British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

GeoReports

Example Report,
BGS Wallingford

Borehole Prognosis:

This report contains the geological succession derived from 1:10 000 data (where available) at a specific point. This includes geological map extracts for the surrounding area, taken from the 1:50 000 scale BGS digital geological map of Great Britain (DiGMapGB-50).

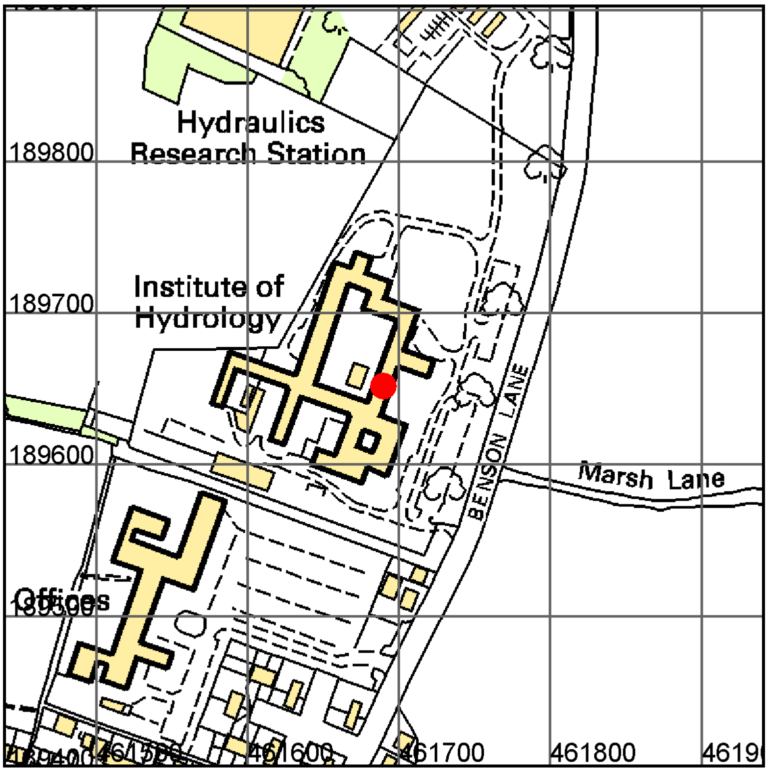
Modules:
Geological Map Extracts
Borehole Prognosis (point)
Groundwater Abstraction
Temperature and Thermal properties detailed
Geoscience Data List

Report Id: ***GR_999999/1***

Client reference:

Location and extent of site

Point centred at: 461690,189652



This product includes mapping data licensed from Ordnance Survey.

Scale: 1:5 000 (1cm = 50 m)

Search area indicated in red

Geological Map Extracts

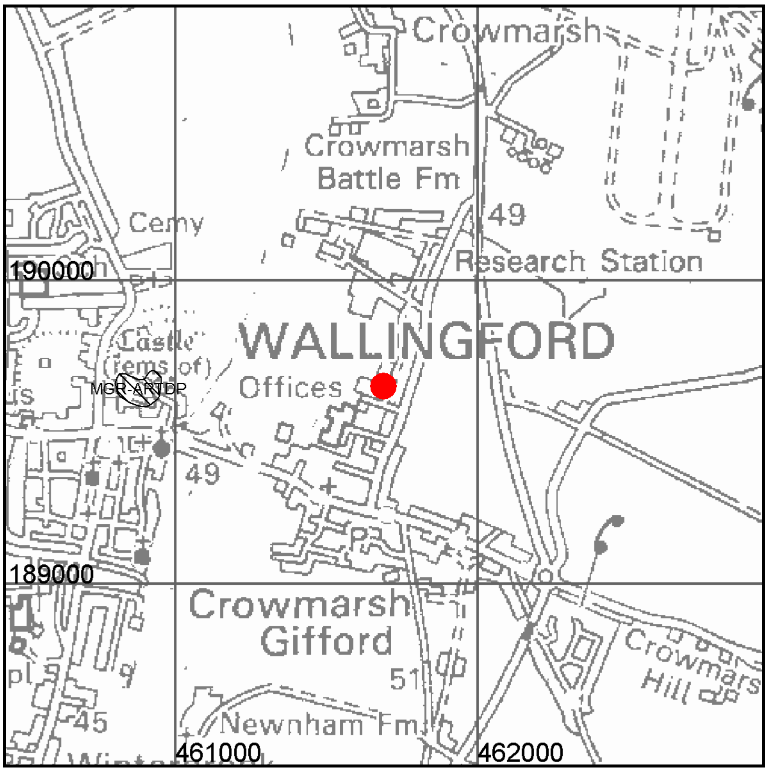
This part of the report contains extracts of geological maps taken from the 1:50 000 scale BGS Digital Geological Map of Great Britain (DiGMapGB-50). The geological information in DiGMapGB is separated into four themes: artificial ground, landslide deposits, superficial deposits and bedrock, shown here in separate maps. The fifth 'combined geology' map superimposes all four of these themes, to show the geological formations that occur at the surface, just beneath the soil.

More information about DiGMapGB-50 and how the various geological units are classified can be found on the BGS website (www.bgs.ac.uk). The maps are labelled with two-part computer codes that indicate the name of the geological unit and its composition. Descriptions of the units listed in the map keys may be available in the BGS Lexicon of Named Rock Units, which is also on the BGS website (http://www.bgs.ac.uk/lexicon/). If available, these descriptions can be found by searching against the first part of the computer code used on the maps. Please treat this labelling with caution in areas of complex geology, where some of the labels may overlap occurrences of several geological formations. If in doubt, please contact BGS Enquiries for clarification.

