk/ Aquifer properties - literature search on Google/ Google Scholar.
	Source protection zones	Defra MAGIC website, at: http://magic.defra.gov.uk/ and https://environment.data.gov.uk/spatialdata/source-protection-zones-merged/wms
	Groundwater abstractions and discharges	Licensed abstraction data request to EA Private water supply data request to Crawley Borough Council; Surrey County Council; and West Sussex County Council. EA permitted sites, at Public Registers Online (data.gov.uk)
	Springs	OS 1:25,000 scale mapping
	Baseflow	National River Flow Archive, https://nrfa.ceh.ac.uk/
	Groundwater levels and flows	Groundwater level data request to EA

Type	Data	Source
	Groundwater resource availability	EA Mole Abstraction licensing strategy (EA, February 2013[4])
	Groundwater quality	EA River Basin Management Plan (2016 cycle 2) information, via the EA Catchment Data Explorer accessed 24/09/21 at: http://environment.data.gov.uk/catchment-planning/ EA and DEFRA online water quality archive

1.8 Report Structure

In this report this Section contains an overview and scope of the study and important information key assumptions/ limitations, consultation, and the data collection methodology. **Section 2** introduces the water neutrality strategy applied to the project and important groundwater principles in the protection of groundwater. **Section 3** puts forward data to establish a site baseline and **Section 4** uses this data to develop a conceptual hydrogeological site model in terms of source, pathways and receptors. An assessment of potential water supply is given at the end of this section. **Section 5** presents the hydrogeological risk assessment with results and **Section 6** gives conclusions and recommendations.

[4] https://assets.publishing.service.gov.uk/media/5a7c22a140f0b61a825d6ab8/LIT_3097_7b4776.pdf

2. Groundwater Principles

2.1 Overview

An overview of the proposed scheme and water neutrality requirements are given below. The legislative and regulatory framework for the protection of groundwater and groundwater dependent receptors in terms of quantity and quality are discussed. Key guidance used within the report is also given.

2.2 Water Neutrality

The Proposed Development is located within the Sussex North Water Supply Zone (SNWSZ)[5]. Concerns have been raised that additional groundwater abstraction within the SNWSZ may harm biodiversity within internationally designated sites. Water supplied by Southern Water (SW) within the zone is sourced from abstraction points that are hydrologically linked to the Arun Valley, which includes internationally designated sites.

In 2021, Natural England published a position statement[6] advising local authorities, including Horsham District Council (HDC) that any new development to be granted planning permission within the SNWSZ should be water neutral. Consequently, HDC requires that a water neutrality statement is submitted as part of the planning application for any development that would lead to a material increase in water demand.

2.3 Scheme details

The Proposed Development site includes 3000 homes and lies within the boundaries of HDC. The water neutrality strategy ('WNS') prepared by Homes England, lays out options for the Proposed Development to achieve water neutrality, including:

- Implementing water efficient fittings in the residential buildings;
- Considering grey water recycling ('GWR') and rainwater harvesting ('RWH');
- Offsetting water usage against existing developments on the site, i.e. Ifield Court Farm and the Ifield Golf and Country Club;
- The treatment of an alternative water supply[7], such as a groundwater borehole supply; and
- Using the Sussex North Offsetting Water Scheme (SNOWS).

Within the WNS the remaining demand to achieve water neutrality is 391.3 m^3/day which includes the potable requirements for the residential and non-residential parts of the development, plus the two schools. It is proposed within the WNS that this will be offset by abstraction of 293.5 m^3/day of

[5] This is an area that includes parts of the Chichester, Horsham and Arun areas of the South Downs National Park. Most of Crawley borough is situated within the zone except for Maidenbower, Gatwick Airport and land to the north of Manor Royal. Water in the zone includes supplies sourced from abstraction points that drain water from designated nature conservation and protection sites in the Arun Valley. An online Water Neutrality Map is given on the https://www.westsussex.gov.uk/planning/water-neutrality/ site.

[6] Natural England's Position Statement for Applications within the Sussex North Water Supply Zone, September 2021 – Interim Approach (accessed August 2023) (https://www.southdowns.gov.uk/wp-content/uploads/2021/10/NE_Position_statement_Water_Neutrality_Sept.21-Final.pdf)

[7] WSP, January 2024. Proposed Water Treatment for Drinking Water Supply West of Ifield.

groundwater from the UTWSM. To meet drinking water standards[8], the groundwater is likely to require blending with Southern Water potable water at a ratio of 75% groundwater to 25% Southern Water (or rainwater when available). SNOWS credits will be purchased to offset the remaining demand of 97.8 m^3/day, the volume of potable water required from Southern Water for blending purposes. The use of the Southern Water supply will be minimised through the use of rainwater for blending and further assessment of this will be undertaken as the project progresses.

2.4 Protection of Groundwater

The approach to protecting groundwater in England is set out in The EA's Approach to Groundwater Protection (EA, 2018)[9]. The priority is to protect groundwater and water supplies intended for human consumption, as well as to ensure protection of the quality of groundwater that supports ecosystems. This is achieved by preventing hazardous substances and limiting non-hazardous pollutants from entering groundwater and by identifying the sensitivity of groundwater, i.e. within principal and secondary aquifers that can provide significant quantities of drinking water, and their vulnerability.

Sensitive groundwater locations have protection zones applied for areas where pollution on or below the land may present a risk to groundwater. These include drinking water protected areas (DrWPAs) and source protection zones (SPZs). The EA applies a general level of protection for all drinking water sources through the use of SPZs. In addition, private water supplies provide water to homes, businesses, or services, commonly in rural areas, and are regulated by local authorities. All PWSs used for human consumption or food production purposes have an SPZ 1 designation with a default radius of 50m and a default catchment radius area of 250m.

The installation of an abstraction borehole for the Proposed Development may impact groundwater resources through the risk of contamination during construction affecting groundwater quality. Depending on the potential severity of the hazard, the EA may object (through planning or permitting controls) to such activities in certain areas. Where works and infrastructure are close to sensitive receptors, the EA is likely to adopt the precautionary principle as even where the likelihood is not high, the consequences may be serious or irreversible. In addition, the abstraction of groundwater has the potential to reduce the quantity of groundwater to other receptors, such as surface water bodies and water dependent ecological habitats. The EA will require receptors to be identified (a Water Features Survey), suitable testing of any abstraction borehole and the application for licencing if the borehole is brought into production as planned.

Legislative and Regulatory Framework

This section identifies the legislation, policy and other documentation that has informed the study. Further information on policies relevant to the Proposed Development are given in **Chapter 14 - Water and Flood Risk** of the EIA**.** National and local legislation and policy relevant to the protection of groundwater is given in **Table 2-1**.

[8] The WNS suggests that groundwater is likely to have fluoride and boron concentrations that exceed the Drinking Water Standards.

[9] Environment Agency, February 2018. The Environment Agency's approach to groundwater protection Version 1.2 https://assets.publishing.service.gov.uk/media/5ab38864e5274a3dc898e29b/Envirnment-Agency-approach-to-groundwater-protection.pdf

Table 2-1 Relevant Legislation and Policy

Legislation	Relevance to protection of groundwater
<u>National</u>	
The Water Environment Regulations, 2017	This applies to surface waters (including some coastal waters) and groundwater (water below the surface of the ground). These regulations set out requirements to prevent the deterioration of aquatic ecosystems; protect, enhance and restore water bodies to 'good' status; and achieve compliance with standards and objectives for protected areas. Local planning authorities must, in exercising their functions, have regard to River Basin Management Plans. These plans contain the main issues for the water environment and the actions needed to protect them.
Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (the EU WFD)	The requirements of various EU Directives such as the Water Framework Directive (WFD) (2000/60/EC), the European Liability Directive (2004/35/EEC) and the Groundwater Daughter Directive (2006/118/EEC) have been transposed into domestic legislation by the Environment Regulations 2019. Previously the WFD and now the Environment Regulations 2019 and supporting domestic legislation establish a legal framework for the protection, improvement and sustainable use of surface waters, transitional waters, coastal waters and groundwater resources.
National Policy Statement for Water Resources Infrastructure	The section on Water Quality and Resources links directly with EA guidance that explains the legal requirements associated with groundwater activities. In this respect the National Policy Statement for Water Resources Infrastructure requires activities to adhere to the principles of the EA approach to groundwater protection.
Department of Environment, Food and Rural Affairs (Defra) (2023)[10]	In addition, the section on land use including open space, green infrastructure and Green Belt under the Applicant's Assessment states that the *"Risks to the quality and quantity of groundwater resources should …. be assessed".*
Environmental Permitting (England and Wales) Regulations (EPR) 2016	The EPR (2016) is the principal legislation governing the environmental permitting and compliance regime which applies to various activities and industries. The EPR (2016) has specific schedules: 21 and 22, Water discharge activities and Groundwater activities respectively.
Core guidance for the Environmental Permitting (England and Wales) regulations (EPR) 2016 (SI 2016 No 1154) Defra (2020)	This aims to provide comprehensive help for those operating, regulating or interested in 'regulated facilities' covered by the EPR. Such facilities could potentially harm the environment or human health, and EPR requires their operators to obtain a permit or to register some activities, which would otherwise require permits, as 'exempt facilities'. Under EPR it is a criminal offence to "*cause or knowingly permit*" groundwater to become polluted. Penalties include fines, imprisonment or both. Relevant to the Proposed Development and associated works include the following: • Schedule 8 – Part B installations and Part B mobile plant (regulation 8(1)(b)); • Schedule 21 – water discharge activities (regulation 8(1)(f)); and

[10] DEFRA (2023). Draft National Policy Statement for Water Resources Infrastructure [online]. Available at: https://assets.publishing.service.gov.uk/media/6437e3a2f4d420000cd4a1a7/E02879931_National_Policy_Statement_for_Water_Resources.pdf [Accessed 1 February 2024].

Legislation	Relevance to protection of groundwater
	• Schedule 22 – groundwater activities (regulation 8(1)(g))
Water Resources Act 1991	The Water Resources Act 1991 (UK Government (1991)), Water Act 2003 (UK Government, 2003) and Environmental Permitting (England and Wales) Regulations 2016 (UK Government, 2016) are key legislation relevant to the Water Environment. The Water Resources Act 1991 states that it is an offence to cause or knowingly permit polluting, noxious, poisonous or any solid waste matter to enter controlled waters. The Act was revised by the Water Act 2003, which sets out regulatory controls for water abstraction, water impoundment and protection of water resources. Provisions for the regulation of water discharges to controlled waters are set out in the Environmental Permitting (England and Wales) Regulations 2016 and have replaced provisions in the earlier Acts mentioned here. These Acts and Regulations set out the permitting and compliance framework which will regulate all site emissions, water abstractions and discharges with the potential to interact with the water environment. Important to the Proposed Development is the requirement to obtain a licence for dewatering of engineering works and to ensure that any impact on the environment can be mitigated.
Water Framework Directive (2000/60/EC)	The EA may use SPZs as the basis for safeguard zones (SgZs) (European Commission 2007). These are used at sources at risk of groundwater pollution resulting in a deterioration in the quality of water abstracted leading to a likely increase in treatment needed to supply good quality water used for human consumption (EA, 2019). SgZs are established around public water supplies where additional pollution control measures are needed. The Water Framework Directive (2000/60/EC) requires that Drinking Water Protected Areas (DrWPAs) are identified (WFD Article 7.1) and that they are given the necessary protection (WFD Article 7.3) with the aim of avoiding deterioration in their quality, in order to reduce the level of treatment required in the production of drinking water (EA, 2021). The geometry of groundwater SgZs are based on groundwater SPZs, usually SPZ1 and SPZ2, and use additional assessment to identify areas, which may or may not coincide with the SPZ, for example where additional measures are required to ensure that abstraction waters meet Article 7.3 of the WFD (EA, 2021). All groundwater bodies in England are designated as drinking water protected areas. This aims to protect groundwater from over-abstraction and to prevent deterioration in groundwater quality that could increase the treatment of drinking water. DrWPAs are required to be identified under the Water Framework Directive (2000/60/EC) in order to protect groundwater and prevent groundwater pollution (EA, 2017).
Planning Act 2008 (as amended) (PA2008)	Relevant policies with respect to managing and protecting groundwater are detailed further under the sections below.
National Planning Policy Framework (NPPF), 2021[11]	The policy states that "*Plans should take a proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk, …. water supply …*". Also, any development should, help to improve local environmental conditions in terms of water quality, taking into account relevant information such as river basin management plans.

[11] Ministry of Housing, Communities & Local Government, June 2021, National Planning Policy Framework

Legislation	Relevance to protection of groundwater
Planning Practice Guidance (PPG), 2020[12]	Advises on how planning can ensure water quality and the delivery of adequate water infrastructure. Gives guidance on how to help protect and enhance local surface water and groundwater. For example, to prevent potentially polluting development in the most sensitive areas, particularly those in the vicinity of drinking water supplies (designated source protection zones or near surface water drinking water abstractions). To aid an awareness of cross-boundary issues and the application of the river basin management plan to protect catchments.
Local	
Crawley Borough Local Plan 2015 – 2030 December 2015	Policy ENV9 considers tackling water stress. Crawley is situated within an area of serious water stress, and development should, therefore, plan positively to minimise its impact on water resources and promote water efficiency.
The Crawley Borough and Upper Mole Catchment Level 1 SFRA, 2020.	Considers the effect of climate change on groundwater levels for sites in areas where groundwater is known to be an issue should be considered at the planning application stage.
Horsham District Planning Framework (excluding South Downs National Park), November 2015	Policy 24 considers the Strategic Policy: Environmental Protection. This includes the maintenance or improvement the environmental quality of any watercourses, groundwater and drinking water supplies.

In addition to national legislation, SW operates in accordance with a number of key guidance policies. A relevant policy with respect to the development include the following:

- Environment: the company aims to conform to its *"compliance obligations by meeting or exceeding the environmental requirements of legislation, regulation and our adopted standards"*; *"prevent pollution, eliminate serious pollution incidents and contain the environmental impact"* of its activities; and be *"a good and trusted neighbour and be a steward for the environment"* wherever it operates (Southern Water, 2023).

Key Guidance

The EA is the regulator with respect to environmental permitting. It is also a statutory consultee for the purpose of the Planning Act 2008. The EA provides practical guidance on how to assess the hydrogeological impact of groundwater abstractions, for those who are preparing applications to the EA for full abstraction licences, within the *Hydrogeological impact appraisal for groundwater abstractions Science Report* (EA, 2007[13]).

The EA's approach to groundwater protection (EA, 2018) contains position statements which provide information about its approach to managing and protecting groundwater. They detail how the EA delivers government policy for groundwater and adopts a risk-based approach where legislation allows. Many of the approaches set out in the position statements are not statutory but may be referenced in statutory guidance and legislation. The most relevant of these policies with respect to the Proposed Development are summarised below:

[12] Ministry of Housing, Communities & Local Government (Live Document). Planning Practice Guidance [online]. Available at: http://planningguidance.communities.gov.uk/

[13] EA, 2007. Hydrogeological impact appraisal for groundwater abstractions Science Report – SC040020/SR2

B1: Initial screening tools: The EA will use SPZs as an initial screening tool to identify "*areas where it would object in principle to certain potentially polluting activities, or other activities that could damage groundwater*" and/ or areas "*where additional controls or restrictions on activities may be needed to protect water intended for human consumption*";

N7: Hydrogeological risk assessment: "*Developers proposing schemes that present a hazard to groundwater resources, quality or abstractions must provide an acceptable hydrogeological risk assessment (HRA) to the EA and the planning authority. Any activities that can adversely affect groundwater must be considered, including physical disturbance of the aquifer. If the HRA identifies unacceptable risks then the developer must provide appropriate mitigation. If this is not done or is not possible the EA will recommend that the planning permission is conditioned, or it will object to the proposal*";

N8: Physical disturbance of aquifers in SPZ1: "*Within SPZ1, the EA will normally object in principle to any planning application for a development that may physically disturb an aquifer*"; and

N11: Protection of resources and the environment from changes to aquifer conditions: "*For any proposal that would physically disturb aquifers, lower groundwater levels, or impede or intercept groundwater flow, the EA will seek to achieve equivalent protection for water resources and the related groundwater-dependent environment as if the effect were caused by a licensable abstraction*". Hence, on the basis of these policies the EA require a hydrogeological risk assessment and suitable mitigation for the proposed works.

Aquifer Status

The designation of an aquifer reflects the importance of the aquifer in terms of groundwater as a drinking water supply resource and its role in supporting surface water flows and wetland ecosystems (British Geological Survey (BGS), 2022). Principal and Secondary aquifers may provide significant quantities of drinking water and water for business needs. They may also support rivers, lakes and wetlands and other groundwater dependent ecosystems.

Aquifers are divided into two different types: superficial (permeable, unconsolidated (loose) deposits, e.g. sands and gravel) and bedrock (solid, permeable formations, e.g. sandstone, chalk and limestone). The designations (in order of importance) are as follows: Principal, Secondary A, Secondary B, Secondary undifferentiated and unproductive strata.

The Defra (2023) Multi-Agency Geographic Information for the Countryside (MAGIC) web application Aquifer Designation Map was used to identify aquifer designations with the study area. Within the study area the sandstone and limestone units within the WCF bedrock are designated as 'Secondary A' aquifer. The UTWSM of interbedded sandstones and siltstone outcropping to the east and south and located below the Proposed Development site is also classified as a Secondary A' aquifer. With regards to superficial deposits, the Defra (2023) MAGIC Aquifer Designation map indicates the alluvium of clay, silt, sand and gravel and river terrace deposits present within the study area are also designated as 'Secondary A' aquifer.

Source Protection Zones

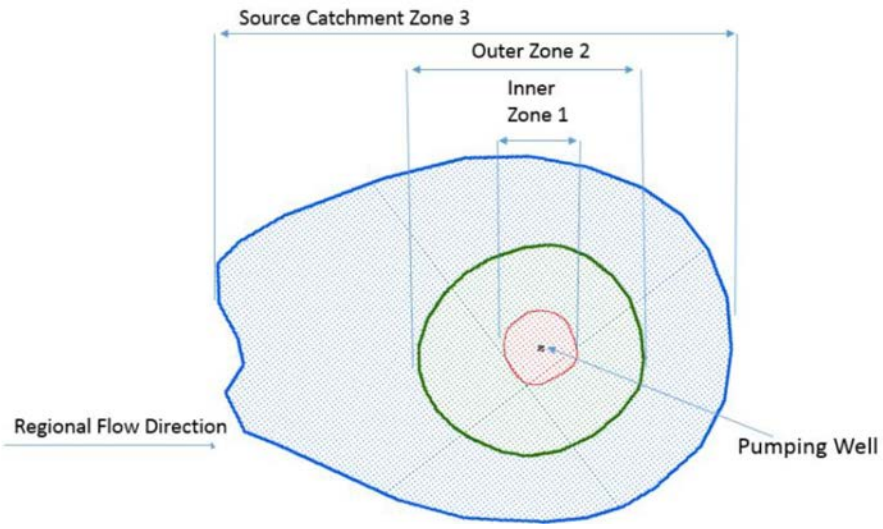
The EA has defined SPZs to protect groundwater abstraction sources (wells, boreholes and springs). SPZs indicate those areas where groundwater supplies are at risk from potentially polluting activities and accidental releases of pollutants. SPZs are primarily a policy tool used to control activities close to public water supplies. Water companies, such as SW, use SPZs to protect their groundwater abstraction sources. They also provide the basis for catchment management work, such as safeguard zones. SPZs are not statutory and are mainly for guidance but they do relate to distances and zones defined in legislation where certain activities may be restricted.

The EA first published SPZ methodology guidance in August 1996 (EA, 1996). An updated document "Groundwater Source Protection Zones – Review of Methods" was published in August 2009 (EA, 2009). The most recent guidance published in March 2019 "Manual for the production of Groundwater Source Protection Zones" (EA, 2019) updates the methodology for defining groundwater SPZ's.

SPZs typically comprise three main zones (**Figure 2-1**). The first two zones are based on the travel time of potential pollutants through the saturated zone, whilst SPZ 3 represents the recharge area:

- Inner 'SPZ 1' – defined as the 50-day travel time of pollutant to source and has a 50m default minimum radius. This zone is usually located adjacent to the abstraction, although in karst terrain it can extend some distance away due to rapid transport pathways. The EA's Approach to Groundwater Protection (2018) sets the tightest control of activities in this zone;
- Outer 'SPZ 2' – is defined as the 400-day travel time of pollutant to source with a 250 or 500m minimum radius around the source depending on the amount of water abstracted;
- Total catchment 'SPZ 3' –the area around a supply source within which all the groundwater ends up at the abstraction point. This is the area from where the recharge water is being taken and can extend some distance from the abstraction.

Figure 2-1 Schematic Representation of SPZ (from EA, 2019)



EA Licensing Strategy

The EA use licensing strategies to manage water resources sustainably. The Proposed Development site is located within the Upper River Mole catchment where the WCF provides very little baseflow to the river as indicated by its low baseflow index and flashy river flow regime. The Mole Abstraction licensing strategy, February 2013 states that there are no significant abstractions or discharges within this sub-catchment that have an impact on the Upper Mole. Secondary aquifers, such as the UTWSM currently have little pressures from abstraction and will be considered by the EA on an individual case by case basis subject to local assessment. Within the EA strategy on the outcrop area of the UTWSM to the east and south of the Proposed Development site water is available for licensing.

For surface watercourses within the vicinity of the Development Site water resource is available at least 50% of the time for the Gatwick Stream and the Upper Mole with approximate volumes available at restriction of 22.2 Ml/d and 0.8 Ml/d respectively.

3. Site Setting

3.1 Climate

The Meteorological Office website holds the latest set of 30-year rainfall averages, covering the period 1991-2020. Mean annual rainfall for southeast and southern England is 806 mm. Data from the nearest climate station (Charlwood 1 km to the west of Gatwick airport) closest to the Proposed Development site is shown within **Table 3.1**. It is likely that the local rainfall at the site is similar to that at the Charlwood climate station. Long term average recharge within the study area is estimated at between 0.81 to 1.5 mm/day (296 mm/yr to 547 mm/yr)[14]. This appears to be high and more typical rates of recharge are likely to be between 200 mm/yr and 300 mm/yr.

Table 3.1 Annual climate information for regional climate stations

Climate Station	Location (NGR)	Distance from Study Area (km)	Altitude (mAOD)	Annual Mean Rainfall (mm)	Annual Days of Rainfall ≥ 1mm
Charlwood	TQ 23664 40455	Approximately 2.5 km to north	67	834	126

3.2 Topography and Drainage

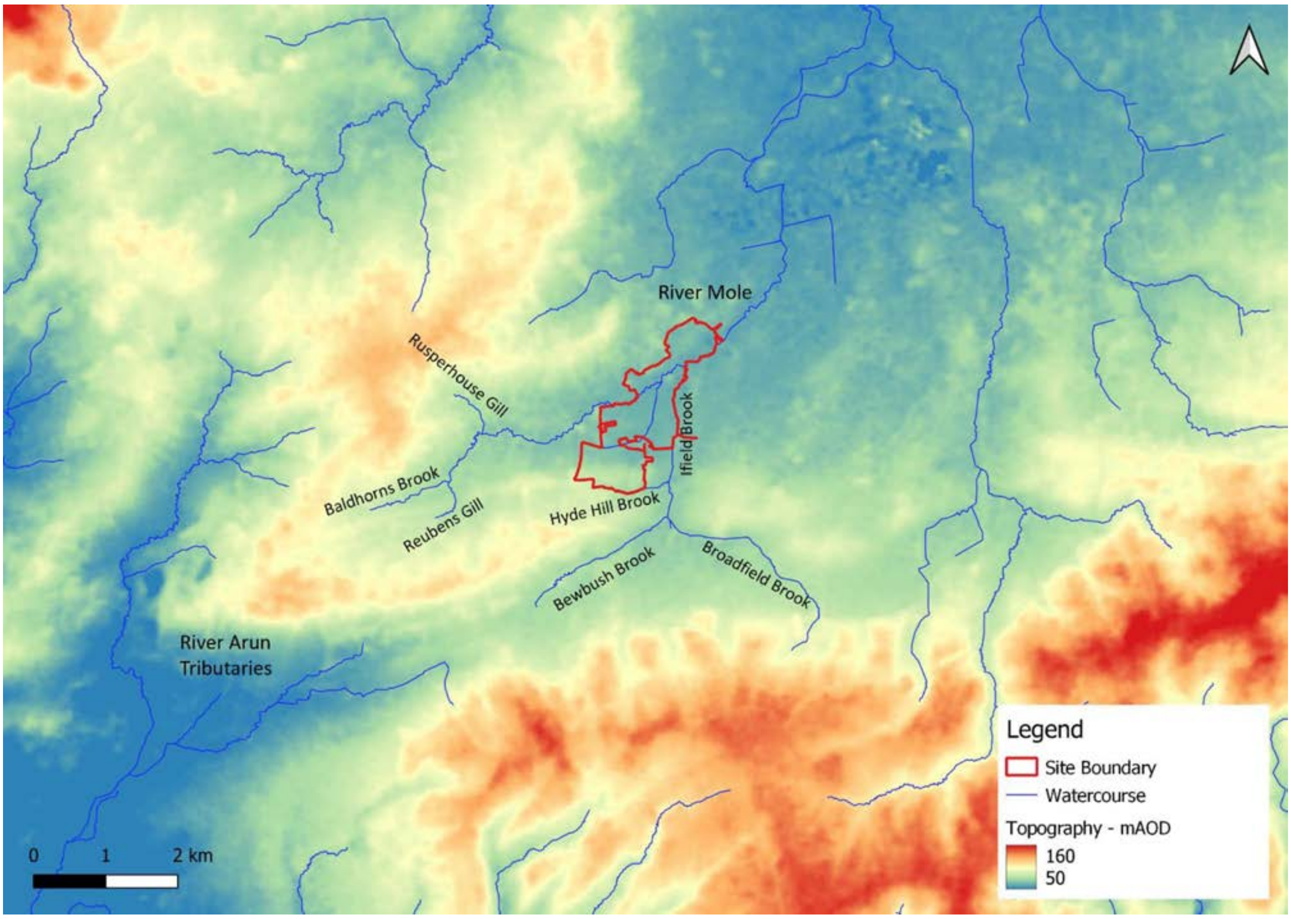
The regional topography and the location of watercourses in the vicinity of the Proposed Development site are presented in **Figure 3-1**. The highest elevations in the area lie to the south and southeast of the site, east of Horsham. A small ridge, rising up to 108 mAOD high, occurs to the southwest of the Proposed Development site, just north of the A264 carriageway and reflects variations in the underlying geology in the area.

The topography across the Proposed Development site ranges from approximately 60 metres above Ordnance datum (mAOD) in the northern and central areas to approximately 85 mAOD in the southern area at the Ifield Golf and Country Club. The area to the north of the golf course is gently sloping from west to east (from approximately 66 mAOD to 61 mAOD) with topographical low points, predominantly around the watercourses.

The River Mole flows through the site in a north-easterly direction. The Ifield Brook, tributary of the River Mole, flows along the eastern part of the site and joins the river at a point located at NGR TQ 24706 38076 within the northern part of the Site. Other water features within the site include two land drains that discharge directly into the River Mole or Ifield Brook.

[14] Based on the Great Britain-wide recharge model was built using BGS: https://www2.bgs.ac.uk/groundwater/modelling/zoodrm.html

Figure 3-1 Site topography and watercourses

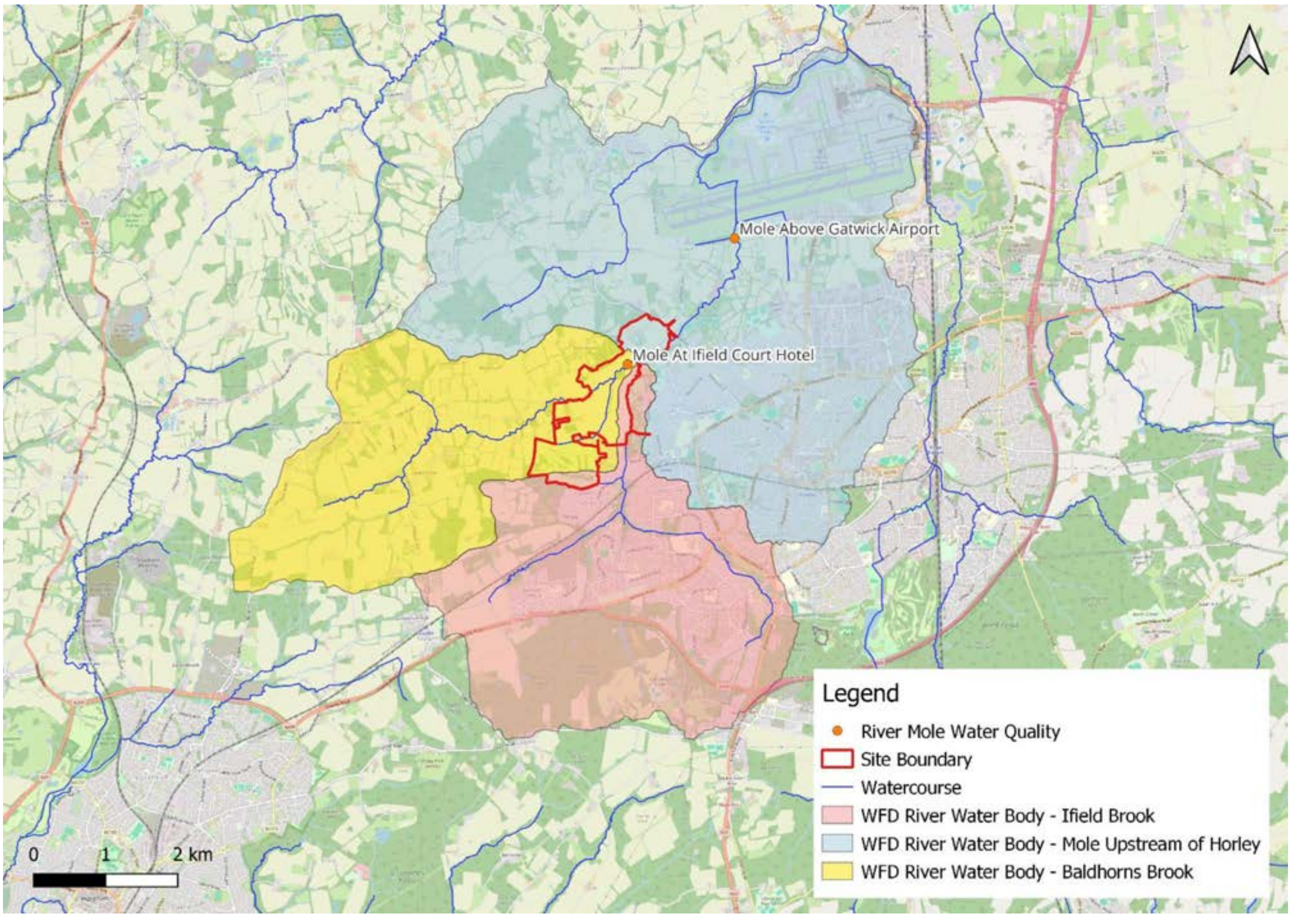


The Proposed Development site lies within three WFD water bodies: the Baldhorns Brook; Ifield Brook and the River Mole upstream of Horley (**Figure 3-2**), although most of the site lies in the Baldhorns Brook water body. The Baldhorns Brook which runs through the Development Site has been given a 'Poor ecological status'. A poor designation has been given due to issues with agriculture and rural land management leading to pollution from rural areas, pollution from wastewater and domestic pollution from urban areas. In terms of chemical quality elements, a poor status was given to dissolved oxygen and phosphate in 2022.

Further afield within the Study Area the Tilgate Brook and Gatwick Stream at Crawley water body flows north from the south of Crawley and through the east of Crawley. This water body has been given a 'Moderate ecological status' with impacts on invertebrates, typical of an urban stream setting. Upstream and to the southeast of this is the Stanford Brook water body. This water body has been given a 'Poor ecological status' due to ecological biological quality elements related to fish.

Water quality results for the River Mole are available for two locations: The River Mole at Ifield Court Hotel within the site boundary and the Mole above Gatwick Airport downstream of the Site. The sampling locations are displayed on **Figure 3-2** below.

Figure 3-2 Water body designation and water quality sampling locations



The EA water quality dataset (downloaded from WIMS website) includes a range of parameters for assessing the surface water quality; total ammonia, electrical conductivity (EC), dissolved oxygen (DO), nitrate, nitrite, pH, temperature, and total oxidised nitrogen (TON).

The following observations have been made:

- Average values for the River Mole at Ifield Court Hotel (pH:7.64, EC: 511 µs/cm, DO: 75%) and Mole Above Gatwick Airport (pH:7.52, EC: 433 µs/cm, DO: 74%) over the period 2022 to 2023 are similar;
- Average values of nitrate and nitrite show elevated levels in the River Mole above Gatwick Airport of 2.61 mg/l and 0.05 mg/l respectively, which is further downstream than the River Mole at Ifield Court Hotel location within the Site, where moderate average values of 0.95 mg/l and 0.019 mg/l respectively were recorded[15]; and
- Orthophosphate, reactive as P (phosphate) averages for the River Mole at Ifield Court Hotel (0.271 mg/l) and the River Mole above Gatwick Airport (0.161 mg/l), suggest a reduction in phosphate values downstream of the Site.

[15] The elevated nitrate and nitrite are likely due to the application of fertilisers and/ or sewage discharges.

The summary statistics for flow gauges downstream of the catchments flowing north from the Study Area are presented in **Table 3.2**.

Table 3.2 River flow gauge summary statistics

Gauge reference	Gauge name	Watercourse	NGR	Catchment Area (km^2)	Mean flow (m^3/s)	Q10 (m^3/s)	Q95 (m^3/s)	BFI	Period of record
39024	Gatwick Stream at Gatwick	Gatwick Stream	TQ 288 402	31.1	0.454	0.878	0.105	0.56	1952-1977
39054	River Mole at Gatwick Airport	River Mole	TQ 260 398	31.8	0.353	0.895	0.015	0.23	1961 - 2022

3.3 Geology

Geology Overview

The site is located within the Weald Basin, which developed as an extension of the considerably larger Wessex Basin along the southern coast of England. Within the Wealden area, the general sequence is one of non-marine sediments (Jones et al, 2000)[16]. The nature of the Wessex Basin depositional environment is still a matter of debate. Allen, (1981)[17] proposed that the Wessex Basin was possibly a shallow embayment opening into a Boreal Sea. Influenced by increased erosion of the surrounding uplands resulted in bursts of sedimentation into a low lying plain, central to the basin (Jones et al, 2000). On occasion, rapid transgression of brackish lagoonal conditions from the northwest covered much of the basin leading to the deposition of silts and clays (Jones et al, 2000). This depositional history has therefore resulted in the interbedded sandstone and clay units within the Wealden area. The lithologies of the key stratigraphic units underlying the site (both for bedrock and superficial geology) are discussed in detail below.

Bedrock

Table 3.3 shows the anticipated bedrock geology beneath the site, with expected thicknesses based on local historical BGS borehole geological logs, orientation of beds, and the generalised vertical section provided on BGS Map (Sheet 302)[18]. Referenced borehole logs are provided in Appendix A.

[16] Jones, HK., Morris, BL., Cheney, CS., Brewerton, LJ., Merrin, PD., Lewis, MA., MacDonald, AM., Coleby, LM., Talbot, JC., McKenzie, AA., Bird, MJ., Cunningham, J., and Robinson, VK (2000) The physical properties of minor aquifers in England and Wales. British Geological Survey Technical Report, WD/00/4. 234pp. Environment Agency R&D Publication 68

[17] Allen P 1981. Pursuit of Wealden models. Journal of the Geological Society, London 138: 375–405.

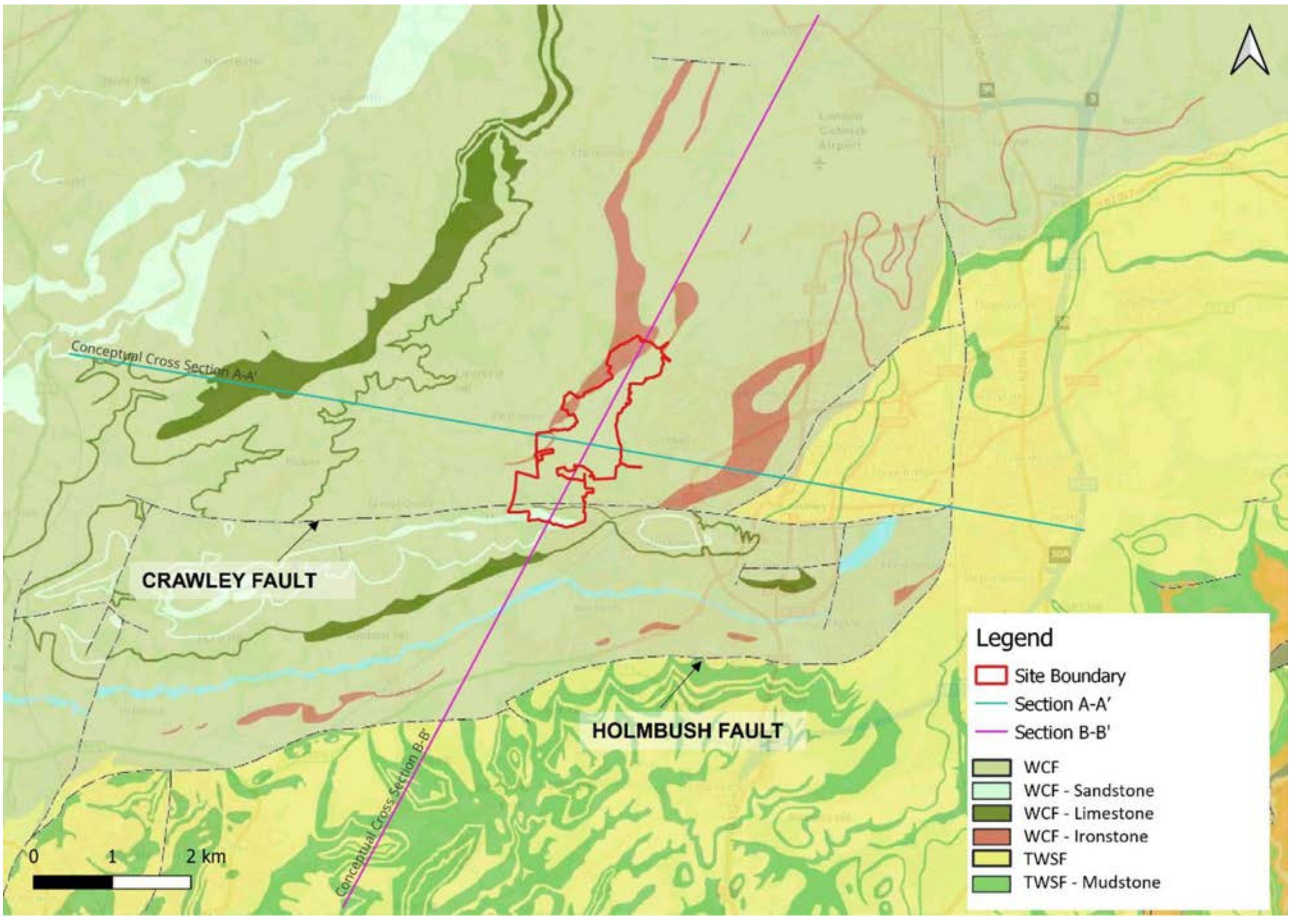
[18] BGS, 1991 1:50,000 Series England and Wales Sheet 302 Horsham (1972): Solid and Drift Geology

Table 3.3 Bedrock Geology

<table>
<tr><th>Group</th><th colspan="2">Formation/ Member</th><th>Lithological Description</th><th>Expected Thickness (m)</th></tr>
<tr><td rowspan="5">Wealden Group</td><td colspan="2">Weald Clay Formation</td><td>Thinly bedded mudstones with subordinate siltstones, and fine to medium-grained sandstones freshwater limestone and ironstone (Jones et al, 2000). Horsham Stone Member is a thin, calcareous sandstone layer near the base of the Weald Clay sequence and clay ironstone bands may mark its base.</td><td>80 to 130</td></tr>
<tr><td rowspan="3">Tunbridge Wells Sand Formation</td><td>Upper Tunbridge Wells Sand Member</td><td>Fine to medium-grained silty sandstone, siltstone and silty sand rhythms with finely bedded mudstones and thin limestones.</td><td>113 to 128</td></tr>
<tr><td>Grinstead Clay Member</td><td>Very silty mudstones with thin beds of siltstone, nodular clay ironstone and shelly limestone. Numerous small seams of clay are developed, which affect groundwater flow by dividing the sandy facies into smaller units. Occasionally the sandy facies appear to be replaced locally entirely by clay (Jones et al, 2000).</td><td>13 to 27</td></tr>
<tr><td>Lower Tunbridge Wells Sand Member</td><td>Fine to medium-grained sandstone, siltstone and silty sand rhythms with finely bedded mudstones and thin limestones. Generally, less clayey than the Upper Tunbridge Wells Sand.</td><td>18 to 42</td></tr>
<tr><td colspan="2">Wadhurst Clay Formation</td><td>Grey-green clays and silty shales with thin sandstone and limestone beds. The Ashdown Formation lies beneath the Wadhurst Clay Formation.</td><td>60</td></tr>
</table>

BGS GeoIndex bedrock geology in the vicinity of the site is presented in **Figure 3-3**. The map shows that the site is underlain by the WCF, with the TWSF underlying the WCF. The strata below the site dip to the northwest, with the WCF thickening in this direction. This is consistent with the site location in relation to the Wealden Anticline. The UTWSM outcrops at surface ~2 km to the east of the site. Schematic geological cross-sections are presented in **Section 4** as part of the conceptual hydrogeological site model.

Figure 3-3 Bedrock geology, faulting and conceptual section lines



The outcropping UTWSM beds beneath the centre of Crawley have a dip of between 2 and 3 degrees to the northwest (BGS Map Sheet 302). The Proposed Development site is ~2.5 km from the outcrop, which gives a depth range of 87 to 131 m beneath the site for the top of the UTWSM

The log for a borehole at the Brighton Road Pumping Station, Crawley borehole (TQ23NE77) (**Figure 3-6**), approximately 3 km southeast of the site, provided in Appendix A, indicates that the base of the WCF is at approximately 84 mbgl at that location. The Horsham Stone is absent beneath the site (to the north of the Crawley Fault), where ironstone bands outcrop at the surface and persist to the base of the WCF.

The Brighton Road Pumping Station borehole is reported to have a sharp clay/ sandstone contact at 230.1 m depth, which may indicate the Grinstead Clay/ Lower Tunbridge Wells Sand Member contact (BGS Memoir, 1993)[19]. A thickness of 113 to 128 m for the UTWSM is based on the borehole at the Brighton Road Pumping Station, which proved the existence of the WCF and Hastings Beds (TWSF) to 281 mbgl. The Brighton Road Pumping Station location is separated from the site by the Crawley Fault, therefore there is some uncertainty as to whether this will be representative of geological conditions at the site, due to the displacement of strata along it.

[19] Webapps.bgs.ac.uk, Geology of the country around Horsham (1993). Memoir for 1:50 000 geological sheet 302 (England and Wales). [online] Available at: https://webapps.bgs.ac.uk/Memoirs/docs/B01684.html [Accessed, February 2024].

Superficial Deposits

The anticipated superficial geology is provided in **Table 3.4** and the BGS GeoIndex mapping for the superficial deposits is presented in **Figure 3-4**. Superficial deposits are largely absent from the site. Where they occur, they consist of alluvium and river terrace deposits associated with the River Mole and its tributaries. The alluvium deposits outcrop across the central and northern sections of the site. The river terrace deposits outcrop within the centre of the site area, to the north of the golf course. The superficial deposits are expected to be between 3 and 4 m thick based on borehole evidence in the Crawley area.

Figure 3-4 Superficial deposits

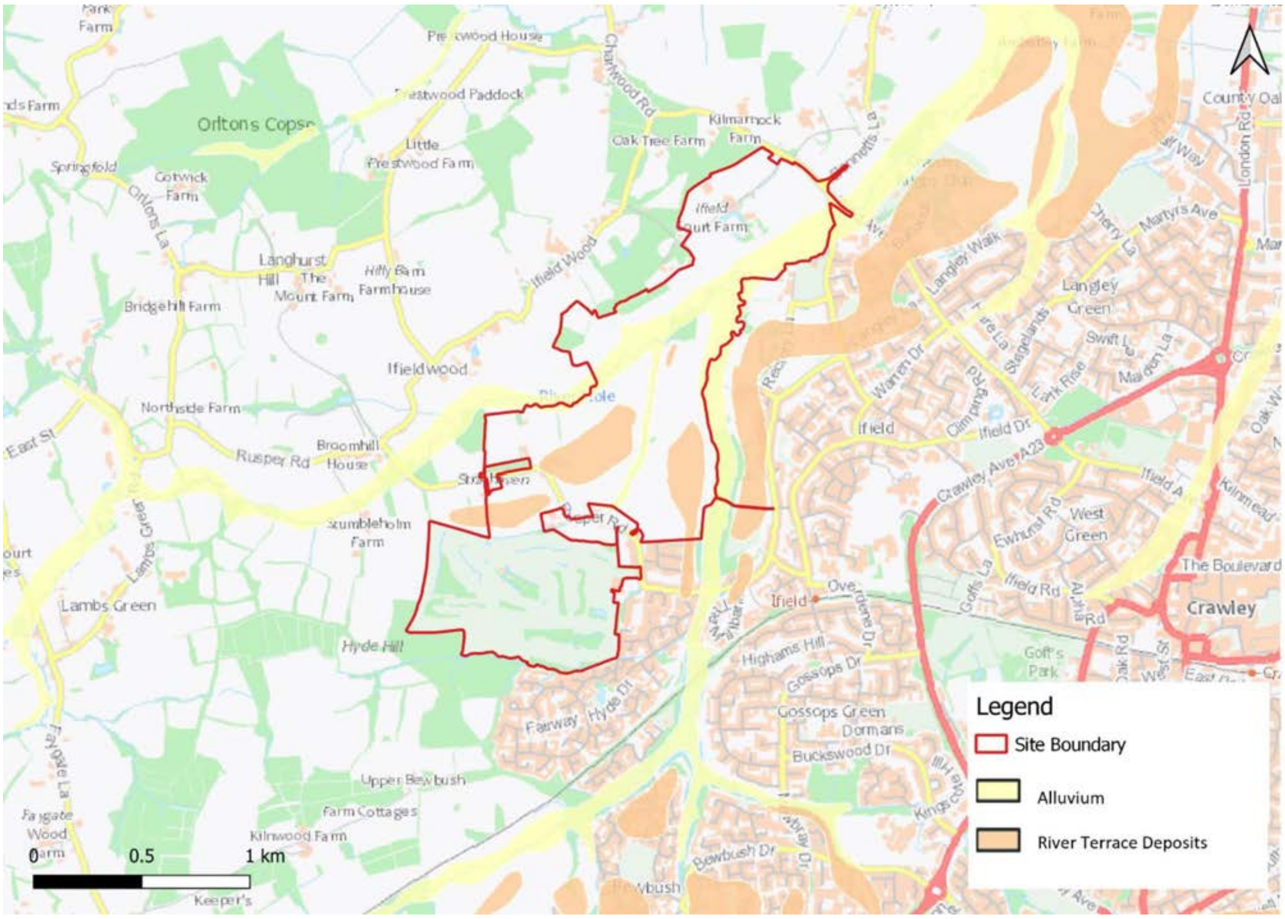


Table 3.4 Superficial Deposits

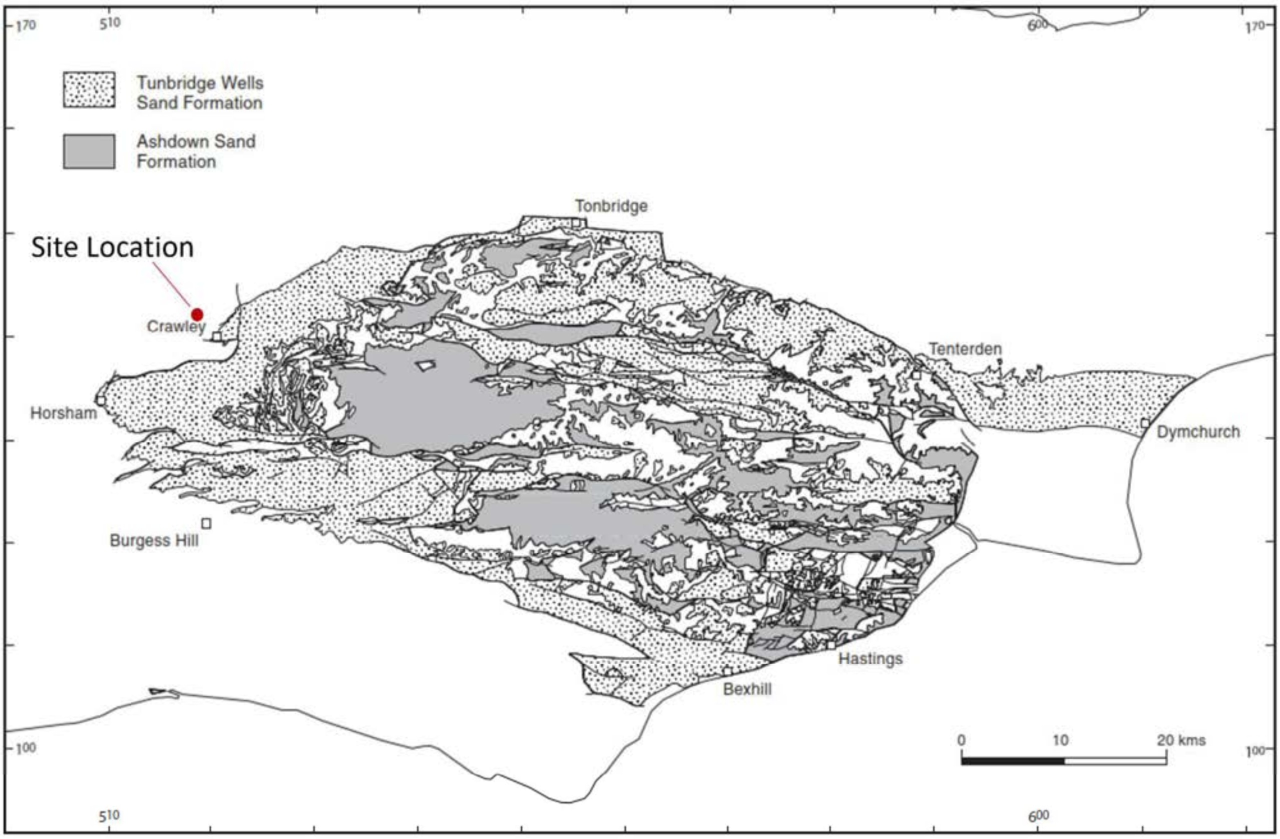
Superficial Deposits	Lithological Description	Expected Thickness (m)
Alluvium	Clay, silt, sand and gravel. Unconsolidated detrital material deposited by a river or stream as a sorted or semi-sorted sediment in the bed of the stream.	0 to 3
River Terrace Deposits	Mole river sand and gravel. Consist of alluvium forming one of a series of level surfaces in a stream or river valley, produced as the dissected remnants of earlier abandoned floodplains.	0 to 4

Regional Structural Geology

The site is situated within the northern limb of a northwest plunging anticline (the Wealden Anticline). This fold formed during the Alpine orogeny as an uplifted form of the Weald basin, through inversion of the basin, resulting in 180m of uplift. As a result of erosion of this anticline, the oldest rocks are exposed at the centre, away from which the beds dip in all directions, with the youngest rocks at the edge (Jones et al, 2000).

The anticlinal structure can be seen in **Figure 3-5** below, with the older Ashdown Sand Formation in the centre of the structure and the younger TWSF on the edges of this. As with the nature of a plunging anticlinal structure, the steepest dipping beds are on the northern and the southern limbs and the shallow dipping beds are to the west, in line with Crawley and Horsham, where the surface outcrops appear widest.

Figure 3-5 Regional Wealden Anticline and outcrops (Jones et al, 2000)



Local Structure

The Crawley Fault trends from east to west, through the southern section of the Proposed Development site as displayed in

Figure 3-3. The throw of this fault is about 60 m to the south in its eastern part (BGS Memoir, 1993). It is understood that this is a normal fault with a steep inclination (dipping to the south) and with geological strata downthrown on the southern side.

The Holmbush Fault trends from north to south, 4.3 km east of the Site and trends from east to west 1.7 km to the south of the site boundary. The amount of throw is uncertain, but it is probably about 30 m to the northwest, along most of the fault (BGS Memoir, 1993). As with the Crawley Fault, this is a normal fault likely to have a steep inclination (dipping to the north and west). There is therefore a faulted contact between the Weald Clay and the UTWSM to the southeast of the site.

Appendix B shows the interpretation of seismic lines identified in the area of the Proposed Development site, which give estimates of the depths to geological strata units of interest and the location and nature of the faults. The interpretations of the geological unit thicknesses from the seismic data estimated the WCF at 100 to 120 m thick beneath the site which is in line with that expected from borehole data and literature review. The UTWSM was estimated as significantly thicker at 190 to 210 m in thickness[20].

3.4 Hydrogeology

Aquifer Designation

Table 3.5 below describes the properties of the possible aquifers beneath the Proposed Development site based on a literature review.

Table 3.5 Hydrogeology and Aquifer Designation

Formation	Description
Weald Clay Formation	*Unproductive Strata* where mudstones predominate and *Secondary A aquifer* where sandstone and/or limestone bands are present. The hydrogeology of the WCF is complex and not well understood due to its heterogeneity. The formation is divided into a layered sequence composed of sandstone, limestone and clay deposits leading to some potential for unconfined/ leaky aquifers in the discontinuous layers. The WCF is essentially an impermeable (or low permeability), confining clay formation, although it contains thin silty sandstones and limestones which may yield small local supplies (Jones et al, 2000).
Upper Tunbridge Wells Sand Member	*Secondary A aquifer* containing permeable layers capable of supporting water at a local, rather than strategic scale. Groundwater flow within the TWSF is both intergranular and through joints with variable yields (Jones et al., 2000). Values of transmissivity for the TWSF range from 6.1 – 39.5 m^2/d. Yields from the TWSF are generally less than 400 m^3/d, and often less than 100 m^3/d, although significantly higher yields have been obtained on occasion (Jones et al, 2000).
Grinstead Clay Member	*Unproductive Strata*. Separates the Upper and Lower TWS units, acting as an aquiclude. Often results in perched water tables.

[20] There are uncertainties in the seismic estimation of thicknesses since there are few boreholes to validate layer depths along the seismic lines. The seismic was run for deep identifying deep formations for hydrocarbon exploration, whilst this study is focused on shallow data and may be subject to signal noise. The interpretation of the layer contacts were undertaken using broad visual interpretations and have been taken from deep boreholes Brockham Oil Well and Leigh 1 (Appendix B), which are approximately 10 km north of the Site and 1.5 km and 2.2 km off the seismic line, respectively.

Lower Tunbridge Wells Sand Member	*Secondary A aquifer*. Shares the same hydrogeological description as the Upper unit. It has been suggested that larger yields are generally obtained from the Lower Tunbridge Wells Formation (Jones et al, 2000).
Wadhurst Clay Formation	*Unproductive Strata*. Acts as an aquiclude, confining the underlying Ashdown Formation aquifer and separating it from the overlying TWS aquifer.

The secondary aquifers within **Table 3.5** are dominated by sands or poorly cemented sandstones, and water movement is principally through the matrix. As rock sequences, these strata comprise alternating sands and mudstones, frequently forming multi-aquifer systems. However, the layers are not always laterally persistent, adding to the complexity of the aquifer system (Jones et al, 2000). The mean yield for a 300 mm diameter borehole penetrating 30 m of saturated TWSF in the Wealden district has been calculated to be 750 m^3/d for a 10 m drawdown (BGS Memoir, 1993).

The Proposed Development site lies within two WFD groundwater bodies: the Copthorne Tunbridge Wells Sands (GB40602G602400) beneath the UTWSM outcrop; and the Arun & Western Streams Hastings Beds (GB40702G500600) (**Figure 4-1**). Both have been given an overall 'Good Status'. (quantitative and chemical). These WFD groundwater bodies are DrWPAs although they are not at risk of failing to achieve good status or have any reasons for not achieving good status.

Local Borehole Records

A selection of data from historical boreholes (Appendix A) drilled within 8 km of site is presented in **Table 3.6**. The location of these historical boreholes and additional locations (without available borehole logs) is presented in **Figure 3-6**, to give a spatial representation of the water levels for the WCF as well as the confined and unconfined (at outcrop) TWSF.

All borehole to the north and west of the site targeted the WCF, rather than the underlying UTWSM. This is likely due to the borehole achieving a satisfactory yield within the WCF and/ or drilling to depth being uneconomical. The maximum depth drilled into the WCF was 114.6 m, 6.5 km west of site. Local borehole records indicate yields of between 55 and 218 m^3/d from the WCF are possible.

The historical boreholes to the east and south of the site primarily target the UTWSM. In most of these water wells, the UTWSM was targeted where it outcrops. Local records indicate expected yields of between 109 and 676 m^3/d from the UTWSM are possible. However, lower yields can be encountered near the top of the formation due to increased clay content.

Higher yields were achieved by drilling to approximately 110 – 150 m into the UTWSM (and the underlying Lower Tunbridge Wells Sand Member), where it is overlain by the WCF. This is based on evidence from drilling records at Brighton Road Pumping Station, where a yield of 46 m^3/d (Borehole A) increased to 227 m^3/d (Borehole B) between 113 and 151 m depth into the UTWSM respectively. This increase in yield with depth into the UTWSM could be related to the contact with the WCF being less productive, as it is predominantly comprised of interbedded clay and sandstone layers.

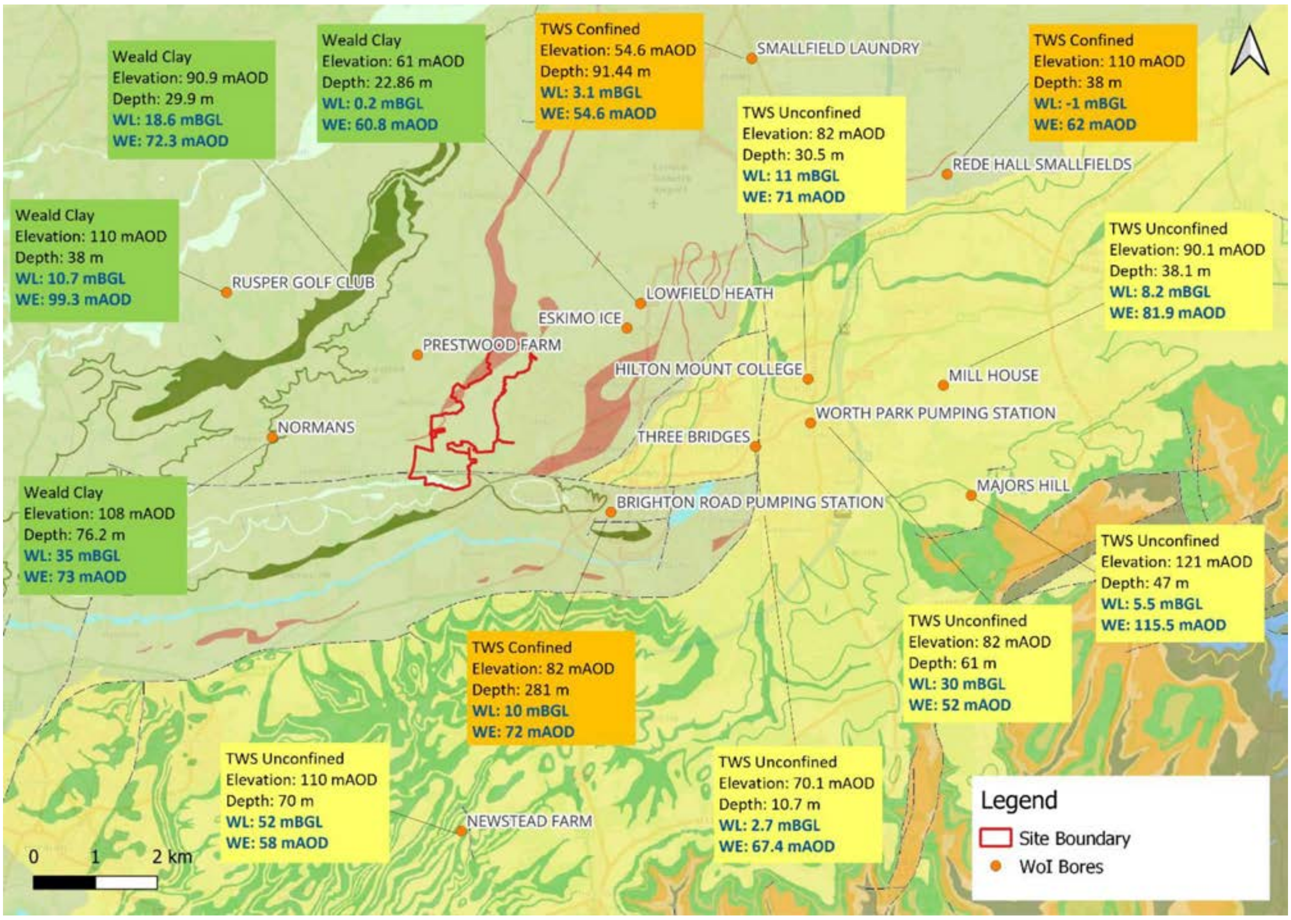
The Eskimo Ice borehole is approximately 2 km to the east northeast of the site (**Figure 3-6**), located on WCF and at a similar distance from the WCF/ UTWSM outcrop boundary as the Proposed Development site. This borehole was licenced for a maximum pumping rate of 130 m^3/d, although the step test data from the borehole indicates that higher abstraction rates could be possible (312 m^3/d or even 432 m^3/d). This suggests that the top of the UTWSM may be able to support a significant yield, although in the case of this borehole the screen is set across 67 m of WFC strata and it is uncertain how much this formation contributes to yield.

The borehole logs for Brighton Road Pumping Station and Worth Park Pumping Station indicate drops in yield over time (**Table 3.6**). This indicates that the productive sandstone layers may not be laterally extensive or that the faulting in the area creates a barrier to that limits lateral flow. The BGS map sheet and seismic sections confirm this for the Brighton Road Pumping Station, as it is situated within a fault block, bound by the Crawley fault to the north and the Holmbush fault to the south. Displacement along these faults (especially that along the Crawley fault) is likely to limit the lateral connectivity of the productive sandstone layers. It is possible that the faults are barriers to flow between the same aquifer units either side of the faults and it is likely that flow will be impeded across the faults where throw is greatest, due to more permeable layers being discontinuous.

The Brighton Road Pumping Station had a rest water level recorded at 10 mbgl (72 mAOD) in 1919/ 1920, which indicates that the water is under confining pressure within the UTWSM aquifer, beneath the WCF. The UTWSM is likely recharged where the unit outcrops, to the east and southeast of Crawley, beneath higher ground. A pumping water level of 174 mbgl in the Brighton Road Pumping Station (Borehole B) indicates that the majority of the flow is from the UTWSM (beneath 90 m), rather than from any productive bands of sandstone or limestone within the WCF. This pumping level gives a total drawdown of 164 m, suggesting a low productivity unit.

There is also a note in the log for a second borehole at the Brighton Road Pumping Station location that records significant drops in rest water level over a short period of time (one year) and did not recover. This suggests that the aquifer was depleted over this time, suggesting a limited long-term sustainable yield. This fits with the observed drop in yield over time, potentially due to poor lateral connectivity or faulting creating a barrier to flow.

Figure 3-6 Boreholes measured rest groundwater levels and bedrock geology



Note: For bedrock geology key see **Figure 3-3.**

Table 3.6 Historical Local Borehole Data

Well ID	Normans	Brighton Road Pumping Station	Hilton Mount College	Worth Park Pumping Station	Newstead Farm	Eskimo Ice
Easting/ Northing	520940, 137160	526420, 135950	529610, 138100	529650, 137390	524000, 130800	526730 138900
Distance from Site	Approx. 2.9 km west of intended site	Approx. 3 km southeast of intended site	Approx. 5.8 km east of intended site	Approx. 5.9 km east of intended site	Approx. 5.5 km south of intended site	Approx. 2 km to the east northeast of intended site
BGS ID	**TQ23NW4**	**TQ23NE77**	**TQ23NE46**	**TQ23NE48**	**TQ23SW46**	**N/A**
Completion Date	1928	1934	1925	1941	1996	2011
Completion Depth	76.2 m	281.0 m	30.5 m	61.0 m	70.0 m	85.0 m
Site Elevation	108 mAOD	82 mAOD	82 mAOD	82 mAOD	110 mAOD (obtained from 1:10000 OS map)	62 mAOD (obtained from 1:10000 OS map)
Aquifer	WEALD CLAY FORMATION	TUNBRIDGE WELLS SAND FORMATION	UPPER TUNBRIDGE WELLS SAND MEMBER	UPPER TUNBRIDGE WELLS SAND MEMBER	UPPER TUNBRIDGE WELLS SAND MEMBER	UPPER TUNBRIDGE WELLS SAND MEMBER
Rest Water Level (RWL)	73 mAOD in 1928 (35 mbgl)	72 mAOD in 1934 (10 mbgl)	70 mAOD in 1925 (12 mbgl) and 71 mAOD in 1947 (11 mbgl)	52 mAOD in 1941 (30 mbgl)	58 mAOD in 1996 (52 mbgl)	62 mAOD in October 2011 (0.0 mbgl) or artesian/ near artesian conditions (+0.5 bar)
Pumping Test/ Groundwater Yield	54.6 m^3/d (500.0 g.p.h. (gallons per hour) test recorded on log)	676 m^3/d (6,200 g.p.h. in 1935 with combined abstraction from two boreholes) (2,083 g.p.h @ 235 m before borehole deepened)	109.1 m^3/d (1,000 g.p.h. recorded on log)	596.5 m^3/d in 1941 (5,467 g.p.h. recorded on log) 360 m^3/d in 1948 (3,300 g.p.h. recorded on log) 272.8 m^3/d in 1958 (2,500 g.p.h. recorded on log)	163.7 m^3/d (1,500 g.p.h. recorded on log)	5.2 m^3/h at a sustainable rate over 24 hours in October 2011 and 5.1 m^3/h for a smaller drawdown in February 2011.
Comments	Well indicated to be suitable for domestic supply.	Testing of TQ23NE77 and TQ23NE78 in 1935 gave combined yield of 6,200 g.p.h. Borehole A at the same location gives a yield of 420 g.p.h. @ 197 m.				The well was drilled into the top 5 m of the UTWSM with a screen set from 13 mbgl to 84 m so utilising yield also from the WCF. Step tests in Feb 2012: @ 5.5 m^3/h – 1.7 mbgl @ 9.9 m^3/h – 8 mbgl @ 13.4 m^3/h –12.9 mbgl @ 18 m^3/h –22.9 mbgl Feb 2012 Constant Rate Test: 16 hours @ 5.1m^3 gave drawdown of 1.8m and full recovery within 1 min. A licence was issued for 13 m^3/h (3.6 l/s), 130m^3/d,

Note: Borehole data from BGS GeoIndex, except for the Eskimo Ice borehole data that was received from the EA .

Water Quality

The Proposed Development site is in an area designated as having 'low groundwater vulnerability'. This is due to the low permeability WCF geology across the site which limits the potential for contaminants to migrate to depth in the area.

Water quality results for productive bands within the WCF are available from Normans borehole (TQ23NW4) and Billinghurst Water Works borehole (TQ02SE6). At Normans borehole groundwater had 1,497 mg/l of total solids, 247 mg/l of chloride, 0.49 mg/l of ammonia and 85.5 mg/l of total hardness. At Billinghust Water Works borehole, (17.5 km southwest of Normans borehole) chloride was at 210 mg/l. The Drinking Water Standard for chloride is 250 mg/l (Schedule 2 of The Water Supply (Water Quality) Regulations 2016).

Groundwater quality results are available for the UTWSM from Newstead Farm borehole (TQ23SW46), which is 5.5 km to the south of the Site and Eskimo Ice borehole which is approximately 2 km to the east northeast of the site. The UTWSM at this Newstead Farm borehole is at outcrop. However, the water bearing layers of the aquifer are likely confined beneath 22 m of clay from 6 to 28 mbgl. Water quality was relatively good with representative values as follows: chloride at 18 mg/l, pH of 9, conductivity of 981 µs/cm. There was a spike in lead of 0.0167 mg/l (16.7 µg/l), which is just over the DWS of 0.01 mg/l, although his appears to be an isolated result. The full water quality results are presented in Appendix C, Table B-1[21].

The Eskimo Ice details are not available on BGS but information from the EA[22] indicates the borehole targets the top of the UTWSM and the WCF. The WCF is likely of a similar thickness (i.e., 80 to 90 m), as that at the Proposed Development site. Water quality is good with representative values as follows; chloride = 23 mg/l, pH = 8.9, conductivity = 780 µs/cm. The full results are presented in Appendix C, Table B-2[23].

Water from both Newstead Farm and the Eskimo Ice sites had elevated levels of fluoride and boron which were above the DWS of 1.5 mg/l and 1.0 mg/l respectively (Schedule 3 of The Water Supply (Water Quality) Regulations 2016).

3.5 Private Water Supplies

Under the Private Water Supplies Regulations, Local Authorities should maintain a register of private water supplies used for potable supply where they are below the licensing threshold of 20 m^3/d. Although, the EA do not hold records for supplies less than 20 m^3/d the Local Authority have an obligation to record this data. A freedom of information environmental data request was made to Crawley Borough Council; Surrey County Council; and West Sussex County Council requested data on surface and groundwater PWSs in the study area. In each case, councils indicated that they do not hold private water supply data and in some cases indicated that the EA may hold the data.

The Proposed Development site is within the Thames Cookham Teddington and Wey surface water drinking water safeguard zones (WSZ) (Zone ID SWSGZ4015) which extends as far south of Crawley along the River Mole.

It should also be noted that historical OS 1:25,000 1937- 1961 mapping shows numerous wells within the vicinity of the Proposed Development site. Five wells are marked along the Rusper Road

[21] Groundwater quality information was obtained from the EA's UK data Services Platform. Sample point SO-5GWQ0491: Newstead Farm at Handcross (26 samples between 2006 and 2023). Note – only recent samples between 2013 and 2023 were used for this assessment.

[22] Personal communication: Pumping Test Summary (SE Region EA) technical note from Jessica Scherer (Hydrogeology Technical Officer, Kent South London and East Sussex, EA), e-mail 16th April 2024.

[23] Groundwater quality information was obtained from the EA's UK data Services Platform. Sample point TH-PGWU2269: Eskimo Ice Tunbridge Wells Sand Borehole, Crawley (9 samples between 2017 and 2023).

alone near the site at for example at Lower Barn, Sandalwood, Hyde Cottage, Dumfries and by the river at Ifield Park. These likely no longer exist and indeed no BGS records could be found for these potential wells.

3.6 Abstractions/ Discharges

The EA license all groundwater and surface water abstractions that take more than 20 m^3/d and all discharges to controlled waters. Details of licensed abstractions in the area were acquired through a freedom of information environmental data request to the EA. There are no abstraction licences in the EA within the study area. One surface water abstraction licence was identified by the EA, within the 5 km buffer, on the Stanford Brook in the southeast of Crawley for heat pump use (**Table 3.7**).

59 current discharges[24] permitted under the Environmental Permitting Regulations (2016) have been identified within 5 km of the site (25 discharges within 2 km of the site) (Appendix D and **Figure 4-1**). Some 41 of the discharges were for sewage effluent, 6 were water company discharges related to wastewater treatment and the municipal sewage network, whilst the remainder are discharges from a range of activities, such as domestic premises, trade, and other amenities etc. Other discharges are for trade and miscellaneous. One discharge occurs within the Proposed Development site (**Table 3.8**) and relates to a sewage treatment plant (Permit registration number TH/CTCR.0825/001) for a bungalow adjacent to Yew Tree cottage on Rusper Road at NGR TQ 24100 37100. This location lies on the tributary which flows north through the centre of the Proposed Development site into the River Mole. Only one discharge occurs on the downstream reach of the River Mole, (Permit registration number TH/CNTM.0014/001) associated with farming activities at Willoughby Farm (NGR TQ 25200 38600). Two discharges occur on the UTWSM outcrop over 2.5 km to the west of the Proposed Development site. These are the domestic discharge (Permit registration number TH/CTWC.3504/001) at Dalewood Gardens (NGR TQ 28000 37800); and the Tesco superstore discharge (Permit registration number TH/CTWC.1325/001) at Hazelwick Avenue in Crawley (NGR TQ 28800 37800).

[24] 50 within the EA area: Kent and South London; and 9 within the EA area: Solent and South Downs

Table 3.7 Licensed abstractions located within the study area

Abstraction licence number	Licence holder name	Address	Use	Source of supply description	Easting	Northing	Max Daily Quantity (metres cubic)	Max Annual Quantity (metres cubic)
TH/039/0032 /020	Crawley Borough Council	Town Hall The Boulevard Crawley RH101UZ	Water supply private water supply heat pump	Stanford Brook at Maidenbower	529316	135709	81	19800

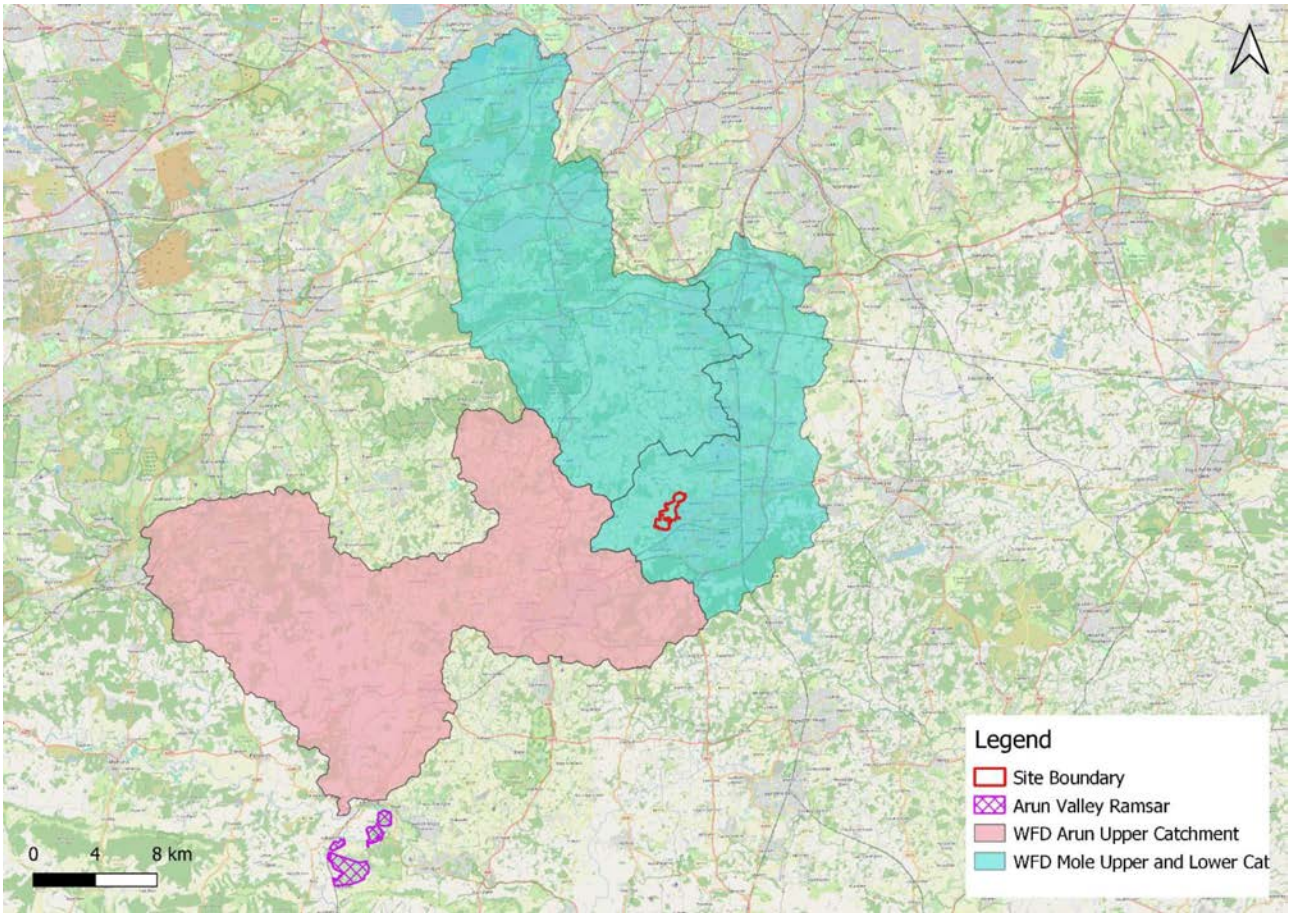
Table 3.8 Licensed discharges located within the Proposed Development site

Permit registration no.	Permit holder	Site name	Site Address	Site type	Effluent type	Easting	Northing	Start Date	Distance to site (km)
TH/CTCR.08 25/001	Mr. D.M. Stass	Bungalow adjacent to Yew Tree cottage	Bungalow adjacent to Yew Tree cottage, Rusper Road, Ifield, Sussex	Water treatment (not water company at a private premises)	Sewage - not water company	524100	137100	15/02/1966	< 0.5

3.7 Conservation Sites

The SNWRZ[25] is associated with the River Arun catchment and contains conservation sites such as Amberley Wild Brooks Site of Special Scientific Interest (SSSI), Pulborough Brooks SSSI and Arun Valley Special Protection Area (SPA)/ Special Area of Conservation (SAC) and the Arun Valley Ramsar site (Hardham) presented in **Figure 3-7**. The protected River Arun catchment, which supplies the Arun Valley Ramsar site drainage is to the south, 2.1 km to the southwest of the Proposed Development site at its closest point. The River Mole catchment drainage is to the north, towards the Thames and therefore not hydraulically connected to the River Arun catchment.

Figure 3-7 Catchments and Arun Valley Ramsar



Given the large number of conservation sites within the vicinity of the Proposed Development site a study area of 2 km around the site was used to identify water sensitive receptors. This is the same as the study area size used within the **Chapter 14 - Water and Flood Risk** of the EIA. There are no internationally designated sites such as SACs, SPAs or Ramsar sites within a 2 km radius of the Proposed Development site. There are four statutory designated sites and ten non-statutory designated sites, local wildlife sites (LWS) within 2 km of the site, as summarised in **Table 3.9**.

[25] Horsham District Council (2023) Water neutrality guidelines. Online. Available at: https://www.horsham.gov.uk/planning/water-neutrality-in-horsham-district [Accessed 6 February 2024]

Table 3.9 Conservation Sites within 2 km of the Site

Site Name	Designation	Reasons for Designation	Distance from Site (Approx.)
Designated			
Buchan Hill Ponds	SSSI	Three ponds are the best example in West Sussex of Wealden hammer ponds on acid Tunbridge Wells Sands. A nationally uncommon woodland type occupies the wetlands around the ponds and the site supports a rich dragonfly fauna. The ponds were formed by the damming of two streams and at low points within the topography, but the groundwater input is uncertain.	1.6 km
House Copse	SSSI	A small, isolated woodland, Likely, an 'ancient' woodland with continuity of woodland cover since at least the Middle Ages. A small, isolated woodland on elevated topography (> 100 mAOD) where groundwater input to the habitat is unlikely.	0.8 km
Willoughby Fields	LNR	Large site containing several unimproved grassland fields with a network of hedgerows, areas of scrub and small copses that lies between the River Mole and an unnamed stream on the outskirts of Langley Green in Crawley. Any groundwater dependency for the habitat is unlikely.	0.6 km
Target Hill Park	LNR	A mosaic of habitats including wetlands, woodlands, meadow and scrub areas. A pond and several ephemeral scrape ponds have been excavated, creating a range of wetland habitats.	1.9 km
Non designated			
Hyde Hill	LWS	Lowland mixed deciduous woodland, a NERC S41[26] habitat. A moderate sized woodland. Much of this broadleaved woodland is also ancient and semi-natural.	Adjacent to Site, borders south of the golf course.
Ifield Brook Wood and Meadows	LWS	A patchwork of grass fields surrounded by blocks and strips of scrub and semi-natural broadleaved woodland (a NERC S41 habitat), and mosaic habitats. A watercourse also flows along the eastern boundary. The grasslands appear to be largely unmanaged and as a consequence are dominated by coarse grasses.	Adjacent to Site, borders the east of the arable fields.
Ifield Mill pond and surroundings	LWS	This large pond, situated on the edge of Crawley, is of considerable local importance notably on account of its birdlife, dragonflies, and amphibians.	0.4 km to south
Willoughby Fields	LWS	Large site containing several unimproved grassland fields with a network of hedgerows, areas of scrub and small copses that lies between the River Mole	0.6 km to northeast

[26] NERC S41; 'Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006: habitats and species of principal importance in England'

Site Name	Designation	Reasons for Designation	Distance from Site (Approx.)
		and an unnamed stream on the outskirts of Langley Green in Crawley.	
Wood near Lower Prestwood Farm	LWS	This woodland is dominated by hornbeam and ash, mainly as trees grown from coppice. There are very few mature standards remaining as most have been felled.	0.7 km to northwest
Orltons Copse	LWS	This site consists of two large areas of oak/ hornbeam woodland. There are several small streams throughout and a hay meadow.	1 km to northwest
Woldhurstlea Wood	LWS	Much of this small wood is semi-natural and it has many characteristics of an ancient semi-natural woodland, including a rich ground flora.	1 km to southeast
Kilnwood Copse	LWS	This woodland is of variable structure but in the main, it consists of oak and hornbeam. Unusually, small-leaved lime is also present throughout. There are two small ponds included but these are over-grown and of little aquatic interest at present.	1.3 km to southwest
Ewhurst Wood	LWS	The wood is mostly oak Quercus sp., ash Fraxinus excelsior and birch Betula sp. and has good structure and a diverse ground flora. It is of importance as an area of semi-natural habitat in a heavily built-up area.	1.5 km to east
Buchan Country Park	LWS	This site is a country park. It consists of an area of woodland with an increasing area of heathland, a small meadow and three large lakes on the southwest edge of Crawley.	1.7 km to south

Three LNRs occur on the UTMSM outcrop within a 5km buffer of the Proposed Development site and comprise the following:

- Grattons Park: A broad-leaved woodland, pond and meadows habitat, through which the Gatwick Stream in part meanders;
- Broadfield Park: Lakes and ponds within a wet mixed woodland, meadow and parkland habitat; and
- Tilgate Forest: A broadleaved, coniferous woodland and lowland heathland habitat with a few small ponds.

Areas of ancient woodland identified on the MAGIC website within the vicinity of the Proposed Development site comprise the following:

- Part of the woodland within the Ifield Brook and Meadows LWS, between the Ifield Brook and the Ifield Mill Stream;
- Adjacent to the south of the Proposed Development site along the Hyde Hill Brook;
- Two areas, called Five Acres and at The Grove, on the south bank of the River Mole, to the northwest of the site;

- At Ifield Wood and at Druids coppice to the northwest of the site (west of Ifield Court); and
- Bonnetts coppice to the 400 m to the northeast of the site.

A UKHab survey was undertaken in 2022 (**Chapter 8 – Biodiversity within the ES**) and recorded a number of ponds habitats on the Proposed Development site. Ponds were identified as relatively common in the local area with some managed of ponds on the Ifield golf course area, for example a large pond at NGR TQ 24044 36584. The only other pond identified is a small rectangular pond, located 15 m to the south of the moat at Ifield Court Farm at NGR TQ 24688 38306 outside of the Proposed Development site boundary but encapsulated by it.

Other significantly sized ponds/ lakes within the study area comprise the:

- Douster Pond WFD surface water body (GB30644358) at NGR TQ 24466 34335, 2.2 km to the south of the Proposed Development site which has been assigned a 'Moderate ecological status' and is heavily modified, partly for recreation purposes;
- Ifield Mill pond at NGR TQ 24442 36102 which feeds the Ifield Brook to the north and is 340 m to the southeast of the site; and
- Tilgate Lake at NGR TQ 27894 34418 (Silt Lake and Titmus Lake) to the south of Crawley, 4.3 km from the site.

3.8 Heritage

Heritage sites that may be sensitive to changes in groundwater levels, such as those with a moat, where considered as potential receptors. Given the large number of heritage sites within the study area, a search area of 1 km around the site boundary was used to identify water sensitive receptors which is line with what was used within the **Chapter 9 – Cultural Heritage** within the EIA. The medieval moated site at Ifield Court is a scheduled monument and has considerable heritage significance. The manor is a moated site, currently full of water and approximately 12 m wide and enclosing an area of land 60 m by 66 m. The depth of the moat is unknown but from available photographs[27], it appears that the moat is brick lined with water levels at 2 to 3 m below ground surface.

There are a number of palaeochannels and an oxbow lake (NGR TQ 2473 3821) between the River Mole and the Ifield Court. The **Chapter 9 – Cultural Heritage** within the EIA mentions that such features have the potential to contain deposits which could yield information about the palaeoenvironment and past land use, particularly in the context of the proximity of the medieval moated site at Ifield Court.

There is also a moated site at Ewhurst Place approximately 1 km to the east of the Proposed Development site, within the northwest of Crawley urban area. It is recorded that on the island there is a "*functioning well …. from which clean and unpolluted drinking water can still be drawn*"[28].

Numerous other non-designated heritage sites have been identified across the Proposed Development site[29], such as earthworks etc. The area is also associated with iron ore mining on the clay ironstone geological strata of the WFC and the BGS notes bell pits within the vicinity of the site which often leaves the circular depressions on the surface when abandoned.

27 The Six Moated Manors of Crawley (iansapps.co.uk)
28 The Six Moated Manors of Crawley (iansapps.co.uk)
29 https://iansapps.co.uk/oldbritain/crawley/west_of_ifield.html

4. Conceptual Hydrogeological Site Model

4.1 Project Description/ Proposed Works

The proposed works is to install abstraction well/s for a Proposed Development of 3,000 homes requiring a supply of approximately 500 m^3/day. The WCF at the Proposed Development site is unlikely to provide sufficient yield and therefore the underlying upper part of the TWSF, the UTWSM is the likely target aquifer from which abstraction would take place. The proposed works include the drilling of more than one exploration bores and the installation of one or more abstraction wells (and possibly monitoring well/s) within the Proposed Development site to meet the required demand. Drilling through the WCF and to the base of the UTWSM geological strata is assumed. During operations abstractions will likely be from the abstraction borehole, via a down hole submersible pump, and the maintenance of this and other surface equipment will be undertaken.

The development of the treatment works and/ or installation of pipelines (if required as currently assumed) are also included within this assessment in terms of shallow workings and excavations. However, it should be noted that the interaction with groundwater from these works is expected to be minimal.

4.2 Potential Sources (of impact)

Water resources

The source of impact is the abstraction of water from the deeply confined UTWSM aquifer underlying the WCF. No water will be abstracted from the shallower aquifer formations after drilling is completed and production well/s installed. Water resources impact could occur through the propagation of drawdown or lowering of groundwater levels and/ or hydraulic heads in the UTWSM around the abstraction well/s through that aquifer and/ or into other surrounding aquifers. This could potentially affect other groundwater abstractions, groundwater dependent features and reduce groundwater baseflow to rivers and streams.

Water quality

The shallow workings, drilling and operation of boreholes will require the use of potential pollutants in the form of drilling fluids (if used[30]), fuel oil, drilling rig lubricants and cements that have the potential to leak into aquifers causing pollution. Environmentally hazardous drilling fluids, or those containing groundwater hazardous substances, will not be used during drilling and, therefore, comply with the requirement of the Environmental Permitting Regulations 2016 to prevent entry of hazardous substances into groundwater. The potential sources during drilling operations are set out in **Table 4.1**.

Drilling and abstraction may also encounter poor quality groundwater and the borehole may create a pathway for migration of this groundwater into high/ good quality groundwater.

[30] The design and drilling methodology will be confirmed prior to commencement of the drilling and finalised during the construction of the borehole.

Table 4.1 Potential Sources of groundwater contamination

Source	Description	Components
Drilling fluid(s)	Fluids to aid recovery of cuttings and support the borehole wall and maintain pressure	Bentonite, barytes, foaming agents, e.g. polyacrylamide
Cement	Cement is used to seal the annulus between the casing and formation. A range of additives may be used but are mainly solid materials added to the cement and remain within the cement.	Water Ordinary Portland Cement (OPC) Additives
Fuel oils	Fuel oils are stored at surface and used to power generators. Vehicles at the surface.	Hydrocarbons (Diesel) for the drilling Fuel in vehicles.
Chemical Storage	Chemicals used in drilling stored at surface.	As listed in drilling fluid and spacer fluid rows
Produced Water	Water from other formations – typically brines and/ or other elevated determinands.	Sodium chloride/ salinity; fluoride and boron

4.3 Potential Pathways

The proposed scheme is consumptive and there will be overall loss of water resources from the aquifer. The abstraction of water at the pumping well will result in a local reduction in pressure at that location and this will create a hydraulic gradient within the UTWSM and in overlying formations towards the pumping well. Most of the water abstracted will be drawn laterally within the UTWSM. Downwards water movement from the overlying formation will likely be negligible due to the low permeability of the overlying WCF and its thickness in excess of 100 m.

Because of the hydrogeology within the vicinity of the site, the groundwater resources in the WCF are not considered a relevant receptor since it is not currently used for public and private water supply. In addition, river baseflow and springs are not supported by the WCF or UTWSM in the area of the Proposed Development site and as such, are not considered important in the support of fresh groundwater inputs to water dependent conservation and heritage sites in the area.

The mobilising of contamination from areas of poor land quality is not considered within this hydrogeological risk assessment since the Proposed Development does not lie in an area of significant current and historic industrial uses and construction. The Proposed Development will therefore not introduce significant contaminant pathways to human health, watercourses or damage to buildings or infrastructure.

Pathways by which the sources could result in contamination of groundwater during shallow workings and drilling comprise the following:

- Leaks and spills at the surface followed by downward vertical migration to the water table in the superficial deposits and/ or higher permeability strata within the WCF. Further downward migration into the target UTWSM aquifer is considered very unlikely given the low vertical hydraulic conductivity of the WCF and its considerable thickness. This may also affect surface water through runoff from the drilling area;
- Leaks and spills at the surface followed by downward vertical migration to the superficial deposits and/ or higher permeability strata within the WCF via the borehole or annulus during early stages of drilling. Leaks and spills on the drill floor have the

potential to migrate via this route. However, these are the same fluids used during drilling (see below);

- Loss of drilling fluids to the formation during drilling;
- Loss of cements to the formation during cementing; and
- Leaks of formation water between aquifer units via casing and the migration of formation water via well annulus.

Pathways during operation comprise:

- Leaks and spills from above ground pipework at the surface followed by downward vertical migration to the water table/ surface water bodies; and
- Leaks of abstracted groundwater to other subsurface formations via casing.

Pathways within the WCF or UTWSM would be expected along strata with higher hydraulic conductivity, such as permeable sandstone units and/ or along bedding planes.

4.4 Potential Receptors

Potential Receptor List

The focus of the hydrogeological risk assessment is on potential receptors that may be adversely impacted by the shallow workings and borehole construction at the Proposed Development site as well as water supply from a borehole installed within the UTWSM. The list of potential receptors within the study area are listed below within **Table 4.2** and shown within **Figure 4-1**.

- Surface water bodies: such as rivers and streams; lakes, ponds springs;
- Groundwater bodies;
- Water resources: Public water supplies and PWSs and surface water drinking WSZ;
- Licenced abstractions and discharges;
- Conservation sites (wetlands): designated and non-designated and ancient woodland; and
- Heritage.

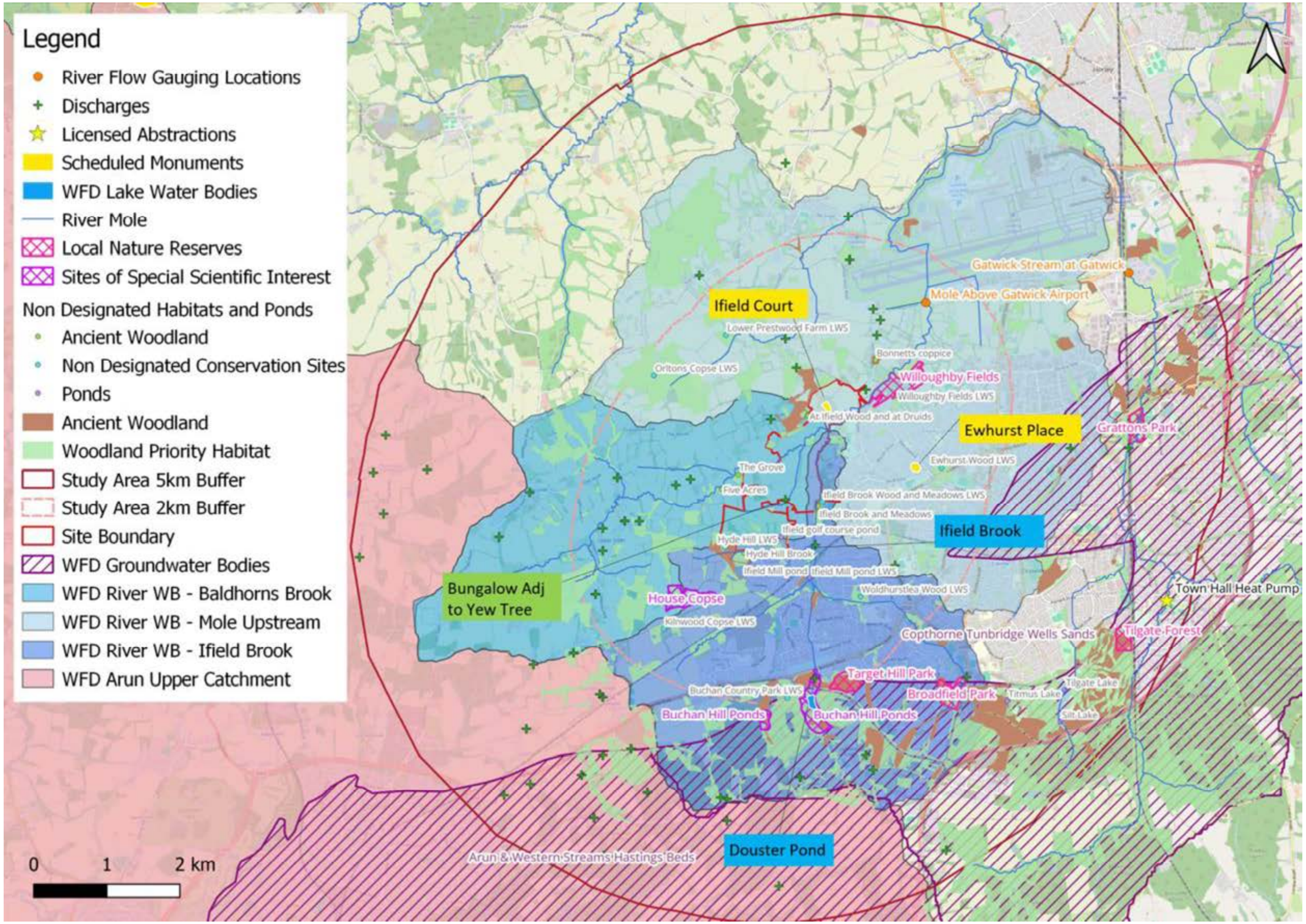
Table 4.2 Potential Water Features Receptor List

Receptor	Rationale for potential receptor
Surface Water Bodies	
River Mole and Ifield Brook	Surface water features that may receive baseflow from groundwater. Abstraction has the potential to change groundwater levels and hydrogeological flow regimes. Shallow workings and drilling have the potential to introduce contaminates into catchment runoff.
Arun river catchment	
Douster Pond	
Groundwater Bodies	
Wealden Clay Formation	
Tunbridge Wells Sand Formation	

Superficial Deposits: Alluvium and river terrace deposits	The shallow workings and the drilling of boreholes through these groundwater bodies has the potential to introduce contaminants. Abstraction has the potential to change groundwater levels and hydrogeological flow regimes.
Water Resources	
Public water supplies (SPZ)	
Registered PWS	The shallow workings and drilling within SPZs and/ or within catchment zones of PWSs has the potential to introduce contaminants. Abstraction has the potential to change groundwater levels and hydrogeological flow regimes. This could impact groundwater availability to public water supplies/ PWSs and baseflow to surface water river flows.
Surface water abstractions	
Unlicensed/ unregistered (assumed potable) groundwater PWS abstractions.	
Licences and Discharges	
Licence Number: TH/039/0032/020 Permit: TH/CTCR.0825/001 Bungalow adjacent to Yew Tree cottage	Reduction in baseflow to surface water features may influence overall cumulative effects on river flow/ quality within and downstream of the Proposed Development site.
Surface water drinking WSZ	
Thames Cookham Teddington and Wey	
Conservation Sites	Upstream surface water features that may receive baseflow from groundwater have the potential to influence downstream river flows.
Designated	
Buchan Hill Ponds SSSI	
House Copse SSSI	
Willoughby Fields LNR	
Target Hill Park LNR	
Grattons Park LNR	
Tilgate Forest LNR	
Non-Designated	
Hyde Hill	Water dependent ecological habitats and associated conservation sites may receive baseflow from groundwater and/ or be dependent on river flows. Abstraction has the potential to change groundwater levels and hydrogeological flow regimes.
Ifield Brook Wood and Meadows	
Ifield pond and surroundings	
Wood near Lower Prestwood Farm	

Orltons Copse	
Woldhurstlea Wood	
Kilnwood Copse	
Ewhurst Wood	
Buchan Country Park	
Ponds	
Ifield Mill pond Tilgate Lake (Silt Lake and Titmus Lake) Other smaller ponds and lakes, such as pond at NGR TQ 24044 36584 (Ifield golf course)	Surface water features that may receive baseflow from groundwater. Abstraction has the potential to change groundwater levels and hydrogeological flow regimes. Shallow workings and drilling have the potential to introduce contaminates into catchment runoff.
Ancient Woodland	
Woodland within the Ifield Brook and Meadows LWS (NGR TQ 24544 37006)	
Along the Hyde Hill Brook **(**NGR TQ 23537 36369)	
Five Acres (NGR TQ 23225 37247) The Grove (NGR TQ 23453 37445)	
At Ifield Wood and at Druids (NGR TQ 24409 38248)	Woodland habitats that may be sensitive to groundwater levels and water supply if they are groundwater dependent. Abstraction has the potential to change groundwater levels and hydrogeological flow regimes.
Bonnetts coppice (NGR TQ 25331 39005)	
Heritage	
Medieval moated site at Ifield Court	Water levels within moats may be dependent upon groundwater levels within the area. Abstraction has the potential to change groundwater levels and hydrogeological flow regimes.
Moated site at Ewhurst Place	

Figure 4-1 Potential receptors



Scoped Out Receptors

Although the Proposed Development site is within the SNWRZ this zone is associated with the protection of surface water supplies to the Arun Valley Ramsar site within the River Arun catchment. The boundary, or divide, to this catchment is 2.1 km to the southwest of site at its closest and therefore not hydraulically connected to the Proposed Development site area. Therefore, the UTWSM aquifer is hydrologically disconnected from the Arun River catchment within the SNWRZ and the Arun Valley Ramsar site potential receptor has also been scoped out on this basis.

The proposed production borehole/s are to be installed within the UTWSM below more than 100 meters of WCF which is a low permeability confining layer and will act as a hydrogeological barrier to groundwater flow. As such, it is considered that any surface water features at the Proposed Development site will be hydraulically isolated from deep groundwater abstraction from the UTWSM aquifer. Therefore, the following receptors are considered as unaffected by the proposed abstraction placing them out of scope of this assessment:

Table 4.3 Water Features Receptor Scoped Out List

Receptor	Rationale for scoping out
Surface Water Bodies	
River Mole and Ifield Brook[31]	The WCF forms a low permeability barrier to groundwater flow so any abstraction from the UTWSM will not have an impact on the quantity of baseflow to surface water features. The Proposed Development site is not within the Arun River catchment and not hydraulically connected so surface water quality impacts due to contamination events and discharges during testing are not possible.
Arun River catchment	
Ponds and lakes	
Groundwater Bodies	
Superficial Deposits: Alluvium and river terrace deposits	The WCF forms a low permeability barrier to groundwater flow so any abstraction from the UTWSM will not have an impact on the quantity of baseflow to superficial deposit aquifers.
Wealden Clay Formation	During the operation of the abstraction borehole within the UTWS the WCF will be cased out within the borehole and the low permeability nature of the WCF will prevent any major impact on the quantity of groundwater within more permeable layers within the WCF.
Water Resources	
Public water supplies (SPZ)	
Registered PWS	

[31] River Mole and Ifield Brook are still receptors in terms of surface water quality due to discharges during shallow workings, borehole drilling and testing processes.

Surface water abstractions Unlicensed/ unregistered (assumed potable) groundwater PWS abstractions Surface water drinking WSZ	The WCF Formation forms a low permeability barrier to groundwater flow so any abstraction from the UTWSM will not have an impact on the quantity of baseflow to surface water features or perched water tables within superficial deposits. The single licenced surface water abstraction within the study area is over 4.5 km from the Proposed Development site and not hydraulically connected to the site.
Licences and Discharges	The WCF forms a low permeability barrier to groundwater flow so any abstraction from the UTWSM will not have an impact on the quantity of baseflow to surface water features and river flows and any abstraction from the WCF. Discharges on the UTWSM outcrop are over 2.5 km from the Proposed Development site boundary and influence on groundwater levels and resultant baseflow is highly unlikely.
Conservation Sites	
Designated SSSI and LNR and non-designated LWS sites	The WCF forms a low permeability barrier to groundwater flow so any abstraction from the UTWSM will not have an impact on the quantity of baseflow to surface water/ shallow groundwater dependent conservation sites. All conservation sites within the study area are over 400 m from the Proposed Development site. Any contamination and discharges would be diluted and not have a significant impact on downstream habitats.
LNR sites on the UTWSM outcrop	The habitats are likely to have minimal groundwater dependency and are often associated with alluvial superficial deposits where groundwater levels will likely interact with the local stream.
Ancient Woodland	All woodland habitats are out with the Proposed Development site. Any contamination and discharges would be diluted and not have a significant impact on downstream habitats. The WCF forms a low permeability barrier to groundwater flow so any abstraction from the UTWSM will not have an impact on the quantity of baseflow to ancient woodland habitats which are not likely to be sensitive to deep aquifer hydrogeological changes.
Heritage	
Medieval moated site at Ifield Court Moated site at Ewhurst Place	It is likely that much of the water within the moats comes from pluvial and surface drainage input with minimal groundwater baseflow. In addition, the WCF forms a low permeability barrier to groundwater flow so any abstraction from the UTWSM will not have an impact on the quantity of baseflow to moated

	heritage sites within the study area. Both moated heritage sites are outside of the Proposed Development site boundary and a runoff contamination pathway to Ewhurst Place is not possible and unlikely to the moated site at Ifield Court.

Impacts on Water Framework Directive (WFD) status of groundwater and surface water bodies and conservation sites have not been considered within the assessment since these aspects will be dealt with in the **Chapter 14 - Water and Flood Risk** of the EIA. The Proposed Development site is not in the vicinity of any discharges or licenced abstractions and so these have been scoped out of the assessment. In addition, no PWSs within the study area has been identified and the single licenced surface water abstraction identified within the study area is over 4.5 km from the Proposed Development site and not hydraulically connected to the site and this has therefore been scoped out from the assessment.

Final Scoped in Receptors

The following receptors (**Table 4.4**) have been scoped in for the assessment based on a potential hazard (source) and pathway to the receptor identified.

Table 4.4 Water Features Receptor Scoped in for Assessment

Receptor	Rationale for scoping in
Surface Water Bodies	
River Mole and Ifield Brook	Receptors in terms of surface water quality due to discharges during shallow workings, borehole drilling and testing processes due to a potential runoff pathway from the borehole location/ discharge point into the surface watercourse.
Pond at NGR TQ 24044 36584 (Ifield golf course)	
Groundwater Bodies	
Superficial Deposits: Alluvium and river terrace deposits	Receptor in terms of water quality due to discharges during shallow workings, borehole drilling and testing processes, i.e. surface water runoff and recharge into the aquifer.
Wealden Clay	Receptor in terms of water quality due to shallow workings on and drilling through the formation.
UTWSM	Receptor in terms of water quality due to borehole drilling processes and water quantity due to long term abstraction.

4.5 Conceptual model

Overview

The Proposed Development site lies on relatively flat rural ground at approximately 60 mAOD in the northern and central areas, rising gently to approximately 85 mAOD in the south of the site. The River Mole flows through the Proposed Development site in a north-easterly direction and the Ifield Brook flows to the north along the eastern border of the site. The land usage is predominantly of arable fields, occasional housing and farms with the Ifield Golf and Country Club in the extreme south of the Proposed Development site. The urban area of Crawley lies just beyond the site boundary to the east. A minor road, Rusper Road, runs through the southern area of the Proposed Development site from southeast to the northwest. Other water features within the area include field and land drains flowing to the north directly into the River Mole or Ifield Brook and occasional small ponds. The low-lying nature of the terrain is typical of the Weald in this area and surface water features reflect the low permeability geology of the Wealden Series at the site.

The hydrogeology conceptual understanding is presented below and supported by two conceptual cross sections running north to south and east to west through the study area (**Figure 4-2** and **Figure 4-3**). The conceptual key indicates source/ pathway/ receptor linkages and impacts that are assessed within the hydrogeological risk assessment.

Local History

Local historical mapping indicates that the Proposed Development site has not undergone any major changes in historical land use although some surface pit/ quarry workings is possible in the area. No historical contaminant areas of potential concern have been identified. It is noticeable that many of the dwellings/ farms in the area had wells (five counted along the Rusper Road alone) in the past, pre-1900 indicating that shallow strata in the area is capable of supporting small supplies. The depth and source of water for these wells is uncertain and it is presumed that they were abandoned as piped domestic supply became available across the area although this is uncertain.

Geology

At the Proposed Development site, the geology comprises the WCF at outcrop which consists of mudstones, siltstones, fine to medium-grained sandstones with occasional limestones and clay ironstone bands (**Figure 4-2**). Local borehole logs suggest the WCF is between 80 and 130 m thick beneath the site, although this is uncertain. Below the WCF lies the TWSF, the shallowest unit being the UTWSM of fine to medium-grained silty sandstone, siltstone and silty sand with finely interbedded mudstones and thin limestones.

The UTWSM is expected to be between 113 m and 128 m thick beneath the Proposed Development site. Below this is the Grinstead Clay Member of silty mudstone (3 to 27 m thick) and the Lower Tunbridge Wells Sand Member (18 to 42 m thick) which is composed of similar strata to the upper member, albeit generally less clayey. The total thickness of the TWSF is not well documented but expected to be up to 197 m thick.

Depths are estimates and can only be confirmed by drilling at the site in part due to faulting in the area, i.e. along the Crawley fault, and the lack of borehole logs within the vicinity of the Proposed Development site. It is believed that the UTWSM strata beneath the Proposed Development site outcrops at the surface approximately 3.5 km to the east within the area of central Crawley. Two laterally continuous mudstone units are mapped by the BGS within this area and may extend in the direction of and beneath the Proposed Development site.

Superficial deposits

Alluvium clay, silt, sand and gravel deposits occur within the centre of the Proposed Development site along the paths of the River Mole, its tributary and Ifield Brook watercourses. River terrace deposits of sand and gravel also exists on the Proposed Development site representing older abandoned floodplains deposits. On the site these occur in three main patches, two to the north of the Rusper Road and one to the south, between the main watercourses in the area (**Figure 3-4**). Superficial deposits are approximately 3 or 4 m in thickness.

Geological structure and faulting

The dip of the geological strata is shallow and to the northwest at approximately 2 or 3 degrees as indicated by the outcrop on geological mapping to the east of the Proposed Development site (**Figure 4-2**). Given the direction/ amount of dip and topography of the area, the boundary between the WCF and UTWSM which outcrops approximately 2 km to the east of the Proposed Development site should occur at a depth of approximately 100 m. There is uncertainty with this, and it could be greater than this depth, since the WCF and UTWSM outcrop boundary is faulted in places by a northeast to southwest trending fault, to the east of the A23 carriageway, with downthrow to the northwest. This fault is truncated to the south by the Crawley Fault where it stops.

The Crawley Fault trends from east to west (**Figure 3-3**), through the extreme south of the Proposed Development site, within the Ifield golf course. The throw of this fault is about 60 m to the south, at its eastern extent and thickens the WCF south of the fault. Geophysical seismic data indicates that the WCF strata is flexed downwards as a result of the fault movement downwards to the south. Also, just to the south of this fault are mapped WCF sandstone and limestone units forming a small east to west trending synclinal structure, which could be folding associated with this fault. The Holmbush Fault (located approximately 2 km south of and parallel to the south Crawley Fault) trends from east to west approximately 2.75 km to the south of the Proposed Development site. The amount of throw along this fault is uncertain, but it is probably about 30 m to the northwest, along most of its length.

The faults in the area, by truncating the UTWSM and more permeable strata, form barriers to groundwater flow between the same aquifer units because of the juxtaposition of permeable and impermeable layers. For example, the downthrown WCF south of the Crawley Fault will reduce the potential for groundwater flow to the north across the fault into the UTWSM aquifer units. In general, it is uncertain whether these faults are permeable or form barriers to groundwater movement. For the purposes of this assessment, and as a conservative assumption, the faults have been assumed to form barriers to groundwater flow that will limit the size of the potential resource, particularly to the south.

Recharge

The source of recharge for the UTWSM beneath the site is uncertain. There is likely to be limited vertical leakage through the overlying thick low permeability WCF and groundwater flow through and along faulting is unknown. Any recharge to the south of the site is unlikely to migrate northwards due to the structures between, such as folding and faulting. Faulting has moved the WCF layers to greater depth south of the Crawley fault and may have aligned impermeable to prevent flow northwards into the UTWSM (**Figure 4-3**). With this being the case, any potential recharge from the south would only feed the deeper UTWSM strata.

The dip of the UTWSM is shallow (2 to 3 degrees) to the northwest. Strata within the UTWSM outcropping 2 km to the east of the Proposed Development site, within central Crawley, occurs at approximately >100 and 150 m depth below the site. This area therefore represents a potential recharge area where groundwater flow could be preferentially aligned along bedding planes to the northwest. Jones et al., (2000), note the structural controls of groundwater flow within the Weald with tends to flow in the direction of dip towards the axes of synclines and away from the axes of anticlines.

As the potential recharge area for the UTWSM below the site is unclear this has implications for the overall sustainability of any abstractions within the area. Estimating the required recharge area to supply and sustain a proposed production borehole yield of 500 m^3/ day, based on the average long term average recharge of between 0.5 to 0.8 mm/day (200 to 300 mm/year, equates to an area of between 0.9 and 0.6 km^2, which represents much of central Crawley. However, urban land use areas will capture and divert rainfall to surface water and therefore limit the potential for recharge. Therefore, although the potential recharge outcrop area is available the rate of recharge to the aquifer in this area is difficult to determine and the amount of runoff verses leakage into the subsurface is unknown.

Groundwater Heads

Groundwater heads directly beneath the Proposed Development site are uncertain since there is little local data. Regionally records of groundwater heads within the WCF and TWSF/ UTWSM are also sparse and often dating back to before the 1940s. The role of faulting on groundwater heads in the area is also uncertain. It is therefore impossible to verify groundwater levels and vertical head differences prior to exploration drilling, because of the lack of current data and also the complex nature of local controls, i.e., strata dip, structural faulting and lithology variations with depth.

However, general indications are that within the UTWSM outcrop groundwater heads are close to the surface (within 10 meters depth) as demonstrated within the Hilton Mount College, Worth borehole and the well at Three Bridges borehole Crawley (**Figure 3-6**). Beneath the WCF the UTWSM is confined and the BGS geological log records from the Brighton Road pumping station borehole, (Crawley) gives an indication that the piezometric surface is close to ground surface and the borehole occasionally became artesian as it was deepened numerous times. Slight artesian conditions are also indicated by the Eskimo Ice borehole with the UTWSM confined by 80 m of WCF. Lithological variations within the UTWSM will affect groundwater flow and heads, as clay horizons split the sandstone into a multi-layered aquifer, resulting in variations in vertical heads. The groundwater heads within the WCF are also likely to be close to ground surface within the Proposed Development site area but be at greater depth below locations at higher elevations.

Groundwater Yields

Historical borehole geological logs, often pre-1930s, indicate initial yields between 55 and 218 m^3/d are possible from the WCF and higher yields of between 109 and 676 m^3/d are possible from boreholes installed through the full thickness of the UTWSM. However, each of boreholes shown on **Figure 3-6** have varying depths, response zones and local hydrogeological regimes. As groundwater flow within the UTWSM is both intergranular and through joints yields are likely to vary depending on the lithology and strata within the response zone. Long-term sustainable yield will depend on intercepting laterally extensive and productive sandstone layers with a connection to a recharge zone. The Eskimo Ice borehole was drilled into the top 5 m of the UTWSM and was licenced for the abstraction of 130m^3/d.

It is also noted (Jones et al., 2000) that smaller diameter boreholes tend to have a disproportionately lower yield, and at some sites usually being less than 300 m^3/d (i.e. 200 mm diameter borehole). Boreholes records indicate that many boreholes in the area, particularly on the WCF, have been abandoned. The reason for their abandonment is unknown and may be due to the availability of piped domestic supplies. However, it may also be due to declining yields and poor performance. There is an indication that the yield drops over time from the UTWSM aquifer (for example as described in detail within Brighton Road Pumping Station borehole log) and boreholes have been deepened, often more than once due to a drop in yield and/ or siltation of the borehole. Jones et al., (2000) notes that combined with the problem of siltation it has sometimes proved necessary to excavate adits to obtain and maintain productive capacity from boreholes.

Hydrogeological Parameters

Values of transmissivity within the TWSF range from 6.1 - 39.5 m^2/d, with a geometric mean of 19.0 m^2/d and an interquartile range of 13.8 to 35.4 m^2/d (Jones et al, 2000). Groundwater flow within the strata is both intergranular and through joints. The lithology and degree of cementation within the TWSF have been found to show considerable variation and therefore predictions of aquifer properties are difficult (Jones et al, 2000). The potential UTWSM aquifer thickness is at the Proposed Development site is approximately 120 m thick.

Groundwater flow

Shallow perched groundwater tables may exist within superficial deposits on the site and feed limited baseflow to the River Mole and its tributaries. The baseflow index of the River Mole is 0.23, which is typical of rivers draining impervious clay catchments, and indicating that most of the flow is from runoff with only a small groundwater contribution. Observed heads of specific geological strata in the study area are too sparse to be able to determine groundwater flow gradient heads. However, within the WCF groundwater levels are expected to be close to the surface and some limited shallow groundwater flow regimes may exist, which may flow towards later water bodies from higher elevations.

It is also likely that groundwater at the Proposed Development site within the deeper WCF and UTWS is relatively slow moving because there are no major driving hydraulic gradients to generate groundwater flow. The introduction of a new abstraction borehole/s into the site would reduce hydraulic pressures within the confined aquifer system and develop increased groundwater flow and draw more water into the confined aquifer from recharge areas. Recharge areas are uncertain, but as describe above, are possibly to the southeast of the Proposed Development site and, therefore, flow is likely to be from this recharge area towards the abstraction. Flow directions may also be influenced by the dip of the UTWSM, which is shallow to the northwest and by layering within the aquifer.

The Grinstead Clay Member below the UTWSM forms an aquiclude that forms the base of the system of interest. Faulting (the Crawley and Holmbush faults) also adds uncertainty to the deeper groundwater flow within the region. Faults may be impermeable and the dislocation along them may disrupt more permeable strata to reduce any potential flow paths.

Groundwater quality

There is no groundwater quality data for the sites and data is sparse within the surrounding area and there is limited regional water quality data. Therefore, there is uncertainty regarding the quality of groundwater below the site. However, regional data gives an indication of likely groundwater type and potential water quality issues.

Water quality results available for the productive bands within the WCF suggests moderately hard groundwater (for example 85.5 mg/l of total hardness); strongly alkaline, with elevated concentrations of chloride close to the 250 mg/l DWS. High chloride is possibly a widespread issue in the WCF. The depth of the aquifer below the WCF will reduce the vulnerability and therefore free from anthropogenic surface contamination inputs.

Water quality within the UTWSM beneath the WCF is based on available information from the Eskimo Ice borehole[32], and although the aquifer is confined, it appears to be generally of good

[32] Geological log and construction details for the Eskimo Ice borehole were supplied by the EA and indicated that a 85 m deep borehole was screened from 13 m to 84 m (response zones of 67 m of WCF and 4 m of UTWSM). It is assumed

quality. The groundwater is characterised by low hardness water with high levels of $NaHCO_3$ (sodium bicarbonate) indicating ion exchange processes[33] have taken place between groundwater and the aquifer. For this assessment it is assumed that water quality from this borehole is representative of the confined aquifer groundwater type beneath the Proposed Development site. However, this assumption should be treated with caution since the water quality may be stratified with the upper part of the formation giving better (less saline) water quality and/or also giving better yield due to less confining pressure.

Water quality at Newstead Farm borehole is more representative of groundwater water quality beneath the UTWSM outcrop and may be different to quality in the deep confined aquifer. This groundwater would be more representative of potential recharge groundwater. From the data obtained some differences/ similarities between the groundwater quality of that below UTWSM outcrop and below WCF and it is worth comparing the two groundwater types as follows:

- pH and conductivity are higher within the Newstead Farm samples (on outcrop) than the Eskimo ice borehole samples;
- Slightly higher dissolved sodium within the Newstead Farm samples (on outcrop) on average between 180 – 240 mg/l, above the DWS standard of 200 mg/l;
- Slightly higher chloride within the Eskimo ice borehole samples (beneath WCF);
- Elevated Boron up to ~1,100 µg/L above the DWS (1000 µg/L) within the Newstead Farm samples (on outcrop);
- Higher alkalinity within the Newstead Farm samples (on outcrop) current level >350 mg/l as $CaCO_3$ (no DWS guideline);
- Low levels of dissolved Ca within both borehole sample analysis;
- Low levels of dissolved metals (Fe and Mn) within both borehole sample analysis;
- Both sites have a level of fluoride higher than the DWS (1.5 mg/)l, being higher within the Eskimo ice borehole samples (beneath WCF) up to > 7 mg/l. High fluoride is unusual and most groundwaters have low or acceptable concentrations of fluoride (<1.5 mg/l).

Fluoride in water derives mainly from the dissolution of natural minerals in the rocks and soils with which water interacts and long reaction times with aquifer minerals are also important. High fluoride concentrations can build up in groundwaters which have long residence times in the host aquifers[34]. In addition, low dissolved calcium concentrations will reduce the stability of mineral fluorite to release Fl into solution (Appelo & Postma, 2005)[35]. This likely indicates that the groundwater beneath the WCF is "*fossilised groundwater*", that is it has been largely static for a long time, possibly since the formation's deposition.

Based on the available existing water quality data the anticipated water quality is expected to be suitable for potable use with the exception of fluoride and boron. In addition, there may be wholesomeness issues due to the high sodium bicarbonate content.

A water quality risk assessment[36] (WQRA) has been undertaken comparing the statistical water quality to the prescribed concentration values included in *The Water Supply (Water Quality)*

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that yield is predominantly from the UTWSM and water quality is representative of this formation although the degree to which there is mixing of water from the WCF is uncertain.

[33] $NaHCO_3$-type water forms when fresh groundwater invades an area that previously contained seawater (sodium-rich brine) and the Na in seawater takes up exchange sites in the sediments. When fresh groundwater invades the area, the Ca of standard $Ca\text{-}HCO_3$-type groundwater exchanges with the Na.

[34] https://www2.bgs.ac.uk/groundwater/downloads/element_sheets/Fluoride.pdf

[35] Appelo, C. and Postma, D. (2005) Geochemistry, Groundwater and Pollution. 2nd Edition, Balkema, Rotterdam.

[36] WSP 17 November 2023 Memo - Proposed Water Treatment for Drinking Water Supply West of Ifield.

Regulations 2016 and recognised standards (applied at the tap) and guidelines. Results from this risk assessment indicate that groundwater will require treatment to reduce the fluoride levels to below the required standard, whilst sodium and alkalinity may impose noticeable aesthetic (taste, odour, feel) character to the water. The level of boron in the water is also marginal and may at times exceed the DWS and will also likely require treatment.

Figure 4-2 Conceptual Cross Section A-A' (East to West)

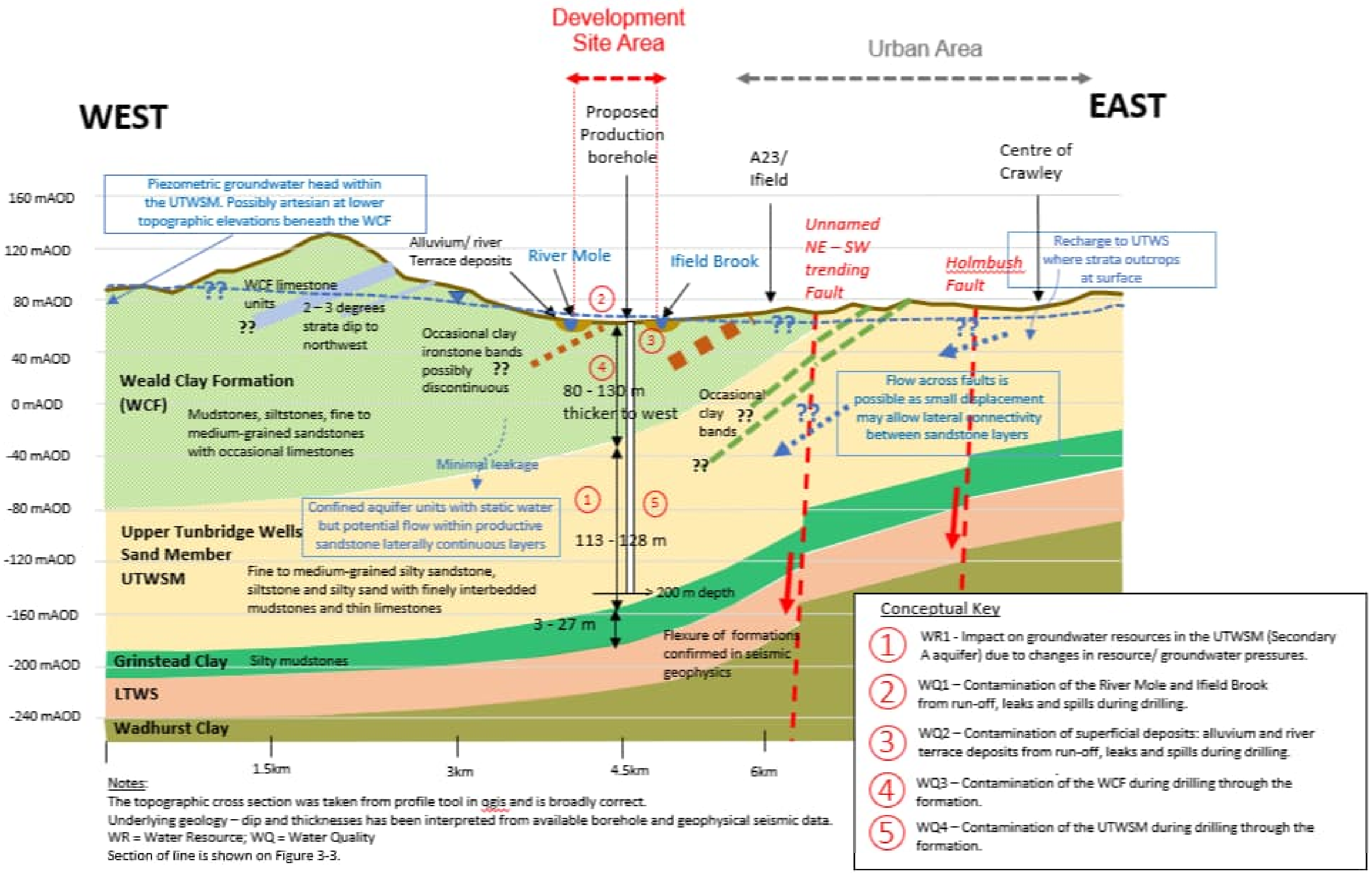
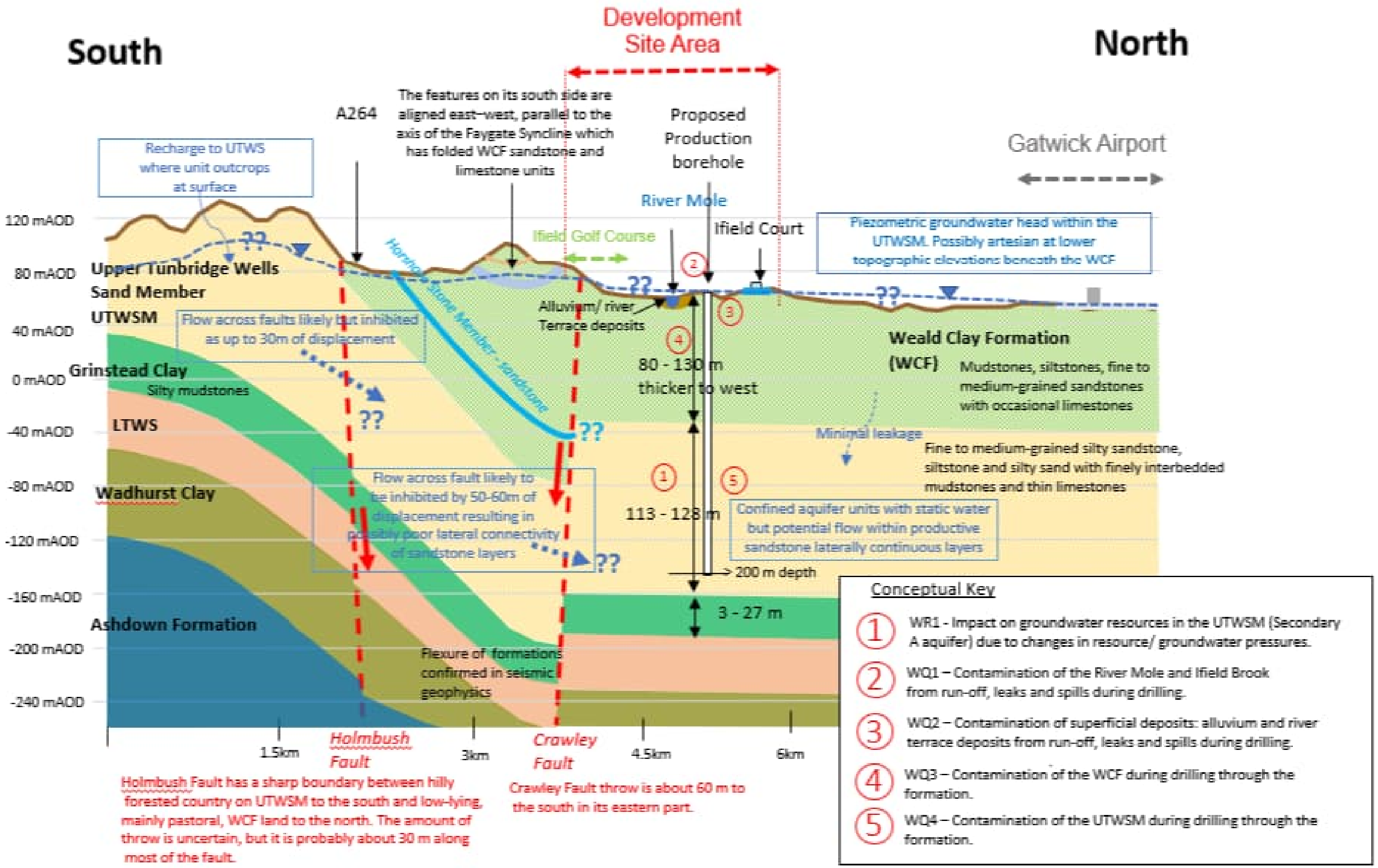


Figure 4-3 Conceptual Cross Section B-B' (North to South)



Notes:
The topographic cross section was taken from Google Earth and is broadly correct. Underlying geology – dip and thicknesses has been interpreted from available borehole and geophysical seismic data.
WR = Water Resource; WQ = Water Quality
Section of line is shown on Figure 3-3.

4.6 Potential Target Aquifers and Assessment of Water Supply

The target aquifer is the UTWSM from which higher yields are expected than within the WCF, particularly if drilling through the full thickness of the formation. This formation is of fine to medium-grained silty sandstone, siltstone and silty sand with finely interbedded mudstones and thin limestones. Laterally extensive and productive sandstone layers are the target strata which will aid sustainability of production. Although uncertain, the depth of the UTWSM is expected at between 80 and 130 m beneath the site, with thickening strata to the northwest. The UTWSM is expected to be between 113 m and 128 m thick beneath the development site.

Yield is also uncertain, although based on data collected from other boreholes in the area, there is potential for the UTWSM at depth below the Proposed Development site to supply the required yield of 500 m^3/d at least initially. However, the sustainability of any supply is unclear, i.e., it may not be possible to maintain the initial yield in the long term.

There is uncertainty regarding the quality of groundwater below the site, although it appears to be of reasonable quality and better than that from the WCF. However, it is likely to require treatment to reduce the fluoride and boron levels to below the required standard, whilst sodium and alkalinity may impose noticeable aesthetic (taste, odour, feel) character to the water that affect water wholesomeness and therefore may also require treatment before domestic use. The UTWSM aquifer may be stratified with the upper part of the formation giving better (less saline) water quality and other determinands will have to be tested during borehole testing to confirm they meet the DWS. Evidence of high chloride within WCF indicates that this formation should be cased and grouted to prevent cross contamination of the UTWSM.

The uncertainties regarding both water quantity and quality can only be resolved through collection of additional data. Some additional water quality data may be available from existing boreholes or through additional testing of water from those boreholes. However, further information on yields and water quality beneath the development can only be acquired through the drilling and testing of new boreholes.

In addition, it should be noted that the significant depth of the boreholes to the target UTWSM aquifer, requirements on borehole design specifications, such as borehole diameter and pump size, to maximise yield and treatment to improve water quality will likely impose significant costs for installation and operations of any project.

5. Hydrogeological Risk Assessment

5.1 Approach

This preliminary desk-based study (Phase 1) has been undertaken to determine the feasibility for a new borehole to supply drinking water at the development and it will be used to support a future application for an abstraction licence from the EA. This section sets out the approach to the hydrogeological risk assessment which supports the EIA for the proposed housing development.

The EA's guidance (EA, 2007) on undertaking hydrogeological impact assessments for abstraction sets out a multi-step process, as follows:

- Step 1: Establish the regional water resource status;
- Step 2: Develop a conceptual model for the abstraction and the surrounding area;
- Step 3: Identify all potential water features that are susceptible to flow impacts;
- Step 4: Apportion the likely flow impacts to the water features;
- Step 5: Allow for the mitigating effects of any discharges, to arrive at net flow impacts;
- Step 6: Assess the significance of the net flow impacts;
- Step 7: Define the search area for drawdown impacts;
- Step 8: Identify all features in the search area that could be impacted by drawdown;
- Step 9: For all these features, predict the likely drawdown impacts;
- Step 10: Allow for the effects of measures taken to mitigate the drawdown impacts;
- Step 11: Assess the significance of the net drawdown impacts;
- Step 12: Assess the water quality impacts;
- Step 13: If necessary, redesign the mitigation measures to minimise the impacts; and
- Step 14: Develop a monitoring strategy.

The guidance identifies three tiers of assessment:

- Tier 1 (Basic): Conceptual model developed from information and data from published sources and bodies such as the EA and the BGS. The conceptual model is typically tested using simple analytical equations, to arrive at a 'best basic' conceptual model. A Tier-1 assessment is likely to be required in virtually all cases;
- Tier 2 (Intermediate): The sophistication of the conceptual model is increased by testing it using more detailed data, such as time-variant heads and flows. More detailed analytical solutions may be used (to investigate the impact of abstraction on river flows, for example), or two-dimensional steady-state groundwater models. Limited field investigations may be required to fill important gaps in the data. Tier-2 assessments are likely to focus on (and be limited to) specific areas of uncertainty that have been highlighted during Tier 1.
- Tier 3 (Detailed): The conceptual model represents a high degree of understanding of the hydrogeological and hydrological system and is likely to be tested using a spatially-distributed and time-variant numerical groundwater model, calibrated and validated against historical data.

Given the scale and current stage of the development the Tier 1 (basic) approach set out in EA (2007) guidance has been applied:

- Gather data on the study area of the Proposed Development site;
- Develop a hydrogeological conceptual model for the area; and
- Undertake a hydrogeological risk assessment following EA guidance, which has been divided into two sections:
  - Water quality impacts; and
  - Water resources (quantity) impacts.

The methodology for hydrogeological impact appraisal (HIA) is designed to fit into the Environment Agency's abstraction licensing process, including the changes brought about by the Water Act 2003. It is also designed to operate within the Environment Agency's approach to environmental risk assessment, so that the effort involved in undertaking HIA in a given situation can be matched to the risk of environmental impact associated with the proposed groundwater abstraction. Accordingly, the same approach is considered highly pertinent to this hydrogeological risk assessment.

The overall methodology used here follows the approach set out in EA (2007). Not all 14 steps require detailed consideration at this time given the depth and scale of the abstraction and stage of development with the approach adopted being summarised in **Table** 5.1.

Step 1 indicates that the HIA is likely to concentrate on specific impacts at the local scale (1 km around the site), particularly during borehole drilling, installation and testing periods, i.e. during construction. However, for Step 2 the preliminary conceptual model for the area considers a wider area (5 km around the site), taking into account the outcrop of the UTWSM and potential recharge zone areas. Given the confined nature of the target aquifer, this will be most applicable during long term abstraction and operational phases of the project. As described within Step 7, the depth and location under the WCF mean that water resources impact on surface water and near surface groundwater will likely be minimal locally and the screen of potential receptors (**Section 4.4**) has been undertaken on this basis.

Table 5.1 Steps within the Hydrogeological Impact Appraisal and Approach Taken

Steps	Approach within the hydrogeological impact appraisal
Step 1: Establish the regional water resource status	The *EA Mole Abstraction licensing strategy, February 2013* (Protection of Groundwater (EA Licensing Strategy)) states that on the outcrop area of the UTWSM water is available for licensing. New licences can be considered depending on impacts on other abstractors and on surface water. The two WFD groundwater bodies: the Copthorne Tunbridge Wells Sands beneath the UTWSM outcrop and the Arun & Western Streams Hastings Beds both have been given an overall 'Good Status'. (quantitative and chemical) and are not at risk. Given the abstraction management strategy (*water available*) and WFD status (*not at risk*) the hydrogeological assessment is likely to concentrate on specific impacts at the local scale.
Step 2: Develop a conceptual model for the abstraction and the surrounding area	The preliminary conceptual model is described within **Section 2.5** of this document.
Step 3: Identify all potential water features that are susceptible to flow impacts	Water features at local scale (1 km around the site) will be identified within the Water Features Survey (WFS) accompanying a Section 32 application for drilling and testing of borehole/s. The default search area for an abstraction rate of 500 m^3/d is set at 1km by the EA. Considering the confined nature and distant outcrop of the UTWSM and potential recharge zone areas a 5km buffer around the site is conservatively considered for long term operational abstraction. Water features within a wider area (5km around the site) are listed within **Table 4.2** of this document.
Step 4: Apportion the likely flow impacts to the water features	500 m^3/d is equal to 0.5 Ml/d which during long term abstraction operations can be apportioned to springs and baseflow feeding surface watercourses on the UTWSM outcrop, i.e. the Gatwick Stream to the east of the Development Site and the very upper reach of the Upper Mole to the south of the Development Site.
Step 5: Allow for the mitigating effects of any discharges, to arrive at net flow impacts	No mitigation effects are anticipated since discharges associated with the abstraction will be minimal. Any possible return of abstracted groundwater would be into the Upper Mole catchment.
Step 6: Assess the significance of the net flow impacts	Water resource availability is for at least 50% of the time for the surface watercourses: Gatwick Stream and the Upper Mole with approximate volumes available at restriction of 22.2 Ml/d and 0.8 Ml/d respectively. For these watercourses there is more water than required to meet the needs of the environment and is water available for licensing. New licences can be considered depending on local and downstream impacts. Gauging stations on both watercourses exist.
Step 7: Define the search area for drawdown impacts	The radius of influence (radius at which drawdown is zero) of an abstraction cannot meaningfully or reliably be determined without the knowledge of geological formation hydrogeological parameters, however a conservative value of 5km around the Development Site has been taken here. In practice it is likely to be much less than this, in part due to the hydraulic divides along the Gatwick Stream to the east of the Development Site and the southern edge of the Upper Mole to the south of the Development Site. In addition, the depth and location of the UTWSM target aquifer under the WCF means that water resources impact on surface water and near surface groundwater receptors locally will likely be minimal. The current conceptual model, due to geological outcrop patterns and faulting, suggests that any recharge area for the UTWSM target aquifer below the site is likely to be to the east of the Development Site within the predominantly urban central and eastern area of Crawley.
Step 8: Identify all features in the search area that could be impacted by drawdown	Local features are identified within the WFS accompanying an EA Section 32 application and not impacted by drilling, testing and operations due to the overlying low permeability WCF. Other water features further afield (>1 km) (**Section 4.4 – Potential Receptors**) have been screened out due to the overlying low permeability WCF. There are no large abstractions or significant conservation sites within the search areas. Even the Gatwick Stream and associated ponds and abstraction (TH/039/0032/020) on the Stanford Brook (Gatwick Stream) at Maidenbower, which lie on the UTWSM outcrop area are over 4 km from the Proposed Development site and will likely have minimal (measurable) impacts. This is because any wider long-term influence on groundwater levels away from the abstraction borehole will be potentially much reduced across a distant and large recharge area.
Step 9: For all these features, predict the likely drawdown impacts	The drawdown of an abstraction at a receptor cannot meaningfully or reliably be determined without the knowledge of geological formation hydrogeological parameters. However, the below information can be used to gauge the significance of impact of operational abstraction on groundwater resources in the UTWSM Secondary aquifer and dependent receptors. The base flow index for the Gatwick Stream is 0.56 indicating that it receives an only moderate amount of water from groundwater flow. Drawdown would likely only be to the western side of the catchment nearest the proposed abstraction well. The proposed abstraction of 500 m^3/d (0.5 Ml/d) represents a very small percentage of the 95% flow (0.105 m^3/s). In addition, the approximate volume available at restriction is 22.2 Ml/d of which the proposed abstraction would comprise only 2.3% and it is unlikely that this will be taken directly from the river. The abstraction on the (TH/039/0032/020) Stanford Brook (Gatwick Stream) at Maidenbower only takes 81 m^3/d and is upstream of any potential drawdown impacts from the abstraction at the Proposed Development site.
Step 10: Allow for the effects of measures taken to mitigate the drawdown impacts	This does not apply since receptors on the recharge area are not downstream of any potential discharge areas.

Step 11: Assess the significance of the net drawdown impacts	This is not currently known and would be assessed after production borehole testing and as part of the abstraction licence application.
Step 12: Assess the water quality impacts	Water quality impacts on surface water bodies during borehole drilling and construction on the River Mole and Ifield Brook and pond at NGR TQ 24044 36584 (Ifield golf course) are assessed (see **Table 5.6** of this hydrogeological risk assessment). Potential water quality impacts on groundwater bodies within superficial deposits: alluvium and river terrace deposits, the Wealden Clay and UTWSM during borehole drilling and construction are also assessed.
Step 13: If necessary, redesign the mitigation measures to minimise the impacts	Mitigations will be applied during borehole drilling, construction and operations by best practise and EA permit and licencing regimes. During operations water neutrality strategy efficiencies will be in place to conserve water (see Table 5.6 of this hydrogeological risk assessment) and restrictions/ controls on certain activities within the SPZ1 (50 m buffer).
Step 14: Develop a monitoring strategy	Associated monitoring will be via the EA Section 32 borehole drilling and testing licence and abstraction licence requirements.

5.2 Methodology

Groundwater impacts have been evaluated for construction, operational and decommissioning phases within this assessment. The construction phase refers activities related to development construction and the installation of a groundwater abstraction well and associated testing. The operational phase is associated with the long term pumping and supply of groundwater to the development and maintenance. Decommissioning phases associated with the abstraction well are considered on the failure of exploration boreholes or at the end of the life of the production borehole/s.

The significance of hydrogeological impacts of the proposed development works and borehole abstraction have been assessed using a qualitative approach. This is because the conceptual model has shown that there is no direct pathway between the target aquifer and the surface receptors that could be affected. In addition, there is insufficient data available upon which a quantitative assessment of impacts could be based.

In the qualitative approach adopted, the significance of the impacts is evaluated as a function of the magnitude of the impact and the sensitivity of receptors to that impact. Both impact magnitude and sensitivity are evaluated qualitatively using the definitions given in **Table 5.2** and

Table 5.3 respectively. Magnitude and sensitivity are combined into an assessment of the significance of the impact using the matrix in **Table 5.4**.

Significance is evaluated for the 'residual impact' i.e., the impact remaining after consideration of measures incorporated into the scheme to mitigate impacts. If residual impacts are deemed significant, additional requirements/ mitigation to reduce impacts or uncertainties associated with the impact assessment are detailed following the assessment. Where effects have a magnitude that is greater than Negligible, monitoring is indicated to support the scheme.

Table 5.2 Definitions of Magnitude used in the assessment of impact

Magnitude classification	Definition
High	The impact causes change at the receptor that can be easily measured and is of much greater size than the variability in the baseline.
Moderate	The impact causes change at the receptor that can be easily measured and is of a comparable size to the variability in the baseline.
Low	The impact causes change at the receptor that can be measured but the size of the change is much smaller than the variability in the baseline.
Negligible	Change at the receptor is so small that the change cannot be distinguished from the baseline.

Table 5.3 Definitions of Sensitivity used in the assessment of impact

Sensitivity classification	Definition
High	Any change from the baseline is likely to affect the hydrological function of the receptor.
Medium	A small change from the baseline is unlikely to affect the hydrological function of the receptor.
Low	A substantial change from the baseline is unlikely to affect the hydrological function of the receptor.
Very low	The hydrological function of the receptor can accommodate large changes from the baseline without being affected.

Table 5.4 Determination of impact significance from Magnitude and Sensitivity

Sensitivity	Magnitude ----------------- High	Moderate	Low	Negligible
High	**Significant**	**Significant**	**Significant**	Not Significant
Medium	**Significant**	**Significant**	Not Significant	Not Significant
Low	**Significant**	Not Significant	Not Significant	Not Significant
Very Low	Not Significant	Not Significant	Not Significant	Not Significant

5.3 Hazard Identification

Hazard identification (contaminant source) has been undertaken for the current proposed development and borehole installation option within the Proposed Development site area to evaluate whether the shallow workings/ excavations and borehole installation and testing (with appropriate mitigation measures) is acceptable in terms of the risk to the receptors. The main mechanisms that could result in a release of contaminants to the groundwater are from the leak of fuel, lubricants and other chemicals during development works and/ or borehole drilling and installation. In addition, there is the potential for water losses in terms of a decline in groundwater levels or decrease in artesian pressure.

5.4 Risk Register

The risk register considers the sources which have potential to cause contamination during works and borehole installation and these are listed in **Table 5.5**. Risks are shown within the conceptual keys on **Figure 4-2** and **Figure 4-3**. Risks include the potential reduction of water availability to support existing groundwater abstractions as a consequence of groundwater availability and groundwater quality effects and impacts on secondary aquifers. It also includes the potential for impacts on surface water quality. This could arise from the shallow workings/ excavations on site and/ or drilling operations, for example the leakage/ spillage of fuels and chemicals onsite. Vulnerability to receptors (aquifer groundwater and water resource) from a source is dependent upon the likelihood of a pathway between the source and the receptor.

Table 5.5 Construction/ operational/ decommissioning activities, potential sources (of impact) and potential effects

Activity	Potential Source	Potential effect
Construction phase		
Shallow workings/ excavations and drilling/ testing operations with machinery and refuelling.	Spillage or leakage of fuels, lubricants or other chemicals during construction and during borehole drilling/ testing.	Potential for accidental contamination entering surface waters, the ground and into groundwater. Reduction of water availability to support existing groundwater abstractions as a consequence of water quantity and/or quality effects.
Abstractions during drilling/ testing activities	Pumping of borehole for drilling and abstraction during testing	A decline in groundwater levels. Reduction of groundwater availability to support existing groundwater abstractions as a consequence of water quantity effects.
Operational phase		
Abstraction from borehole/s	Abstraction of borehole for water supply at 500m^3/day	A decline in groundwater levels. Reduction of groundwater availability to support existing groundwater abstractions as a consequence of water quantity effects.
Decommissioning phase		
Borehole backfilling operations with grouting machinery	Spillage or leakage of fuels, grout cement etc. during backfilling.	Potential for accidental contamination entering surface waters, the ground and into groundwater.

For each source, the risk register considers the hazard (e.g., event causing a release of a contaminated substance to the environment), the consequence of the release (e.g., pollution at a receptor), the likelihood of the event, the mitigation measures that can be implemented to prevent or reduce the consequence of the event. The assessment considers the risk before and after safeguards are put in place. Where the overall risk is identified as high or above then the proposed works are considered to represent an unacceptable risk unless further mitigation measures can be implemented. The following has therefore been undertaken:

- Identification of sources of impact that could give rise to pollution reaching receptors and/ or water availability to receptors;

- Identification of pathways that could release contaminants to the environment or cause water availability issues to receptors;
- Assessment of the likelihood of a contaminant release/ water availability impact occurring;
- Assessment of the consequence of a release of contaminants/ water availability impact to receptors;
- Identification of mitigation measures that would be put in place to stop contaminants escaping into the environment or water availability impacts on the environment;
- Assignment of a relative measure to each of the above parameters to enable a qualitative assessment of the overall risk level (low, medium, high, critical); and
- Recommendations for additional measures or monitoring where a residual risk has been identified.

5.5 Mitigation Measures

Site location measures

The borehole site locations have been selected to be in an area that is likely to be less sensitive to local impacts. The data search for water features within 5 km of the site has identified no water supply abstractions (except for a surface water abstraction from the Stanford Brook) and the site also lies outside the source protection zones for all public water supply sources and PWS catchment zones in the area. There are no sensitive aquifers in the area, but more permeable superficial alluvium and river terrace deposits, may have greater vulnerable to surface activities than areas where these deposits are present. These more sensitive areas have been avoided where possible. The boreholes will be sited over 50 m from the nearest river and outside the area where there is a risk of flooding from rivers. The nearest conservation site, the designated Willoughby Fields, is almost 0.6 km from the site whilst the non-designated Hyde Hill and Ifield Brook Wood and Meadows are adjacent to the Proposed Development site and these features at this site are not believed to be dependent upon groundwater.

Measures during construction

Good practice techniques and methodologies will be undertaken during the implementation of shallow workings, excavations and drilling works[37]. The focus of this section is the mitigation measures undertaken during drilling works because these are most likely to interact with the groundwater environment.

The proposed borehole/s will be designed will be in such a way that the risk of fluids escaping from the well is as low as reasonably practicable. The design will consider these features during construction and operation and provide robust protection for the initial life cycle of the abstraction arrangements. A trained and experienced hydrogeologist supervisor will be on site to collect data, monitor the progress of drilling, ensure construction of the borehole/s is to design specifications and to identify and alert any environmental or health and safety concerns.

During decommissioning[38] the measures in place during this period will be the same as those during construction. Access routes to the drill site will utilise existing tracks, roads, farm entrances

[37] https://www.gov.uk/guidance/pollution-prevention-for-businesses

[38] When the abstraction borehole is no longer required, they will be backfilled from base to top using cement grout. This will be completed in measured stages through the screened section of the borehole which will minimise loss of grout to the formation. Ingress of grout into overlying formations will be prevented by the solid well casing.

etc. as far as practicable, and where necessary no-dig solutions (e.g., aluminium trackway) and other site-specific measures would also be utilised. There will be no storage of hazardous materials including chemicals, oils and fuels within any SPZ or environmentally sensitive area.

The design of the wells will be based on good practice and likely to be completed as 'telescoping' sections (as noted in **Section 2**). This will ensure that upper sections of the borehole/s, which pass through unstable surface deposits and more permeable strata, such as sandstone and limestones within the WCF Secondary A aquifer that is potentially sensitive to impacts, will be fully cased and cemented before any deeper drilling. This also aims to close off the pathway for fluids migration in the borehole. Records and inspections will be used to confirm construction quality throughout the drilling process. Appropriate drilling procedures and measurements will be in place to make sure and confirm that the borehole is vertical and where abstraction is to take place.

Environmentally hazardous drilling fluids, or those containing groundwater hazardous substances, will not be used during drilling of the borehole/s. Drilling requires the use of water as a drilling fluid, either mixed with additives to form a drilling fluid or on its own. Water used for drilling will be potable quality and brought to the site in tankers. Reverse circulation methods of drilling mean that water use should be lower than non-circulating methods. There will be no extraction of groundwater from shallow aquifers for drilling. Drilling muds/additives used will be free from hazardous substances.

During drilling activities, the driller will carefully monitor the fluid usage in the recycling system and will quickly identify if fluid is being lost into the strata. If fluid loss is identified there are a number of measures that can be taken to seal the borehole and reduce losses. Techniques of good drilling practices will be employed by the contractor to manage the risk of drilling fluid losses into the deposits or strata surrounding the borehole including:

- Experienced drillers;
- Standard process and procedures for drilling, data collection and communication;
- Appropriate drill fluid monitoring (fluid properties, volume/ flow and downhole pressure);
- Appropriate borehole design and the use of telescoping casing sections; and
- Development of a breakout response plan, so that equipment and trained personnel are in place for rapid response.

A range of measures will be deployed to protect shallow groundwater and surface water from leaks and spills during drilling and will include the following:

- Minimisation of pollutant loading through:
    - Use of water or water-based drilling fluids for drilling. No hazardous substances present; and
    - Drilling fluids made up in batches as required minimising requirements to store fluids at the site.
- Multiple levels of surface containment consisting of bunded tanks for fuels and chemical storage;
- Development of an Environmental Management Plan (EMP), that will set out how pollution risks will be managed, monitored and how spills will be dealt with;
- Provision of spill kits and use of absorbent matting beneath parts of plant containing oil/ fuel etc and use of these during refuelling operations; and

- All construction waste (drilling cuttings, drilling fluids, excess cement and dry waste from the operations) will be removed from the location and transported to licenced disposal facility.

Drilling and testing of the borehole/s will be subject to conditions of permit from the EA Section 32 application, namely the *Form WR32: Groundwater Investigation Consent through the water abstraction: application for a consent to investigate a groundwater source*, application to the EA. The EA may require the monitoring at any sensitive receptors identified, including a water quality monitoring programme at receptor/s, for example at PWSs in proximity of the Proposed Development site.

Measures during operations

Measures put in place during the design and construction of the wells will continue to function during operation of the borehole. These measures will prevent the loss of water from the deep formations and protect groundwater resources and groundwater quality in any shallower aquifer strata. Monitoring of well performance and inspection of the condition of the wells and above-ground pipework linking the abstraction borehole/s will be conducted throughout operations. Measures will be put in place so that boreholes operations can be stopped without risk whilst repair works are carried out.

Measures required by the facilities making use of the abstracted water will be detailed in the appropriate documents accompanying planning permissions and environmental permit applications for those activities. The operating borehole will be assigned SPZs, with a default minimum inner protection zone SPZ1 with a radius of 50 metres, within which restrictions/ controls on certain activities will apply[39].

Measures during decommissioning

When the exploration/ production abstraction well/s are no longer required, they will be backfilled. Within the screened response zone this is likely to be with a material of similar make up to the formation, and within the cased borehole section it is likely to be filled with cement grout. This will be completed in measured stages through the screened section of the borehole and monitoring of volumes will minimise loss of grout to the formation. Ingress of grout into overlying formations will be prevented by the solid well casing. The EA good practice[40] for decommissioning redundant boreholes and wells will be followed and other measures in place during this period will be the same as those during construction.

5.6 Assessment Results

Assessment of water resources impacts (flow and drawdown)

Impacts on features sensitive to changes in groundwater flow and drawdown have been assessed with the measures listed in **Section 5.5** in place. The results of the impact assessment are presented in **Table 5.6**.

The sensitivity of the UTWSM to water resources impacts (flow and drawdown) is *Low*. During construction the magnitude of residual impact after mitigation is *Low*, whereas during operation,

[39] Environment Agency (2019) Manual for the production of Groundwater Source Protection Zones. [online]. Available at: https://assets.publishing.service.gov.uk/media/5d41a020e5274a0a0bf7757c/Manual-for-the-production-of-Groundwater-Source-Protection-Zones.pdf

[40] Environment Agency (2012) Good practice for decommissioning redundant boreholes and wells. Doc Ref: LIT 6478 / 657_12

because of net abstraction from the aquifer, even after mitigation the magnitude of the residual impact is likely to be *Moderate.* None of the residual impacts identified for WR1 are *significant*.

Assessment of water quality impacts

The assessment of impacts on surface and groundwater quality as a result of the proposed construction works and borehole/s installation is presented in **Table 5.7**. As with impacts related to water resources, the water quality impacts have been assessed with the mitigation in place. Impacts have been assessed for construction and operation. Receptors for potential impacts on water quality have similarly been divided based upon the surface water and groundwater body receptors.

The sensitivity of the River Mole and Ifield Brook surface water receptors is *Medium*. During borehole construction and operation, the magnitude of residual impact on water quality after mitigation is *Low*, giving a *not significant* residual impact for WQ1.

The sensitivity of the alluvium and river terrace superficial deposit receptors is *Low*. During construction/ decommissioning the magnitude of residual impact on water quality after mitigation is *Low*, giving a *not significant* residual impact for WQ2.

The sensitivity of the WCF receptor is *Low*. During construction/ decommissioning the magnitude of residual impact on water quality after mitigation is *Negligible*, giving a *not significant* residual impact for WQ3.

The sensitivity of the UTWSM receptor is *Low*. During construction/ decommissioning the magnitude of residual impact on water quality after mitigation is *Negligible*, giving a *not significant* residual impact for WQ4.

None of the residual impacts identified are considered to be significant.

Table 5.6 Assessment of water resources (flow and drawdown) impacts

ID	Potential impact	Receptor sensitivity	Phase of development	Incorporated mitigation	Magnitude of residual impact	Significance of residual impact
WR1	Impact on groundwater resources in the UTWSM Secondary A aquifer.	The UTWSM has a ***Low*** sensitivity to hydrological impacts because it is not used as a water resource or supports any groundwater dependent features, within the study area.	Construction	Adherence to good drilling practice during construction to ensure well integrity and prevent unintended water losses from the UTWSM. Hydrogeological testing of borehole/s will help determine the impacts on the aquifer, sustainable yields and/ or measurable impacts on the groundwater levels/ pressures.	The magnitude of the residual impact is ***Low*** because there will be net abstraction from the aquifer, but for a short period of time. This may be small comparable to the variability in baseline groundwater levels/ pressures.	***Not Significant.***
			Operation	The borehole/s abstraction volumes will be licensed after assessment and application to the EA and cumulative impacts considered. Licenced according to the EA's abstraction management strategy. A programme of regular inspections of the well/s. Monitoring of well performance and inspection of the condition of the wells and above-ground pipework. Monitoring receptor groundwater levels and pressures as per EA guidance and/or any licence condition requirements. Any wider long-term influence on groundwater levels away from the abstraction borehole will be potentially much reduced across a large and distant recharge area.	The magnitude of the residual impact is conservatively assessed as ***Moderate*** because there will be net abstraction from the aquifer. This may be easily measured and of a comparable size to the variability in baseline groundwater levels/ pressures.	***Not Significant***.

Table 5.7 Assessment of water quality impacts

ID	Potential impact	Receptor sensitivity	Phase of development	Incorporated mitigation	Magnitude of residual impact	Significance of residual impact
	Surface Water Bodies					
WQ1	River Mole and Ifield Brook.	Receptors in terms of surface water quality due to discharges during drilling and testing processes due to a potential runoff pathway from the borehole location/ discharge point into the surface watercourse. Surface water receptors have a ***Medium*** sensitivity to impacts on surface water quality. Runoff from the site area will not directly enter natural river channels but will instead flow into artificial land drains, which are less sensitive to change than river systems.	Construction/ decommissioning	Design location to be over 50 m from the receptors and 10 m from any surface water feature (i.e. drainage ditch etc.). Minimisation of pollutant loading using water or water-based drilling fluids for drilling (i.e., no hazardous substances present). Drilling fluids made up in batches as required minimising requirements to store fluids at the site. Provision of spill kits and use of absorbent matting beneath parts of plant containing oil/fuel etc and use of these during refuelling operations. All construction waste (drilling cuttings, drilling fluids, excess cement and dry waste from the operations) will be removed from the location and transported to licenced disposal facility. Multiple levels of surface containment consisting of bunded tanks for fuels and chemical storage. Runoff will be allowed to settle before passing through oil separators/ silt management prior to discharge to ground.	The magnitude of the residual impact is ***Low*** due to mitigation measures in place.	***Not Significant***.

ID	Potential impact	Receptor sensitivity	Phase of development	Incorporated mitigation	Magnitude of residual impact	Significance of residual impact
				EMP and on-site supervisor to manage and monitor pollution risks during construction and decommissioning. Drilling and testing of the borehole/s will be subject to conditions of agreed with the EA, which will include agreed discharge points. Adherence to good backfilling practice during decommissioning to prevent unintended cement grout losses and other spills.		
	Groundwater Bodies					
WQ2	Superficial Deposits: Alluvium and river terrace deposits	Receptor in terms of water quality due to discharges during drilling and testing processes, i.e. runoff and recharge into the superficial aquifer. The superficial deposits have a ***Low*** sensitivity to hydrological impacts because it is not used as a water resource within the study area.	Construction/ decommissioning	Design location of borehole to be away from superficial deposits and consideration given to where runoff and discharge is flowing. In case, borehole is within unmapped superficial deposits the use of casing and cement seals during drilling of the uppermost section of the well. Minimisation of pollutant loading using water or water-based drilling fluids for drilling (i.e., no hazardous substances present). Drilling fluids made up in batches as required minimising requirements to store fluids at the site. Provision of spill kits and use of absorbent matting beneath parts of plant containing oil/fuel etc and use of these during refuelling operations. All construction waste (drilling cuttings, drilling fluids, excess cement and dry waste from the operations) will be removed from the location and transported to licenced disposal facility. Multiple levels of surface containment consisting of bunded tanks for fuels and chemical storage. EMP and on-site supervisor to manage and monitor pollution risks during construction and decommissioning. Drilling and testing of the borehole/s will be subject to conditions of agreed with the EA, which will include agreed discharge points. Adherence to good backfilling practice during decommissioning to prevent unintended cement grout losses and other spills. Superficial deposits are likely to be cased.	The magnitude of the residual impact is ***Low*** because of the measures in place.	***Not Significant***.
WQ3	Wealden Clay Formation	Receptor in terms of water quality due to drilling through the formation. The WCF has a ***Low*** sensitivity to hydrological impacts because it is not used as a water resource within the study area.	Construction/ decommissioning	Adherence to good drilling practice during construction to ensure well integrity and prevent unintended water cross contamination into the WCF. Adherence to good backfilling practice during decommissioning to prevent unintended cement grout losses and other spills. WCF is likely to be cased.	The magnitude of the residual impact is ***Negligible*** because of the measures in place.	***Not Significant***.

ID	Potential impact	Receptor sensitivity	Phase of development	Incorporated mitigation	Magnitude of residual impact	Significance of residual impact
WQ4	UTWSM	Receptor in terms of water quality due to drilling processes. The WCF has a ***Low*** sensitivity to hydrological impacts because it is not used as a water resource within the study area.	Construction/ decommissioning	The borehole location will be outside of any flood risk zones and away from any potential pollution sources. Casing will separate formations, including the WCF and surface layers. Sampling whilst drilling will be undertaken to confirm groundwater and circulating drill water quality. Adherence to good backfilling practice during decommissioning to prevent unintended cement grout losses and other spills.	The magnitude of the residual impact is ***Negligible*** because of the measures in place.	***Not Significant***.

6. Conclusions

6.1 Conclusions

Homes England is promoting a strategic development of 3,000 homes plus employment area to the West of Ifield, near Crawley in West Sussex. To satisfy Natural England's position statement on water neutrality, the Proposed Development must demonstrate that water neutrality will be achieved, and the evolving water neutrality strategy has identified that it may be possible for water supply requirements to be provided from groundwater beneath the site using a borehole/s capable of sustaining an uninterrupted (i.e., through dry summer periods) supply of approximately 500 m^3/day.

This report has been produced as a Phase 1 desk study for the purpose of providing an initial assessment of the feasibility of, and potential impacts from, the development of a groundwater supply. Although uncertainty remains, it also provides greater clarity on whether a borehole will likely be able to supply the required volume of water in perpetuity for the development and it will support the **Chapter 13 – Water Environment and Flood Risk** of the EIA for the housing development.

The feasibility study based on currently available data indicates that a borehole within the UTWSM at depth of approximately 200 m below the Proposed Development site has the potential to supply the required yield of 500 m^3/d at least initially. However, the sustainability of any supply is uncertain, i.e., it may not be possible to maintain the initial yield in the long term. There is also uncertainty regarding the quality of groundwater, although it is likely to require treatment to reduce the fluoride and boron levels to below the required standard, whilst sodium and alkalinity may impose noticeable aesthetic (taste, odour, feel) character to the water that affect water wholesomeness and therefore may also require treatment before domestic use. Other determinands will have to be tested during testing to confirm they meet the DWS. Evidence of high chloride within WCF indicates that this formation should be cased and grouted to prevent cross contamination of the UTWSM and undesirable effects on quality of proposed groundwater abstraction from the target UTWSM.

The uncertainties regarding both water quantity and quality can only be resolved through collection of additional data. Some additional water quality data may be available from existing boreholes or through additional testing of water from those boreholes. However, further information on yields and water quality beneath the development can only be acquired through the drilling and testing of new boreholes.

Risks of potential impacts of the proposed scheme construction and works to install a production borehole/s at the Proposed Development site considered potential impacts on groundwater flows, groundwater levels and groundwater quality. The construction, operational and decommissioning phases are considered through a qualitative hydrogeological risk assessment, which is proportionate with the level of risk to shallower groundwater-bearing formations from the proposed scheme.

The hydrogeological risk assessment has been based on a conceptual model of the Proposed Development site and the environmental setting that has been developed for the area within 5 km of the proposed drilling site. Data from a wide range of sources has been acquired and evaluated to identify receptors for potential impacts and pathways between the proposed scheme and those receptors. Sources of impact from the scheme have been considered and measures identified to reduce or mitigate the impacts from those sources. Impacts have been evaluated assuming that the measures are in place.

The risk assessment has not identified any significant residual risks to surface water and groundwater resources or quality that may result from the Proposed Development site works or the construction, operation or decommissioning of installed abstraction borehole/s at the site. Any monitoring requirements appropriate for the construction and operation phases will be identified in consultation with the EA and during the determination of any licence for the proposed groundwater abstraction.

6.2 Recommendations

Should Homes England wish to pursue the groundwater supply option, then the drilling and installation of exploration boreholes is recommended to collect information on the hydrogeological conditions beneath the site. Following this if production borehole/s are installed then a programme of testing should be undertaken to determine the likely long term sustainable yield from the borehole/s.

Appendix A Borehole Logs

Three Bridges TQ23NE47

Majors Hill TQ33NW101

Mill House TQ33NW48

Normans TQ23NW4

Smallfield Laundry TQ24SE17

Hilton Mount College TQ23NE46

Brighton Road Pumping Station TQ23NE77

Lowfield Heath TQ23NE41

Worth Park Pumping Station TQ23NE48

Rusper Golf Club TQ23NW5

Rede Hall Small fields TQ34SW45

Prestwood Farm TQ23NW1

Newstead TQ23SW46

TQ 23 NE47

TQ23/19 302

WORTH

GR 2876 3701

20

OD 230

517. *THREE BRIDGES railway station, western side. About 1887. Ht. above O.D. about 250 ft. Map 4 S.W./W

Tunbridge Wells Sand. Sandstone ... ... 85 ft.

R.L.W. 14 ft. from the surface. Could not be lowered below 4 ft. from the bottom. Good water. Information from Mr. Topley. Two tanks, one containing 35,000 gallons, and one 11,700 gallons, are filled twice daily (1926).

sited in 6" 4 SW/W

21

OD 270.

518. POUND HILL, 1 mile N. of church. Ht. above O.D. about 280 ft. Map 4 S.W./W

Tunbridge Wells Sand ... ... 180 ft.

Dug well 80 ft., with headings at base.

Bore-hole 100 ft.

Supplies the Worth Park Estate.

Sunk in 1881

Both visited [illegible] 15·2·40.

Sunk in 1881.

In 1941, the bore was deepened by Cuckfield R.D.C. when they bought it. See record on next sheet.

Information from retired Engineer of Milton Mount [illegible] correspondence EWD/302/21

[illegible] Cuckfield R.D.C.

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TQ23NE/47
302/14/19
302
TQ23/19 20

RAILWAY EXECUTIVE.
SOUTHERN REGION - ASHFORD WORKS.
CHEMICAL LABORATORY. CHIEF MECHANICAL ENGINEER'S DEPARTMENT.

ANALYSIS OF SAMPLE OF WATER.

From ..THREE...BRIDGES..............
Source ....S.R. WELL..................
Laboratory Ref: ..H 29./92...........
Date of Sampling ..10th..Jan...1949.....

CONDITION AT TIME OF ANALYSIS.

Appearance .On standing - containing fine light brown..... (When sampled - practically clear)
pH Value .6.1 (acid).. Bromo Cresol Purple. [suspended matter
Electrical Conductivity ..-.......................................
Suspended matter .Chiefly oxides of iron.....................
Colour ....Very pale...yellow.................................

RESULTS OF ANALYSIS. Grains per gallon.		CONVENTIONAL COMBINATIONS.	
Lime (as CaO)	2.41	Calcium Carbonate	3.30
Magnesia (as MgO)	1.14	Magnesium Carbonate	-
Iron (as Fe_2O_3)	2.90	Sodium Carbonate	-
Silica (as SiO_2)	0.49	Calcium Sulphate	1.35
Chlorides (as Cl)	2.55	Magnesium Sulphate	3.40
Sulphates (as SO_3)	4.26	Sodium Sulphate	1.95
Nitrates (as N_2O_5)	0.16	Calcium Nitrate	-
Free Carbon Dioxide (as CO_2)	4.65	Magnesium Nitrate	-
Total solids at 130°C	19.2	Sodium Nitrate	0.25
Total Alkalinity (to Methyl Orange)	3.3	Calcium Chloride	
Other Constituents.		Magnesium Chloride	-
		Sodium Chloride	4.20
		*Oxide of Iron & Alu	2.90
		Silica	0.5

Temporary Hardness...3.30°...............
Permanent Hardness ...3.85°...............
Total Hardness ....7.15°...............
Scale Forming Matter ..9.80 grains....

REMARKS: * Equivalent to Ferrous Carbonate 4.20 grains
This water is not high in scale forming constituents but would be corrosive to steel, due to the high amount of dissolved carbon dioxide associated with a high iron content

1

TQ 23/19

302/20 **British Railways (Southern Region), Three Bridges Station, Crawley**

W.S.Sx.I, p. 99. Surface +230. Shaft. *Date unknown.*
R.W.L. +216. Yield 93,400 g.p.d. *1926.* Hardness: P. 55, T. 47. Anal. *Jan.*
R.W.L. +212. P.W.L. +204½. Yield 6,000 g.p.h. *Oct. 1949.* R.W.L. +218¾. P.W.L. +213½.
Yield 6,000 g.p.h. *Nov. 1954.* R.W.L. +221. P.W.L. +211½. Yield 6,000 g.p.h. *Dec. 1961;*
4,200 g.p.h. *Dec. 1963.*

UTW	...	...	35	35

GEOLOGICAL CLASSIFICATION	NATURE OF STRATA	THICKNESS	DEPTH
U.T.W.S.	SANDSTONE	35'	35'

TQ23/19

TQ 2873 3696

302/20

CRAWLEY

OD c. 230

517. *THREE BRIDGES railway station, western side. About 1887. Ht. above O.D. about ~~230 ft.~~ Map 4 S.W./W

Upper Tunbridge Wells Sand. Sandstone ... ... 35 ft.

R.L.W. 14 ft. from the surface. Could not be lowered below 4 ft. from the bottom. Good water. Information from Mr. Topley. Two tanks, one containing 35,000 gallons, and one 11,700 gallons, are filled twice daily (1926).

OD +230. sited on 6" 4 SW/W Sussex S Buchan 15.2.40.

Published in W.S.Sx. I, p.99 + W.S.Sx. III, p.215.

Upper Tun. Wells Sand. R.G. 3.12.64.

2.

TQ23/19

ADDITIONAL INFORMATION SHEET

Licence No. 302/20

Date of completion of well catalogue . . . .

Date of publication . . . .

. . . .

Additional Sheet No. . . . .

DATE	*	ADDITIONAL INFORMATION	INIT.
26.6.73		"Pumping now stopped" – information included with Sec 6 return 1965.	BH.
		DATA Bank	

FILMED . . . . . .

* Insert Well Reference Letter, if more than one well at site

P.T.O.

Section 6	Pumping Test	Observ. Well	Recorder	E.R. Log	Institute of Geological Sciences Hydrogeological Dept., Exhibition Road, South Kensington.

TQ23/19
302
20

RAILWAY EXECUTIVE.
SOUTHERN REGION - ASHFORD WORKS.
CHEMICAL LABORATORY. CHIEF MECHANICAL ENGINEER'S DEPARTMENT.

ANALYSIS OF SAMPLE OF WATER.

From THREE BRIDGES
Source S.R. WELL
Laboratory Ref: H29/92
Date of Sampling 10th Jan 1949

CONDITION AT TIME OF ANALYSIS.

Appearance When sampled - practically clear. On standing - containing fine light brown
pH Value 6.1 (acid) - Bromo Cresol Purple [suspended matter
Electrical Conductivity —
Suspended matter Chiefly oxide of iron
Colour Very pale yellow

RESULTS OF ANALYSIS. Grains per gallon.		CONVENTIONAL COMBINATIONS.	
Lime (as CaO)	2.41	Calcium Carbonate	3.30
Magnesia (as MgO)	1.14	Magnesium Carbonate	—
Iron (as Fe_2O_3)	2.90	Sodium Carbonate	—
Silica (as SiO_2)	0.49	Calcium Sulphate	1.35
Chlorides (as Cl)	2.55	Magnesium Sulphate	3.40
Sulphates (as SO_3)	4.26	Sodium Sulphate	1.95
Nitrates (as N_2O_5)	0.16	Calcium Nitrate	—
Free Carbon Dioxide (as CO_2)	4.65	Magnesium Nitrate	—
Total solids at 130°C	19.2	Sodium Nitrate	0.25
Total Alkalinity (to Methyl Orange)	3.3	Calcium Chloride	
Other Constituents.		Magnesium Chloride	—
		Sodium Chloride	4.20
		*Oxide of Iron & Alu	2.90
		Silica	0.5

Temporary Hardness 3.30°
Permanent Hardness 3.85°
Total Hardness 7.15°
Scale Forming Matter 9.80 grains

REMARKS: * Equivalent to Ferrous Carbonate 4.20 grains
This water is not high in scale forming constituents but would be corrosive to steel, due to the high amount of dissolved carbon dioxide associated with a high iron content

TQ33/41

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

INFORMATION MANAGEMENT PROGRAMME

A SITE DETAILS

Borehole drilled for: VICTORIA PARRATT

Location: MAJORS HILL, TURNERS HILL ROAD, WORTH, RH10 4PE

NGR (8 figures): TQ 32251 36220

Ground Level (if known): Please attach site plan

Drilling Company: NICHOLLS BOREHOLES

Date of Drilling: Commenced 13/01/2015 Completed 13/01/2015

B CONSTRUCTION DETAILS

Borehole Datum (if not ground level) ______ above / m below GL

(point from which all measurements of depth are taken e.g. flange, edge of chamber, etc.)

Borehole drilled diameter 200 mm from 0 to 47 m/depth
mm from to m/depth
mm from to m/depth

SURFACE
Casing material STEEL diameter 210 mm from 0 to 2·5 m/depth
and type (e.g. if plain steel, plastic slotted)

Casing material SOLID UPVC diameter 113 mm from 0 to 11 m/depth
Casing material SLOTTED UPVC diameter 113 mm from 11 to 44 m/depth
Casing material SOLID UPVC diameter 113 mm from 44 to 47 m/depth

Grouting details 55 BAGS SHINGLE, TO 8M, 8 BAGS MIKOLIT TO SURFACE

Water struck at 14 m (depth below datum - mbd)
m (depth below datum - mbd)

Rest water level on completion 5·5 mbd

C TEST PUMPING SUMMARY (Please supply full details on Forms WR-39)

Test Pumping Datum (if different from borehole datum) ______ m above / below borehole datum (mbd)

Pump Suction depth ______ mbd

Water Level (Start of Test) ______ mbd

Water Level (End of Test) ______ mbd

Pumping rate ______ m^3/d:1/s

for ______ days/hours

Recovery to (from end of pumping) ______ mbd in ______ mins: hrs: days

Date(s) of measurements ______

Please supply chemical Analysis if available

D STRATA LOG

Geological Classification (BGS only)	Description of strata	Thickness m	Depth m
	TOP SOIL	1	0 - 1
	UPPER TUNBRIDGE WELLS SANDSTONE	7	1 - 8
	SANDY CLAY	6	8 - 14
	SANDSTONE	7	14 - 21
	SANDY GREY CLAY	21	21 - 42
	SANDSTONE - HARD	5	42 - 47

(continue on separate page if necessary)

Other comments (e.g. gas encountered, saline water intercepted, etc.)

FOR OFFICIAL USE ONLY

FILE	CONSENT NO	NGS REF NO:
LIC NO:	PURPOSE:	EA REF NO:
DATE REC:	COPY TO:	ENTERED BY:

TQ33 NW48

1351

WELL BORING at Hill House, Rowfant. County Sussex.
Geol. map — 1 in. map New Series 302; 6 in. map 13S.W.
Made by C. J. Ell and Sons. Date 1930
Sunk feet. Bored 125 feet.
Communicated by C. J. E & Sons.
Height above Ordnance Datum 295.74 ft. Rest level of water 27 ft. down.
Yield good supply of water *
Quality (with copy of analysis on separate sheet)

TQ33/5 302 3180 3800 48

GEOLOGICAL FORMATION.	NATURE OF STRATA.	THICKNESS. Feet.	Inches.	DEPTH. Feet.	Inches.
?Cuckfield Clay. 8	Brown clay	8	-	8	-
W. Tunbridge Wells Beds. 62	Brown sandstone in layers from 1" to 4" thick with grey sand between from 6" to 1' thick	22	-	30	-
	Grey sandstone	4	-	34	-
	Brown clay	1	6	35	6
	Grey sandstone	34	6	70	-
Grinstead Clay 13	Brown clay	13	-	83	-
Lower Tunbridge Wells Beds 42 (Tunbridge Wells Beds)	Red sandstone	8	-	91	-
	Grey sandstone	21	-	112	-
	Red sand	1	-	113	-
	Grey sandstone	2	-	115	-
	Grey sand	2	-	117	-
	Grey sandstone	3	-	120	-
	Grey sand	3	6	123	6
	Grey sandstone	1	6	125	-

Boring 9" Diameter done by Rotary core boring.

Lined 6" Steel tube. Lower end perforated for a length of 16 ft.

Ch. for: F/H 2/4/30

* In two spells of test pumping of 11 hrs and 4 hrs duration respectively, water was drawn from the borehole at a rate of 500 galls. per hour without any appreciable alteration being observed in the water level. The first spell of pumping was done before the casing tube had been inserted in the borehole.

M of H notified 29/3/30.

Boring for. J. A. Jeffrey. Esq.

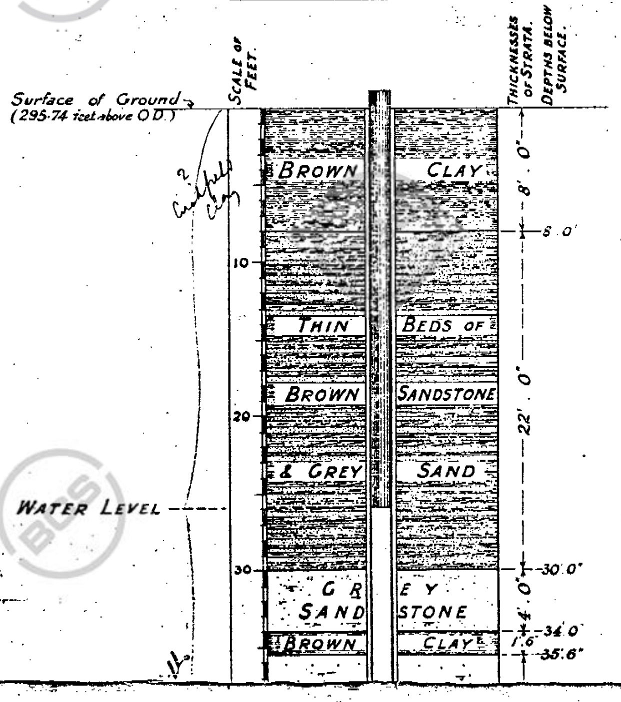
6" - Sussex 42 SW - W.

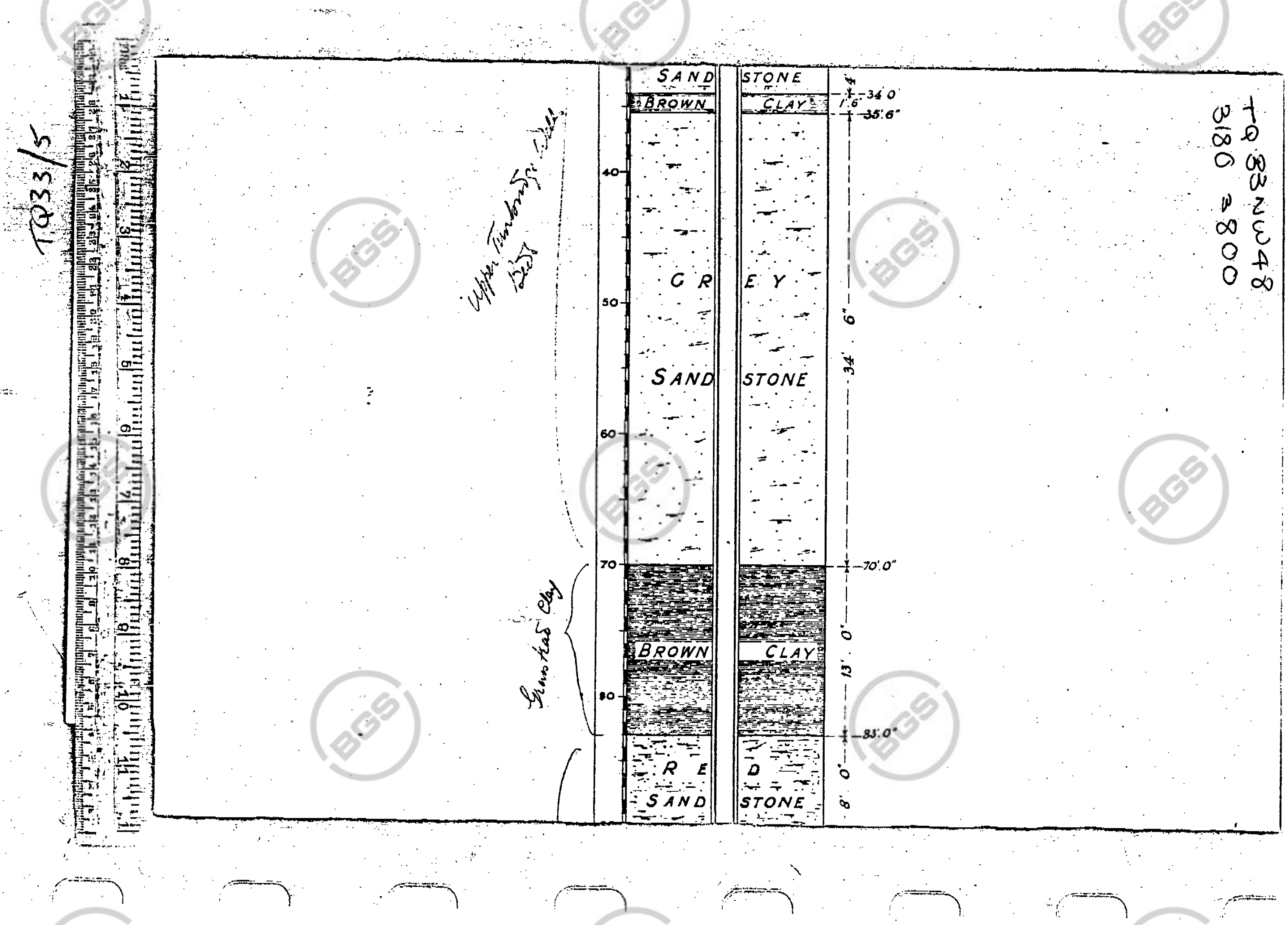
Visited [illegible] 15.2.40.

WELL BORING at [illegible] County [illegible]

TQ 33 NW
48
B180 380C

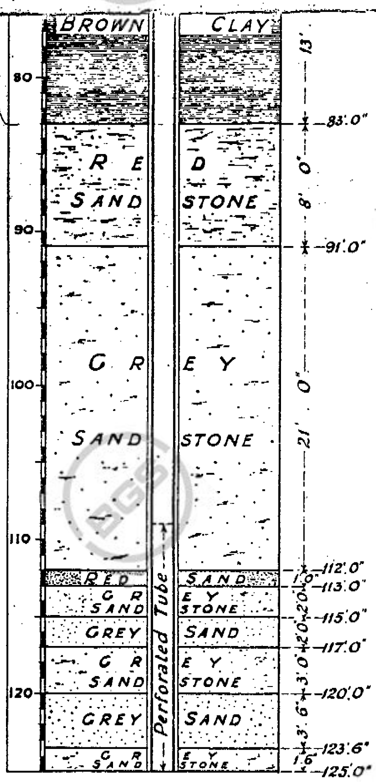
Section of Borehole sunk near The Mill House, Rowfant, Sussex, for J. S. Jeffrey, Esq.




TQ33/5
TQ 33 NW 48
3180 3800
SAND STONE
BROWN CLAY
34' 0"
1' 6"
35' 6"
GREY SAND STONE
34' 6"
70' 0"
BROWN CLAY
13' 0"
83' 0"
RED SAND STONE
8' 0"
40
50
60
70
80
Upper Tunbridge Wells Beds
Grinstead Clay

TQ33/5

TQ 33 NW 48
3180 3800



REMARKS:

1. The Boring was done by the Rotary Process.
2. Boring commenced on the 17th December, 1929, and terminated on the 15th. February, 1930.
3. The Borehole is 9" dia., and it is lined with Steel Casing Tube 6" internal dia. The lower end of the Tube is perforated for a length of 16 feet.
4. In two spells of Test Pumping of 11 hours' and 4 hours' duration respectively, water was drawn from the Borehole at a rate of 500 gallons per hour without any appreciable alteration being observed in the Water Level. The first spell of Pumping was done before the Casing Tube had been inserted in the Borehole.

CONTRACTORS:
CHAS. J. ELL & SONS,
Victoria Well Works,
Leagrave.
LUTON.

Prog. No 107

FRANK H. BRUNT, M.Inst.C.E.,
Chartered Civil Engineer,
17, Victoria Street,
WESTMINSTER.

April, 1930.

TQ 33/5 351

WELL BORING at Mill House, Rowfant, Worth. County Sussex

Geol. map 1 in. map New Series 302. 6 in. map 4NW/E

Made by C. J. Ell and Sons Date 1930

Sunk feet. Bored 125 feet.

302

Communicated by C. J. E & Sons.

Height above Ordnance Datum 295.74 ft. Rest level of water 24 ft down.

Yield good supply of water *

Quality (with copy of analysis on separate sheet) TQ 3183 3792

48

GEOLOGICAL FORMATION.	NATURE OF STRATA.	THICKNESS. Feet.	THICKNESS. Inches.	DEPTH. Feet.	DEPTH. Inches.
Cuckfield Clay 8	Brown clay	8	-	8	-
U. Tunbridge Wells Beds 62	Brown sandstone in layers from 1" to 4" thick with grey sand between from 6" to 1" thick	22	-	30	-
	Grey sandstone	4	-	34	-
	Brown clay	1	6	35	6
	Grey sandstone	34	6	70	-
Grinstead Clay 13	Brown clay	13	-	83	-
Lower Tunbridge Wells Beds 42 (Tunbridge Wells Sand)	Red sandstone	8	-	91	-
	Grey sandstone	21	-	112	-
	Red sand	1	-	113	-
	Grey sandstone	2	-	115	-
	Grey sand	2	-	117	-
	Grey sandstone	3	-	120	-
	Grey sand	3	6	123	6
	Grey sandstone	1	6	125	-

Not classifiable in detail; above incorrect: probably all UTW. R.Gallois 10/1/84.

Boring 9" Diameter done by Rotary core boring.

Lined 6" Steel Tube. Lower end perforated for a length of 16 ft.

Cha. fr: J.H.T. 2/4/30

* In two spells of test pumping of 11 hrs and 4 hrs duration respectively, water was drawn from the borehole at a rate of 500 galls. per hour without any appreciable alteration being observed in the water level. The first spell of pumping was done before the casing tube had been inserted in the borehole.

Mr of Tb notified EJ 3/3/30.

Boring for J. S. Jeffrey. Esq.

6" - (Surrey 42 SW - W.)

Visited [illegible] 15.2.90.

Sited on 6" map Sussex 4 NW/E. 31.10.67

DATA BANK

Geological Survey and Museum, Jermyn Street, London. S.W. 1.

(B10(19). Wt. 15824—S123. 2500. 11/25. Gp. 160. S.A.

TQ 33 | 5

302/48 Mill House, Rowfant, Worth

Surface +295¾. Bore 9 in. Lining tubes: 125 × 6 in (perforated 109 to 125).
R.W.L. +268¾. P.W.L. +c.268¾. Yield 500 g.p.h. (4 h. test). *E11, 1930.*

UTW	...	...	125	125

[illegible]ological Formation.	Nature of Strata.	Thickness Feet.	Thickness Inches.	D[illegible] Feet.	D[illegible] Inches.
Cuckfield Clay 8	Brown clay	8	-	8	-
U. Tunbridge Wells Beds 22	Brown sandstone in layers from 1" to 4" thick with grey sand between from 6" to 1' thick	22	-	30	-
	Grey sandstone	4	-	34	-
	Brown clay	1	6	35	6
	Grey sandstone	34	6	70	-
Grinstead Clay 13	Brown clay	13	-	83	-
Lower Tunbridge Wells Beds 42	Red sandstone	8	-	91	-
	Grey sandstone	21	-	112	-
	Red sand	1	-	113	-
	Grey sandstone	2	-	115	-
	Grey sand	2	-	117	-
	Grey sandstone	3	-	120	-
	Grey sand	3	6	123	6
	Grey sandstone	1	6	125	-

[illegible] [illegible]

Not classifiable in detail; [illegible] [illegible]. probably all UTW. R.Gallois 10/1/64.

TQ33/5

302/48

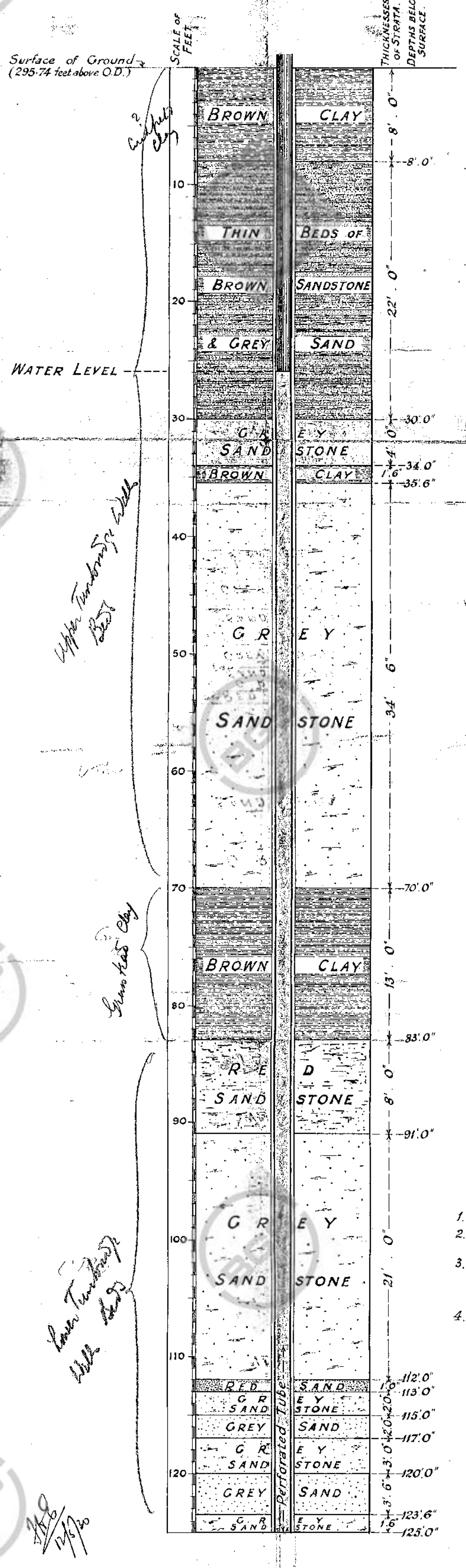
302/48

N.B. Geological classification by F.H.E. incorrect. Probably all OTW.

R.G. 10/1/64.

1951

Section of Borehole sunk near The Mill House, Rowfant, Sussex, for J. S. Jeffrey, Esq.



Remarks:

1. The Boring was done by the Rotary Process.
2. Boring commenced on the 17th. December, 1929, and terminated on the 15th. February, 1930.
3. The Borehole is 9" dia., and it is lined with Steel Casing Tube 6" internal dia. The lower end of the Tube is perforated for a length of 16 feet.
4. In two spells of Test Pumping of 11 hours' and 4 hours' duration respectively, water was drawn from the Borehole at a rate of 500 gallons per hour without any appreciable alteration being observed in the Water Level. The first spell of Pumping was done before the Casing Tube had been inserted in the Borehole.

Contractors:
Chas. J. Ell & Sons,
Victoria Well Works,
Leagrave,
Luton.

Frank H. Brunt, M.Inst.C.E.,
Chartered Civil Engineer,
17, Victoria Street,
Westminster.

April, 1930.

Prog. No 107.

TQ 23 NW 4

County Sussex 286/13

TQ 23/13

WELL BORING at Rusper

Geol. map 1 in. map New Series 302 6 in. map

Made by Duke & Ockenden Date 1928

Sunk 34 feet. Bored 216 feet.

Communicated by Sir Evelyn de la Rue.

Height above Ordnance Datum Rest level of water 113

Yield 500 gph. 302

Quality (with copy of analysis on separate sheet) Suitable for drinking purposes GR 2094 3716

GEOLOGICAL FORMATION.	NATURE OF STRATA.	THICKNESS Feet.	THICKNESS Inches.	DEPTH Feet.	DEPTH Inches.
	(Dug well	34	–)		
	Weald Clay	250	–	250	
	Rocky shale at base				
	Water cut at 70 ft., unfit for use (84·7° of hardness)				
	" " " 240 ft.				
	Lined 6 in. tubes to 87				
	" 4½ " " 170				
	3" " " 250 (perforated)				
	Pumps at 160 ft				

GF m 28 2423

Analysis on Reg.

Rusper—Maps O.S.G. 8, N.S. 302.

534. NORMANS, ½ mile E.S.E. of church. 1928. Ht. above O.D. about 350 ft. Map ~~6 S.W.~~ 3 SW.

	Thickness Ft.	Depth Ft.
Dug well	—	34
Weald Clay	216	250

Rocky shale was encountered at the bottom of the boring, which most probably was the top of the Tunbridge Wells Sand.

1st water cut at 62 ft.–74 ft., with 84·7 degrees of hardness, and unfit for use. 2nd water at 180 ft.–200ft. R.L.W. 113 ft. down. Yield 500 g. p. hour. Lined 6 in. tubes to 87 ft., 4½ in. tubes to 170 ft., and 3 in. tubes to 250 ft. (perforated 170 ft.–218 ft.). Pumps at 160 ft. down. Analyses of water on p. 240. Information from Messrs. Duke and Ockenden, Ltd.

P

Rusper

NORMANS. Well No. 534.

	Grains per gallon.
Total solids ...	105
Chlorine ...	17·3
Ammonia ...	0·0343
Albuminoid ammonia	absent.
Nitrogen as nitrates...	absent
Nitrogen as nitrites ...	absent.
Lead ...	absent.
Total hardness (Clark)	6°

This water is free from sewage pollution and may be regarded as quite suitable for drinking purposes. The water is strongly alkaline and the degree of 'hardness' is very low, hence it is well suited for general domestic uses.

By Mr. R. A. Cripps, F.I.C.

Published in 'Wells & Springs of Sussex.' page 219

M. of H. notified 4/5/28.

Disused visited S. Buchan 16.2.40.

Visited. Disused since house on mains

Listed Sussex. 3 SW/W ~~E~~. 29.5.47.

TQ23NW/4

2 WELL BORING at Rusper County Sussex

Geol. map 1 in. map New Series 302 6 in. map TQ23/13

Made by Duke + Ockenden Date 1928

Sunk 34 feet. Bored 216 feet.

302

Communicated by Duke + Ockenden

Height above Ordnance Datum Rest level of water 113

Yield tested at 500 g.p.h.

Quality (with copy of analysis on separate sheet)

44

GEOLOGICAL FORMATION.	NATURE OF STRATA.	THICKNESS. Feet.	THICKNESS. Inches.	DEPTH. Feet.	DEPTH. Inches.
	Dug well	34	—	34	—
	Wealden clay	216	—	250	—

Lined 6" tubes to 84 ft.
4½" " " 170 ft.
3" " " 250 ft.
(3" tubes perforated 170' – 218')

First water cut at 62'–74'
84.7° of hardness

Water cut at 180'–200'
Alkaline with 6° of hardness

Site Normans
for Sir Evelyn de la Rue.

Rusper At Normans. Sussex
for Sir Evelyn de la Rue DEC 1928

Dug well .. .. 34' 0"
Bored to .. .. 250' 0"
Lined. 6" tubes to 87' 0"
" 4½ " 170' 0"
" 3" " 250' 0"
3" tubes perforated
from 170' to 218'
Water level .. .. 113' 0"
Tested at 500 g.p.h.

Stratum
Wealden Clay
First water cut at 62' to 74'
84.7° degrees of hardness

Water cut at 180 to 200
Water alkaline
with 6° of hardness.

WJB 4/324.

M. of H. notified 2/7/28

Geological Survey and Museum.

1 **302/44 Normans, Rusper.** (Disused) TQ 23/13

W.S.Sx.III, p. 219. Surface +353. Shaft 34; rest bore. Lining tubes: 87 × 6 in from surface; × 4½ in to 170 down; × 3 in to 250 down (perforated 170 to 218). Water struck at +291 to +279 (Hardness: total 1,210), +173 to +153 (Hardness: total 86) and at +113. R.W.L. +240. Suction +193. Yield 500 g.p.h. (test). *Dando, 1928.*

WC	...	...	250	250

NO DETAILS KNOWN

TQ23/13

WELL BORING at Rusper County Sussex

l. map 1 in. map New Series 302 6 in. map 289

de by Duke & Ockenden Date 1928

Sunk 34 feet. Bored 216 feet.

Communicated by Sir Evelyn de la Rue.

Height above Ordnance Datum 353 Rest level of water 113 ft. down 302/4

Yield 500 gph.

Quality (with copy of analysis on separate sheet) Suitable for drinking purposes

TQ 2093 3718

GEOLOGICAL FORMATION.	NATURE OF STRATA.	THICKNESS. Feet.	Inches.	DEPTH. Feet.	Inches.
WC {	(Dug well	34	–)		
	Weald Clay	250	–	250	
	Rocky shale at base				

Water cut at 70 ft., unfit for use (84·7° of hardness)
" " " 240 ft.

Lined 6 in. tubes to 87
4½ " " 170
3 " " 250 (perforated)

Pumps at 160 ft

Gfm 28 2427

Rusper—Maps O.S.G. 8, N.S. 302.

534. NORMANS, ½ mile E.S.E. of church. 1928. Ht. above O.D. about 350 ft. Map ~~6 S.W.~~ 3SW.

	Thickness Ft.	Depth Ft.
Dug well	—	34
Weald Clay	216	250

Rocky shale was encountered at the bottom of the boring, which most probably was the top of the Tunbridge Wells Sand.

1st water cut at 62 ft.–74 ft., with 84·7 degrees of hardness, and unfit for use. 2nd water at 180 ft.–200ft. R.L.W. 113 ft. down. Yield 500 g. p. hour. Lined 6 in. tubes to 87 ft., 4½ in. tubes to 170 ft., and 3 in. tubes to 250 ft. (perforated 170 ft.–218 ft.). Pumps at 160 ft. down. Analyses of water on p. 240. Information from Messrs. Duke and Ockenden, Ltd.

Analysis on file

Rusper

NORMANS. Well No. 534.

	Grains per gallon.
Total solids	105
Chlorine	17·3
Ammonia	0·0343
Albuminoid ammonia	absent.
Nitrogen as nitrates...	absent
Nitrogen as nitrites	absent.
Lead	absent.
Total hardness (Clark)	6°

This water is free from sewage pollution and may be regarded as quite suitable for drinking purposes. The water is strongly alkaline and the degree of 'hardness' is very low, hence it is well suited for general domestic uses.

By Mr. R. A. Cripps, F.I.C.

Published in 'Wells & Springs of Sussex, II, page 219

M. of H notified 4/5/28.

Disused visited S Buchan 16.2.40.

Visited. Disused since house on mains. Sited on Sussex 3 SW/W E. 29.5.47.

O.D + 353. Visited 20.11.57. RH.

GEOLOGICAL SURVEY AND MUSEUM, JERMYN STREET, LONDON, S.W. 1. (B10619). Wt. 15824—S123. 2500. 11/25. Gp. 169. O.A.

WELL BORING at Rusper County Sussex TQ23/13

Geol. map 1 in. map New Series 302 6 in. map 302

Made by Duke + Ockenden Date 1928

Sunk 34 feet. Bored 216 feet.

Communicated by Duke + Ockenden

Height above Ordnance Datum Rest level of water 113'

Yield tested at 500 g.p.h.

Quality (with copy of analysis on separate sheet)

GEOLOGICAL FORMATION.	NATURE OF STRATA.	THICKNESS. Feet.	Inches.	DEPTH. Feet.	Inches.
	Dug well	34	—	34	–
	Wealden clay	216	–	250	–

Lined 6" tubes to 87 ft.
4½" " " 170 ft.
3" " " 250 ft.
(3" tubes perforated 170'— 218')

First water cut at 62'-74'
84.7° of hardness

Water cut at 180'—200'
Alkaline with 6° of hardness

Site Normans
for Sir Evelyn de la Rue.

Rusper At Normans. Sussex
for Sir Evelyn de la Rue D&O 1928

Dug well .. .. 34' 0"
Bored to .. .. 250' 0"
Lined. 6" Tubes to 87' 0"
" 4½ " . . 170' 0"
" 3" . . 250' 0"
3" tubes perforated
from 170' to 218'
Water level .. .. 113' 0"
Tested at 500 g.p.h.

Stratum
Wealden Clay
First water cut at 62' to 74'
84.7° degrees of hardness

Water cut at 180 to 200
Water alkaline
with 6° of hardness.

WSB 4/324.

M. of H notified 2/7/28

Geological Survey and Museum,
Jermyn Street, London, S.W. 1.

(B10619). Wt. 15824—S123. 2500. 11/25. Gp. 160. O.A.

letter of the 10th inst., addressed to Duke & Ockenden, Ltd., which was referred to our Littlehampton Office as the record came from there.

From what I can gather the report that we sent in to you was the final and correct version. I have had nothing to do with this job, nor have I had access to the records, but I am assured that the statement sent in is reliable for insertion in the Memoirs.

I am writing this in case you have not received a reply direct from Littlehampton.

Yours truly,

289 TQ23/13

TELEPHONE: HOP 1768.

126, SOUTHWARK STREET,
LONDON, S.E.1.

302

20th July, 1928.

44

Dear Mr. Edmunds,

Normans, Rusper, Sussex.

This letter is addressed to you personally in regard to your letter of the 10th inst., addressed to Duke & Ockenden, Ltd., which was referred to our Littlehampton Office as the record came from there.

From what I can gather the report that we sent in to you was the final and correct version. I have had nothing to do with this job, nor have I had access to the records, but I am assured that the statement sent in is reliable for insertion in the Memoirs.

I am writing this in case you have not received a reply direct from Littlehampton.

Yours truly,

Maurice A. Ockenden

F. H. Edmunds, Esq.,
The Geological Survey & Museum,
Jermyn Street,
S.W.1.

Page 219

MAO/K.

TQ 24 SE/17
1870 A328

286/23 Smallfield Laundry, Station Road East, Horley (formerly Albert Brewery)

W.S.S. p. 175. Surface +179. Shaft 3; rest bore 6 in. Overflowed at c. 540 g.p.h. Yield 2,000 g.p.h. *Isler, 1895.*
R.W.L. +169. *Feb.* P.W.L. +149. Yield 2,000 g.p.h., 9 h.p.d. *June 1947.*

WC) 300 300
TW)

286/23

[All Weald Clay.]

WC)
TW) 300 300

PERL
4.11.64

	Thickness. Feet.	Depth. Feet.
Weald clay	11	11
Stone	8	19
Blue marl	41	60
Blue marl and stone	19½	79½
Stone	1½	81
Marl	2	83
Marl and stone ...	5	88
Marl	6½	94½
Marl and stone ...	91	185½
Sandstone*	25½	211
Marl and stone ...	2½	213½
Sandstone	8	221½
Marl	3½	225
Marl and stone ...	4½	229½
Marl	5½	235
Marl and stone ...	16	251
Marl	4	255
Marl and stone ...	9	264
Marl	1	265
Marl and stone ...	2½	267½
Marl	21	288½
Sandstone	½	289
Stone	1½	290½
Sandstone	4	294½
Marl and sandstone ...	2½	297
Marl	3	300

TQ 2870 4328

286/23

TQ24/10

Horley.

Ordnance Map 286, new ser. Geological Map 8.

1. Albert Brewery. Messrs. Youell & Elkin. 1895.

Made and communicated by Messrs. Isler & Co.

Dug 3 feet, the rest a boring of 6 inches diameter.
Water overflowed at the rate of about 9 gallons a minute. Pumping goes on at the rate of 2000 gallons an hour.

		Thickness. Feet.	Depth. Feet.
[[illegible]AN Weald Clay.]	Weald clay	11	11
	Stone	8	19
	Blue marl	41	60
	Blue marl and stone	19½	79½
	Stone	1½	81
	Marl	2	83
	Marl and stone	5	88
	Marl	6½	94½
	Marl and stone	91	185½
	Sandstone *	25½	211
	Marl and stone	2½	213½
	Sandstone	8	221½
	Marl	3½	225
	Marl and stone	4½	229½
	Marl	5½	235
	Marl and stone	16	251
	Marl	4	255
	Marl and stone	9	264
	Marl	1	265
	Marl and stone	2½	267½
	Marl	21	288½
	Sandstone	½	289
	Stone	1½	290½
	Sandstone	4	294½
	Marl and sandstone	2½	297
	Marl	3	300

* A letter from Messrs. Youell & Elkin (Nov. 1895) describes this 25 feet bed as limestone, and adds that an adequate supply comes from it.

WC) 300 300
TW)

PERL 4.11.64

Smallfield Laundry O.D 179
Station Road East.

RWL. 10' down Feb. 1947
P.W.L. 30' down yield 2,000 g.p.h. + 149 OD
Well pumped at that rate 9 hours per day
for 5 days per week
Sited on 6" Survey 41 NE/E.

Visited
S. Buchan
3.6.47.

Published in
'The Water Supply
of Surrey',
page 175

TQ24/10

286/23 Smallfield Laundry, Station Road East, Horley (formerly Albert Brewery)

W.S.S. p. 175. Surface +179. Shaft 3; rest bore 6 in. Overflowed at c. 540 g.p.h. Yield 2,000 g.p.h. *Isler, 1895.*
R.W.L. +169. *Feb.* P.W.L. +149. Yield 2,000 g.p.h., 9 h.p.d. *June 1947.*

WC) 300 300
TW)

286/23

[All Weald Clay.]

	Thickness. Feet.	Depth. Feet.
Weald clay	11	11
Stone	8	19
Blue marl	41	60
Blue marl and stone	19½	79½
Stone	1½	81
Marl	2	83
Marl and stone ...	5	88
Marl	6½	94½
Marl and stone ...	91	185½
Sandstone *	25½	211
Marl and stone ...	2½	213½
Sandstone	8	221½
Marl	3½	225
Marl and stone ...	4½	229½
Marl	5½	235
Marl and stone ...	16	251
Marl	4	255
Marl and stone ...	9	264
Marl	1	265
Marl and stone ...	2½	267½
Marl	21	288½
Sandstone	½	289
Stone	1½	290½
Sandstone	4	294½
Marl and sandstone ...	2½	297
Marl	3	300

WC) 300 300
TW)

PERL
4. 11. 64

A = TQ 23 NE 45 B TQ 23 NE 46

WELL BORING at Worth County Sussex TQ 23/17
Geol. map 1 in. map New Series 302 6 in. map
Made by C Isler & Co Date 1925
Sunk feet. Bored
Communicated by Isler & Co
Height above Ordnance Datum Rest level of water 30 ft.
Yield 1400 galls per hour. A 2970 3800
Quality (with copy of analysis on separate sheet) B 2961 3810

A & B

GEOLOGICAL FORMATION.	NATURE OF STRATA.	THICKNESS Feet.	THICKNESS Inches.	DEPTH Feet.	DEPTH Inches.
	Concrete	1	6	1	6
Tunbridge Wells Sand	Marl	2	–	3	6
	Ironstone	–	6	4	–
	Marl	7	6	11	6
	Iron Stone	–	9	12	3
	Marl	6	–	18	3
	Ironstone	–	6	18	9
	Marl	5	3	24	–
	Sandstone	–	9	24	9
	Marl	2	3	27	–
	~~Marl~~ Sandstone	–	6	27	6
	Marl.	72	6	100	–

RLW 30 ft down Yield 1400 g. p. h.

~~Site~~

~~Milton Mount College.~~

Lined 41 ft of 8" tubes 9" below surface.

Information from ~~Messrs Duke and Ockenden Ltd~~ Isler Co

Published in 'Wells & Springs of Sussex,' page 215

Worth—Maps O.S.G. 8, N.S. 302.

516. Milton Mount College, in Worth Park. 1925. Ht. above O.D. 280 ft. Map 4 N.W.

B

		Thickness Ft.	Depth Ft.
	Concrete	1½	1½
Tunbridge Wells Sand	Marl	2	3½
	Ironstone	½	4
	Marl	7½	11½
	Ironstone	¾	12¼
	Marl	6	18¼
	Ironstone	½	18¾
	Marl	5¼	24
	Sandstone	¾	24¾
	Marl	2¼	27
	Sandstone	½	27½
	Marl	72½	100

R.L.W. 30 ft. down. Yield 1,400 g. p. hour. Lined 41 ft. of 8 in. tubes, top 9 in. below surface. Information from Messrs. ~~Duke and Ockenden, Ltd.~~ Isler Co

Omitted & sited on Sussex 4 N.W.W. +260
surface – 270 well cts.
1947 { R.W.L. 26½ below well cts. Yield 1000 g.p.h 5 h.p.d.
JKI. 6.6.47.

Depth is 110' is a 5" bore.

Boring started in basement.

A 1881? 35' 35' deep well. still in use
Information from retired Engineer of Milton Mount College 16.2.50.

Geological Survey and Museum. (B10610) Wt 15824—S123. 2500. 11/25. Gp. 169 O.A.

1 302/43 Milton Mount College, Crawley TQ23/17 A+B

(a) Surface +c.270. Shaft 35. *1881.*
(b) W.S.Sx.III, p. 215. Surface +270. Well-top +260. Lining tubes: 41 × 8 in from ¾ down. R.W.L. +230. Yield 1,400 g.p.h. *Isler, 1925.*
R.W.L. +233½. Yield 1,000 g.p.h., 5 h.p.d. *1947.*

(b)	Made	... ...	1½	1½
	UTW	... ...	98½	100

302/43 B

		Thickness Ft.	Depth Ft.
	Concrete	1½	1½
Tunbridge Wells Sand	Marl	2	3½
	Ironstone	½	4
	Marl	7½	11½
	Ironstone	¾	12¼
	Marl	6	18¼
	Ironstone	½	18¾
	Marl	5¼	24
	Sandstone	¾	24¾
	Marl	2¼	27
	Sandstone	½	27½
	Marl	72½	100

(a) No details known

estimated classn UTW 35 35

TQ23/17 A&B

1

302

WELL BORING at Worth Crawley County Sussex
Geol. map 1 in. map New Series 6 in. map
Made by C Isler & Co Date 1925
Sunk feet. Bored feet.
Communicated by Isler & Co
Height above Ordnance Datum Rest level of water 30 ft.
Yield 1400 galls per hour. A. TQ 2970 3808
Quality (with copy of analysis on separate sheet) B. TQ 2960 3806

43

A&B

GEOLOGICAL FORMATION.	NATURE OF STRATA.	THICKNESS. Feet.	THICKNESS. Inches.	DEPTH. Feet.	DEPTH. Inches.
B	Concrete	1	6	1	6
Tunbridge Wells Sand	Marl	2	–	3	6
	Ironstone	–	6	4	–
	Marl	7	6	11	6
	Iron Stone	–	9	12	3
	Marl	6	–	18	3
	Iron stone	[illegible]	6	18	9
	Marl	5	3	24	–
	Sandstone	–	9	24	9
	Marl	2	3	27	–
	~~Marl~~ Sandstone	–	6	27	6
	Marl.	72	6	100	–

RLW 30 ft down Yield 1400 g. p. hour

~~Site~~

~~Milton Mount College~~

Upper T.W.
R.G. 3.12.64.

Lined 41 ft of 8" tubes 9" below surface.

Information from ~~Messrs Duke and Ockenden Ltd~~ Isler

Published in
'Wells & Springs
of Sussex,' III
page 215

Worth—Maps O.S.G. 8, N.S. 302.

516. MILTON MOUNT COLLEGE, in Worth Park. 1925. Ht. above O.D. 280 ft. Map 4 N.W.

B

		Thickness Ft.	Depth Ft.
	Concrete	1½	1½
Tunbridge Wells Sand	Marl	2	3½
	Ironstone	½	4
	Marl	7½	11½
	Ironstone	¾	12¼
	Marl	6	18¼
	Ironstone	½	18¾
	Marl	5¼	24
	Sandstone	¾	24¾
	Marl	2¼	27
	Sandstone	½	27½
	Marl	72½	100

R.L.W. 30 ft. down. Yield 1,400 g. p. hour. Lined 41 ft. of 8 in. tubes, top 9 in. below surface. Information from Messrs. ~~Duke and Ockenden, Ltd.~~ Isler Co
Depth is 110'. Is a 5" bore.

visited & sited on Sussex 4 N.W.W. +260
Surface + 270 well top
1947 { R.W.L. 26½ below well top.
Yield 1000 g.p.h 5 h.p.d.
J.W.
6.6.47.

Only started in basement.

A 1881 – 35' dug well. – still in use.
Information from retired Engineer of Milton Mount College
16.2.50. KN

GEOLOGICAL SURVEY AND MUSEUM,
JERMYN STREET, LONDON. S.W. 1. Stet.

(B10619). Wt. 15824—S123. 2500. 11/25. Gp. 160. O.A.

NGRC
BOREHOLE RECORDS
ADJUSTMENT FORM

QUARTER SHEET TQ 23 NE

BH REGISTRATION NUMBER 76 - 79

RECORDS ENTERED AND HELD BY WALLINGFORD

BH REGISTRATION NUMBER(S)

302/15 Formerly Horsham R.D.C., Brighton Road Pumping Station, Crawley. (Disused) A-C. TQ2642 3595 TQ 23/16 A-C

(a) W.S.Sx.III, p. 78. Surface +268. Bore 648. Lining tubes: 93 × 4½ in from surface; × ? 3 in to 584 down. Overflowed at +280. P.W.L. -32. Yield 420 g.p.h. Hardness: total 7. Anal. *1898.*

Deepened to 728. When bore 656, overflowed at +274; bore 681, R.W.L. +c.268; bore 684, overflowed at 3¾ g.p.h.; bore 699, R.W.L. +c.268; bore 700, R.W.L. +264; bore 710, R.W.L. +252; bore 722, R.W.L.+253; bore 728, overflowed. *1900.*

(b) W.S.Sx.III, p. 79. Surface +268. Shaft 300 × 8½; rest bore 10 in. Depth ? 770. R.W.L. +c.218. Yield c. 50,000 g.p.d. *Date unknown.*

? Silted to 695. Deepened. Lining tubes: 432 × 15 in from c.250 down; 165 × 12 in from 670 down (92 perforated). P.W.L. -302. Suction -612. Yield 6,500 g.p.h. (test). *LeGrand, 1934.*

(c) W.S.Sx.III, p. 79. Surface +268. Bore 923 × 12 in reduced to 7 in at depth. Lining tubes: 923 from surface (partly perforated). *1907.*

Yield 60,000 g.p.d. *1919-1920.* R.W.L. -32. Yield 5,000 g.p.h. *1926.*

(b) and (c) Yield 6,200 g.p.h., c.19 h.p.d. *Apr. 1935.*

(b) WC	...	...	277	277
Has	...	...	645	922

302/15A

Clay (brownish)	12	12
Hard blue clay (light-grey and buff at 15, grey at 46)	34	46
Soft blue clay (brownish at 52) ...	6	52
Rock	11	63
Blue clay (light-coloured at 84) ...	33	96
Undescribed (light-grey clay at 98)	12	108
Blue clay (brownish-grey at 111) ...	4	112
Rock	3½	115½
Blue clay and rock (greyish clay at 140, darker clay at 146)	32	147½
Rock (grey clay at 148)	7½	155
Rock and clay (grey clay at 158, 162 and 173, the last pale)	20	175
Rock (brownish-grey fissile clay at 185, very pale grey clay at 190) ...	24½	199½
Brown rock	1½	201
Blue and brown rock (grey shaly clay at 204, brownish-grey clay at 206)	8	209
Rock (grey shaly clay at 210 and 250)	68	277
Brown rock (light-grey compacted sand at 280)	6	283
Blue and brown rock	6	289
Brown rock	32	321
Blue rock (light-grey compacted sand at 390)	124	445
Hard blue rock (very pale grey compacted sand at 500. Very fine-grained soft buff earth, compacted, at 550)	139	584
Sand rock (very light-grey compacted clayey sand at 588) ...	4	
Sand (grey, compacted, clayey at 600; grey or buff ditto at 610, light-grey at 630, compacted light-grey, clayey at 637)	[illegible]	[illegible]

145.65

2

TQ23/16B

302/15B

(For Survey use only). GEOLOGICAL CLASSIFICATION.	NATURE OF STRATA. (and any additional remarks)	THICKNESS. Feet.	THICKNESS. Inches.	DEPTH. Feet.	DEPTH. Inches
	Deepening No.3 Existing Borehole.				
Tunbridge Wells Clay ? part of TWS	**Existing Well.** Crawley	8	6	x 300'	
	From the bottom of this well Messrs F.Smith of Basingstoke have bored to:	695	-	695	-
	We continued as follows:				
? Cuckfield Clay	Blue Marl	12	-	707	-
	Blue Rock	1	-	708	-
	Hard Grey Stone	7	6	715	6
	Grey Sandstone & layers of Clay	1	6	717	-
	Brown & Grey Stone	1	6	718	6
	Grey Sandy Clay	8	-	726	6
? Grinstead Clay	Brown Sandy Clay	2	6	729	-
	Grey Sandy Clay	15	6	744	6
	Grey Sandy Clay - hard	10	6	755	-
	Hard Grey Sandstone	8	6	763	6
	Red Sandstone	3	6	767	-
? L. TWS	Grey Sandstone	50	6	817	6
	Grey Sandstone - hard & sticky	55	6	873	-
	Grey Marl	46	-	919	-
	Grey Sandy Marl	3	-	922	-

c)

	thickness	depth
WC	c. 277	c. 277.
HaS.	c 646	c 923

pp. J Mellor 25.10.68.

Site Plan

Notes

The following ... Well Catalogue (I.G.S.) for shafts 301 ... 302 ...

(b) W.S.Sx.III, p. 79. Surface +268. Shaft 300 x 8½; rest bore 10 in. Depth ? 770. R.W.L. +c.218. Yield c. 50,000 g.p.d. *Date unknown.*
? Silted to 695. Deepened. Lining tubes: 432 x 15 in from c.250 down; 165 x 12 in from 670 down (92 perforated). P.W.L. -302. Suction -612. Yield 6,500 g.p.h. (test). *LeGrand, 1934.*

(b)	WC	...	...	277	277
	Has	...	...	645	922 .

... the hole of 1904; & ... the base of the ... 594 ft by Ochenden

... might be

1904 ... 8½ ft
... to c. 594 ft by
... See file for drillers log.
... to 922 (?) ft by

* Well catalog gives pre-1934 depth of ? 770 ft

Tested at 6500 gph ... 1934; PWL = -302 ft O.D.

CRAWLEY BRIGHTON ROAD P.S. (ALSO CALLED GOFFS PARK ROAD?)

TQ 23 – 16 B

Owner	Horsham R.D.C. (Crawley	Licence No.	
Occupier	Water Undertaking)	IGS Ref. No.	302/15 B
Nat. Grid Ref.	2642 3595	Status	P.S. DISUSED
Ground Level	m OD	268	ft. OD
Level of Well Top	m OD		ft. OD
Rest Water Level	m bwt		ft. bwt
(Date ?)	m OD	+ 218	ft. OD
Construction	Shaft + bore		SO/OQ/UX/CY

Aquifer: HASTINGS BEDS

Summary of Geological Section	Thickness	Depth
Weald Clay	277 ft	277 ft
Hastings Beds	645 ft	922 ft

Depth bwt	Dia.	Linings (below well top) From	To	Dia.	Type
300 ft	8' 6"	[illegible]	After deepening (1934):		
770 ft ?	Original bore 10"	250 ft	682 ft	15"	plain
Deepened in	1934 to	670 ft	835 ft	12"	plain + perf
922 ft		(92 ft of this second string is perforated)			

Abstraction Rates		Type of Pump	Airlift
6500	gph (1934)	Chem./Bact. Anal.	YES NO
	gpd	Well Driller	1904 ??. Deepened 1931/4

If insufficient space has been allowed, continue in 'Notes' overleaf. P.T.O.

TQ23/16 302/15

5

Crawley W./wks. 193 Ockenden & Smith

302
15B

Boring from bottom of old well 303' deep

	Depth
Concrete in well bottom	300 - 302½
Hard rock	306
Hard grey marl or stone	310
Hard brn & grey shale	315
~~Puddling~~	
Blue marl	337
Hard blue & brown marl	377
Hard grey sdy marl	393
" " marl	440
Light " compact sand	468
" " marl	472
Compact sand	474
Light grey marl	543
Clay Stone	544
Hard grey marl	546
Light grey rock	551
" " marl	553
Hard blue rock	554
Light brown rock	558
" grey marl	568
" blue marl	570

t/g
6'

Light grey marl	582
Sandy blue marl	583
Dark blue sandy marl	587
Blue marl	591
Dark grey sandy marl	592
Dark grey marl	594

... by
Ockenden & Smith

RECORD of WELL or BORING

TQ23/16,15 302/15 Survey No. 302
1" N.S.
O.S.

at (house or farm) Horsham R.D.C., ~~Council Offices.~~
Town, Village, &c. ~~Horsham.~~ Crawley County Sussex. Six-inch map Sussex
Exact site (unless a tracing from a map is supplied, give distance and direction from parish church, cross-roads, or other object shown on maps). The Waterworks, just S. of Crawley Farm. Popular Edition of one-inch map.
Surface level of ground 267 ft. above Ordnance Datum. Well or Bore commenced at ft. below surface level
Sunk - ft., diameter - ft. Bored 227 ft.; diameter of boring: at top 8½ in., at bottom 12 in.
Details of lining tubes (internal diameters preferred) approx. 432' x 15" top; approx. 250' B.S. 165' x 12" top 670' B.S. - 92' being perforated.
Water struck at depths of (feet) Not stated.
Rest-level of water below ~~above~~ top of well or bore 33 ft. Pumping level 570 ft. Time of recovery - hours.
Suction at 880 590/ ft. depth. Yield: (i) on test 6,500 500/ galls. per hour, (ii) normal - galls. per
Quality (attach copy of analysis if available).
Made by LeGrand, Sutcliff & Gell, Ltd. for Mr. Date of boring 1934
Information from LeGrand, Sutcliff & Gell, Ltd., Southall, Middx. SB 4/562.

(For Survey use only). GEOLOGICAL CLASSIFICATION.	NATURE OF STRATA. (and any additional remarks)	THICKNESS. Feet.	Inches.	DEPTH. Feet.	Inches.
	Deepening No.3 Existing Borehole.				
Hastings beds * Clay and part of U.T.W.S.	Existing Well. Crawley	8	6	x 300'	
	From the bottom of this well Messrs F.Smith of Basingstoke have bored to:	695	-	695	-
	We continued as follows:				
? Cuckfield Clay	Blue Marl	12	-	707	-
	Blue Rock	1	-	708	-
	Hard Grey Stone	7	6	715	6
? U.T.	Grey Sandstone & layers of Clay	1	6	717	-
	Brown & Grey Stone	1	6	718	6
	Grey Sandy Clay	8	-	726	6
? Grinstead Clay	Brown Sandy Clay	2	6	729	-
	Grey Sandy Clay	15	6	744	6
	Grey Sandy Clay - hard	10	6	755	-
	Hard Grey Sandstone	8	6	763	6
	Red Sandstone	3	6	767	-
? L.T.W.S.	Grey Sandstone	50	6	817	6
	Grey Sandstone - hard & sticky	55	6	873	-
	Grey Marl	46	-	919	-
	Grey Sandy Marl	3	-	922	-

* See W.S. of Sussex, p.79. Depth of bore is given as 740 ft. Since this present account states a sequence of strata under commencing from 695 ft, the original statement may be inaccurate, the original depth probably being 700 ft. The interpretation of this section makes the Weald Clay considerably thicker than originally thought (see W.S. of Sussex, well no 113), probably to 600 ft or 800 ft below surface.

J.B.S. 5/8/38

A second borehole, to 923 ft., a few yards away, gave 60,000 gallons per day, pumping 24 hours a day, in 1919-1920. In 1921 the level of water dropped 150 ft., and has never recovered. Yield in 1926 5,000 g. p. hour. R.L.W. 300 ft. down. Analysis on p. 235.

B C

GEOLOGICAL SURVEY AND MUSEUM, SOUTH KENSINGTON, S.W.7.

For Survey use only.

Date received.	G.S.M.	M. of H. notified	Site marked on 1" map.

(24738C) Wt 26930/295 5,000 11/36 H. T. P. Ltd. G.

Site Plan

Notes

RWL reported to have been 350 ft down in 1907 (= -82 ft O.D.), and -32 ft O.D. in 1926.

From IGS Well Catalogue Sheet 301/302

(c) W.S.Sx.III, p. 79. Surface +268. Bore 923 x 12 in reduced to 7 in at depth. Lining tubes: 923 from surface (partly perforated). *1907*.
Yield 60,000 g.p.d. *1919-1920*. R.W.L. -32. Yield 5,000 g.p.h. *1926*.
(b) and (c) Yield 6,200 g.p.h., c.19 h.p.d. *Apr. 1935*.

TQ23NE41 | TQ23/11 | 302 | 83 | TQ27/11

WELL BORING at Lowfield Heath, Crawley County Sussex

Geol. map 1 in. map New Series 302 6 in. map

Made by Duke & Ockenden. Date 1930.

Sunk feet. Bored 75 feet

Communicated by D. & O.

Height above Ordnance Datum 200.00 Rest level of water 6" below surface

~~Yield~~ depresses to 17 ft. when pumping 500 gals per hour

Quality (with copy of analysis on separate sheet)

GR 2690 3932

GEOLOGICAL FORMATION	NATURE OF STRATA	Thickness Feet	Thickness Inches		
Weald clay {	yellow clay	10	–	10	–
	Blue clay	65	–	75	–
	thin layers of rock at 56 ft.				

"F.H.E." 23/12/30.

At Messrs Cheal & Sons Nurseries, 2 m. north of Crawley Station.

Lined 10" tubes to 40' 6"
8" tubes to 75'
perforations 63' 6" to 68' 6"

Mof 76 noušed Eg 12/30.

Crawley — Sussex
At Lowfield Heath
Messrs Cheal & Sons Nurseries — D&O
2 miles N of Crawley Station — Sept 1930
O.D. 200.00

Bored to .. 75' 0"
Lined. 10" Tubes to 40' 6"
" 8" " " 75' 0"
perforations 63' 6" to 68' 6"
Water level 6" below Surface
depresses to 17' 0" when pumping
500 gls per hour

Stratum
Wealden Clay
Yellow Clay .. 0 – 10'
Blue Clay . 10 – 75
Thin layers of Rock at . 56' 0"

WSB 4/422.

J. C. KING, LTD., 42 TO 60, GOSWELL ROAD, LONDON E.C.

Water overflows 1940.
Visited S Buchan 15.2.40.

Visited & sited on Sussex 3 N.E.6.
Still in use. No further details.
JKH. 6.6.47.

WELL BORING at Lowfield Heath. Charlwood. ~~Crawley~~ County Sussex 302 373
Geol. map 1 in. map New Series 302 6 in. map
Made by Duke & Ockenden. Date Sept. 1930.
Sunk feet. Bored 75
Communicated by D. & O. 83
Height above Ordnance Datum 200.00 Rest level of water 6" below surface
~~Yield~~ depresses to 17 ft. when pumping 500 gal. per hour
Quality (with copy of analysis on separate sheet) TQ23/11

TQ 2692 3932

GEOLOGICAL FORMATION.	NATURE OF STRATA.	THICKNESS. Feet.	Inches.		
Weald clay	yellow clay	10	–	10	–
	Blue clay	65	–	75	–
	Thin layers of rock at 56 ft.				

4 H.E." 22/12 30.

at Messrs Cheal & Sons Nurseries, 2 m. north of Crawley Station.

Lined 10" Tubes to 40' 6"
8" tubes to 75'
perforations 63' 6" to 68' 6"

Map of 76 notified Eg 12/30.

Crawley Sussex
At Lowfield Heath
Messrs Cheal & Sons Nurseries
2 miles N of Crawley Station
D&O Sept 1930
O.D. 200.00

Bored to 75' 0"
Lined. 10" Tubes to 40' 6"
8" " 75' 0"
perforations 63' 6" to 68' 6"
Water level 6" below Surface
depresses to 17' 0" when pumping
500 gls per hour

Stratum
Wealden Clay
Yellow Clay 0 – 10'
Blue clay 10 – 75
Thin layers of Rock at 56' 0"

WJB 4/482.

J. C. KING, LTD., 42 TO 60, GOSWELL ROAD, LONDON E.C.

Water overflows 1940.
Visited Buchan 15.1.40.

Visited & ... on Sussex 3 N.E.R. Still in use. No further details. JKH. 6.1.47.

Site transferred to Surrey 41 SE/W

TQ 23/11

302/83 Messrs. Cheal and Sons, Nurseries, Lowfield Heath, Charlwood

Surface +200. Lining tubes: 40½ × 10 from surface; × 8 in to 75 down (perforated 63½ to 68½). R.W.L. +199½. P.W.L. +183. Yield 500 g.p.h. *Dando, Sept. 1930.* Overflowed. *Feb. 1940.*

WC 75 75

GEOLOGICAL CLASSIFICATION	NATURE OF STRATA	THICKNESS	DEPTH
WEALD CLAY	YELLOW CLAY	10'	10'
	BLUE CLAY	65'	75'
	THIN LAYERS OF ROCK AT 56 ft.		
J.H.E. 22.12.30.			

TQ 23 NE48

RECORD OF WELL (SHAFT OR BORE)

302 TQ 23/72
TQ 23/20 21

2

At CUCKFIELD.

Town or Village Three Bridge.

County Sussex. Six-inch quarter sheet 4 SW

For Mr. Cuckfield Rural District Council Council Office, Haywards Heath

Exact site of well Worth Park Estate, Three Bridges, Sussex. GR 2966 3736 (Attach a tracing from a map, or a sketch-map, if possible.)

Level of ground surface above sea-level (O.D.) feet.

Is well-top at ground level? If not, state how far above/below ; feet.

Dug well

~~Shaft~~ 57' ft., diameter 6 ft. Details of headings

Bore ~~200'~~ 143 ft.; diameter of bore: at top 12" ins.; at bottom ins.

Lengths, diameters, perforations, etc., of lining tubes

149' 8½" of 12" perforated pipe top 50' 3½" b.s.

Water struck at depths, below well-top, of (feet)

TEST DETAILS Month Aug. Year 1941 { Rest-level of water 99' 4" ft. ~~above~~ below well-top. Suction at ft. Yield on hours'/days' pumping 5,467 gallons per hour (max. capacity of pump g.p.h.), with depression of --- feet. Recovery to in mins./hours.

WORKING CONDITIONS { Rest-level of water in (month), (year), ft. above/below well-top.
Highest " in (month), (year), ft. above/below "
Lowest " in (month), (year), ft. above/below "
Suction at ft. Rate of pumping galls. per for hours per day.
with average depression of ft. Recovery to in mins./hours

Quality of water (*attach copy of analysis if available*)

Well made by LeGrand, Sutcliff & Gell Ltd. Date of well Aug. 1941

Information from Southall.

ADDITIONAL NOTES.

Present yield 1000,000 gals / day
This is a deepening of the shaft & bore put down in 1881.
Total depth now is 150' from the surface.
16.2.50. AN.

LOG OF STRATA OVERLEAF.

GEOLOGICAL SURVEY AND MUSEUM,
SOUTH KENSINGTON,
LONDON, S.W.7.

Date received.	G.S.M. Office File No.	1" N.S. Map No.	1" O.S. Map No.	Site marked (use symbol) on 1" Map.	on 6" Map.

TQ23NE/48 TQ23/20

Existing dug well.	57	0	57	0
Sandstone & shale.	86	0	143	0
Sandstone.	25	0	168	6
Sandstone and shale.	6	0	174	6
Hard sandy Clay and layers of sand or soft sandstone.	8	6	183	0
Mottled Clay.	2	0	185	0
Hard Grey Clay & layers of sand or soft Sandstone.	7	0	192	0
Mottled Clay & layers of sand or soft Sandstone.	8	0	200	0
	200	0	200	0

302/21 TQ 23/20

[redacted] Formerly North West Sussex Joint Water Board, Worth Park Pumping Station, Crawley. (Disused)

W.S.Sx.III, p.215. Surface +270. Shaft 80 × 6; rest bore. Depth 180. Headings: floor c.80 down. *1881*.

Silted to 57. Deepened by bore. Lining tubes: 149¾ × 12 in from 50¼ down (perforated). R.W.L. +170¾. Yield 5,467 g.p.h. *LeGrand, Aug. 1941*. P.W.L. +100. Yield 3,300 g.p.h. *Oct. 1948*. P.W.L. +100. Yield 2,500 g.p.h. *Oct. 1958*.

UTW	...	...	200	200

		Thickness Feet	Thickness Inches	Depth Feet	Depth Inches
		...	...		
Upper Tunbridge Wells Sand	Existing dug well.	57	0	57	0
	Sandstone & shale.	86	0	143	0
	Sandstone.	25	0	168	6
	Sandstone and shale.	6	0	174	6
	Hard sandy Clay and layers of sand or soft sandstone.	8	6	183	0
	Mottled Clay.	2	0	185	0
B.S. 3.12.64	Hard Grey Clay & layers of sand or soft Sandstone.	7	0	192	0
	Mottled Clay & layers of sand or soft Sandstone.	8	0	200	0
		200	0	200	0

TQ 2965 3739

TQ 23|20

302

CRAWLEY

21

OD 270.

518. POUND HILL, 1 mile N. of church. Ht. above O.D. about ~~200~~ ft. Map 4 S.W./W

Upper Tunbridge Wells Sand ... ... 180 ft.

Dug well 80 ft., with headings at base.

Bore-hole 100 ft. Sunk = 1881

R.J. 3.12.64. Supplies the Worth Park Estate.

Both visited J Buchan 15.2.40. Sited on 6" Sussex 4 SW/W. 15.2.40.

Sunk in 1881.

In 1941, the bore was deepened by Cuckfield R.D.C. when they bought it. See record on next sheet.

Information from retired Engineer of Milton Mount College. For particulars see correspondence WQ/302/21

16.2.50. AN.

Inf from Sect III letter from N.W. Sussex Joint (Co/Bo. 17.2.60

"In the near future the machinery will be removed from the well + it is poss. that the land appertaining will be sold and the well sealed off." STB 1960.

'Wells & Springs of Sussex,' III page 215

2

RECORD OF WELL (SHAFT OR BORE)

602 TQ23/20

21

At CUCKFIELD.

Town or Village Three Bridge. CRAWLEY

County Sussex. Six-inch quarter sheet 4 SW

For Mr. Cuckfield Rural District Council, Council Office, Haywards Heath

Exact site of well Worth Park Estate, Three Bridges. Sussex.

Attach a tracing from a map, or a sketch-map, if possible.

Level of ground surface above sea-level (O.D.) 270 feet.

Is well-top at ground level? ...... If not, state how far above/below; ...... feet.

Dug well
~~Shaft~~ 57 ft., diameter 6 ft. Details of headings ......

Bore ~~200~~ 143 ft.; diameter of bore: at top 12" ins.; at bottom ...... ins.

Lengths, diameters, perforations, etc., of lining tubes
149' 8½" of 12" perforated pipe top 50' 3½" b.s.

Water struck at depths, below well-top, of (feet) ......

TEST DETAILS
Month Aug.
Year 1941

Rest-level of water 99' 4" ft. ~~above~~ below well-top. Suction at ...... ft. Yield on ...... hours'/days' pumping 5,467 gallons per hour (max. capacity of pump ...... g.p.h.), with depression of --- feet. Recovery to ...... in ...... mins./hours.

WORKING CONDITIONS

Rest-level of water in ......(month), ...(year), ... ft. above/below well-top.
Highest " in ......(month), ...(year), ... ft. above/below "
Lowest " in ......(month), ...(year), ... ft. above/below "
Suction at ...... ft. Rate of pumping ...... galls. per ...... for ...... hours per day.
with average depression of ...... ft. Recovery to ...... in ...... mins./hours

Quality of water (*attach copy of analysis if available*) ......

Well made by LeGrand, Sutcliff & Gell Ltd. Date of well Aug. 1941

Information from Southall.

ADDITIONAL NOTES.

Present yield 1000,000 gals/day
This is a deepening of the shaft & bore put down in 1881.
* Total depth now is 150' from the surface.

* N.B. P.W.L. on Sec. 6 card given as 160ft or 170ft b.s on 4 occasions since Feb. 1950. 16.2.50. A.N. BH.

LOG OF STRATA OVERLEAF.

GEOLOGICAL SURVEY AND MUSEUM,
SOUTH KENSINGTON,
LONDON, S.W.7.

Date received.	G.S.M. Office File No.	1" N.S. Map No.	1" O.S. Map No.	Site marked (use symbol) on 1" Map.	on 6" Map.

(17208) Wt.42901/0877 10,000 2/41 A.& E.W.Ltd. Gp.686

(For Survey use only) GEOLOGICAL CLASSIFICATION	NATURE OF STRATA If measurements start below ground surface, state how far... ...	THICKNESS Feet	THICKNESS Inches	DEPTH Feet	DEPTH Inches
	Existing dug well.	57	0	57	0
	Sandstone & shale.	86	0	143	0
	Sandstone.	25	0	168	6
Upper	Sandstone and shale.	6	0	174	6
Tunbridge Wells	Hard sandy Clay and layers of sand or soft sandstone.	8	6	183	0
Sand	Mottled Clay.	2	0	185	0
RG. 3.12.64.	Hard Grey Clay & layers of sand or soft Sandstone.	7	0	192	0
	Mottled Clay & layers of sand or soft Sandstone.	8	0	200	0
		200	0	200	0

DATA Bank

Eastern L.S. Southern NRA. RUSPER GOLF COURSE

302 TQ 23/25 TQ23NW

Owner	Licence No.	Nat. Grid Ref. TQ 202 395
Occupier	IGS Ref. No.	Status To be licensed.

Ground Level	110 m OD	ft. OD	Aquifer WEALD CLAY
Level of Well Top	110.45 m OD	ft. OD	
Rest Water Level	10.73 m bwt	ft. bwt	
(Date 22/7/91)	m OD	ft. OD	
Construction	T8/ES/SU/MV		

Depth bwt	Dia.	Linings (below well top) From	To	Dia.	Type
38m	150 mm	0	20	100 mm	Plain
		20	32		Screen
		32	38		Plain

Summary of Geological Section	Thickness	Depth
Brown clay		8.65
Grey clay		22.15
Grey shale		26.65
Brown/yellow sands		35.65
+ lighter clay		
Grey hard shale		38.0 m
All Weald Clay		
Glen 11/92		

Abstraction Rates: gph; gpd
Type of Pump:
Chem./Bact. Anal. YES NO
Well Driller EUREKA UK (31/5/91)

If insufficient space has been allowed, continue in 'Notes' overleaf.

3550

5th March 92

TQ23NW 5 202-395

Eastern L.S.
Southern NRA.
RUSPER GOLF COURSE

302 TQ 23/25 TQ23NW/5

Owner	Licence No.	Nat. Grid Ref.	TQ 202 395
Occupier	IGS Ref. No.	Status	To be licensed.
Ground Level 110 m OD ft. OD		Aquifer	WEALD CLAY
Level of Well Top 110.45 m OD ft. OD			
Rest Water Level 10.73 m bwt ft. bwt			
(Date 22/7/91) m OD ft. OD			
Construction TP/ES/SU/MV			

Depth bwt	Dia.	Linings (below well top) From	To	Dia.	Type
38m	150 mm	0	20	100 mm	Plain
		20	32		Screen
		32	38		Plain

Summary of Geological Section	Thickness	Depth
Brown clay		8.65
Grey clay		22.15
Grey shale		26.65
Brown/yellow sands		35.65
+ lighter clay		
Grey hard shale		38.0 m
ALL WEALD CLAY		
GR 11/92		

Abstraction Rates	Type of Pump
gph	Chem./Bact. Anal. YES NO
gpd	Well Driller EUREKA UK (31/5/91)

If insufficient space has been allowed, continue in 'Notes' overleaf.

TQ34 SW45

302

TQ 34/9
77

3186 4441

Smallfields

3. Rede Hall, Mr. Tobbs.

Bored and communicated by Messrs. Duke and Ockenden.

Abundance of water, rising 3½ feet above the ground.

		Thickness. Feet.	Depth. Feet.
	Well (? old), the rest bored	—	47
[Weald Clay.]	Soft blue rock	32	79
	Hard rock, with veins of clay a few inches thick	66	145
	Softer strata, with sand ...	5	150

6" 42 N.W./W.

Pub.

TQ 34 SW45

TQ34/9 302/77

3186 4141

Burstow.

Ordnance Map 302, new ser. Geological Map 8.

REDE HALL (Red Hall Farm of the older map). 1894.

Made and communicated by MESSRS. DUKE and OCKENDEN.

Shaft 47 feet, the rest bored.

Water came in quickly in the well, from 40 to 47 feet down, but was cloudy and stunk.

Weald Clay, with two layers of rock in the well. Veins with a little water 70 and 80 feet down. Rock at the bottom, 144 feet.

6" Surrey 42NW. W.

? Disused exact site not known

visited S. Buchan 7.4.70.

Published in 'The Water Supply of Surrey', page 123

TQ 34/9
302
77

Burstow.

Ordnance Map 302, new ser. Geological Map 8.
Rede Hall (Red Hall Farm of the older map). 1894.
Made and communicated by Messrs. Duke and Ockenden.

Shaft 47 feet, the rest bored.
Water came in quickly in the well, from 40 to 47 feet down, but was cloudy and stunk.
Weald Clay, with two layers of rock in the well. Veins with a little water 70 and 80 feet down. Rock at the bottom, 144 feet.

6" Surrey 42NW. W.
? Disused exact site not known
visited S. Buchan 4.4.40.

Visited. Disused. Unable to improve triangle site
Reed Hall and Redehall Nurseries both on mains.
OD approx. 200. 15.11.57. RM

Not classifiable in detail. R.G. 8/1/64.

Published in
'The Water Supply
of Surrey',
page 123