In the map keys the geological units are listed in order of their age, as defined in the BGS Lexicon, with the youngest first. However, where units are of the same defined age they are listed alphabetically and this may differ from the actual geological sequence.

Artificial ground

This is ground at or near the surface that has been modified by man. It includes ground that has been deposited (Made Ground) or excavated (Worked Ground), or some combination of these: Landscaped Ground or Disturbed Ground.



Scale: 1:25 000 (1cm = 250 m)

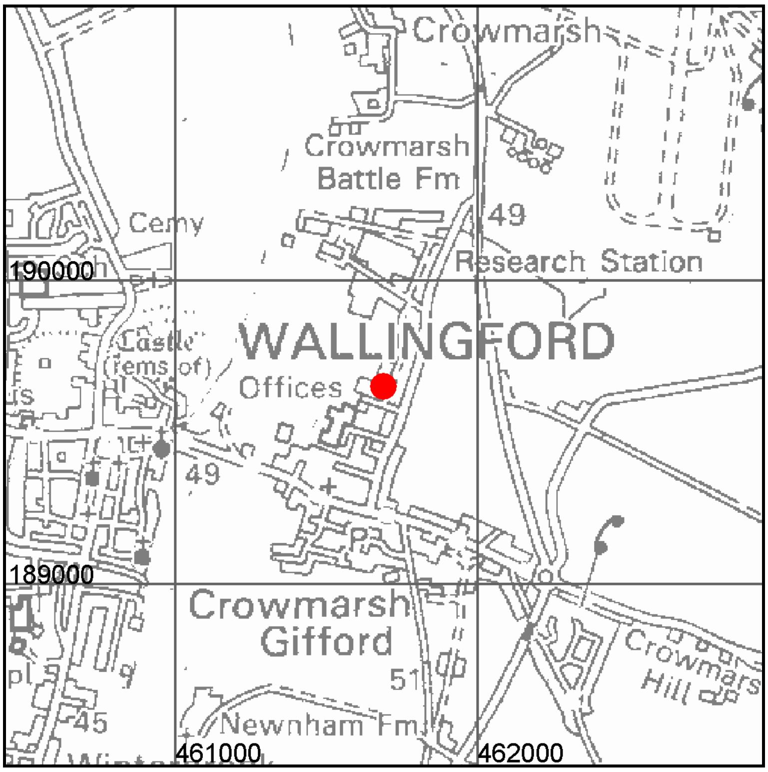
Search area indicated in red

Key to Artificial ground:

Map colour	Computer Code	Name of geological unit	Composition
⧅	MGR-ARTDP	MADE GROUND (UNDIVIDED)	ARTIFICIAL DEPOSIT

Landslide deposits

These are deposits formed by localised mass-movement of soils and rocks on slopes under the action of gravity. Landslides may occur within the bedrock, superficial deposits or artificial ground; and the landslide deposits may themselves be artificially modified.



Scale: 1:25 000 (1cm = 250 m)

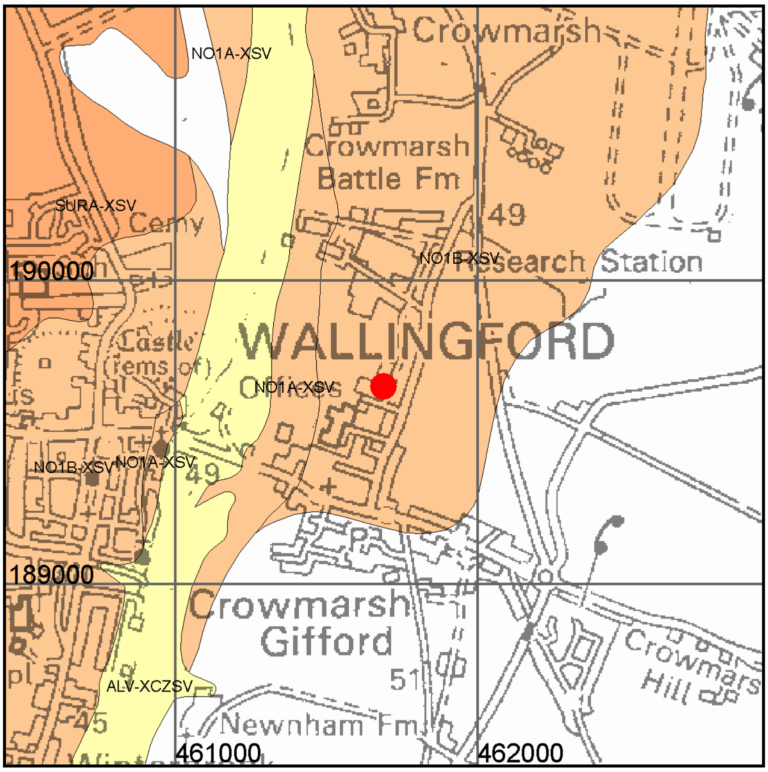
Search area indicated in red

Key to Landslide deposits:

No deposits found in the search area

Superficial deposits

These are relatively young geological deposits, formerly known as ‘Drift’, which lie on the bedrock in many areas. They include deposits such as unconsolidated sands and gravels formed by rivers, and clayey tills formed by glacial action. They may be overlain by landslide deposits or by artificial deposits, or both.



Scale: 1:25 000 (1cm = 250 m)

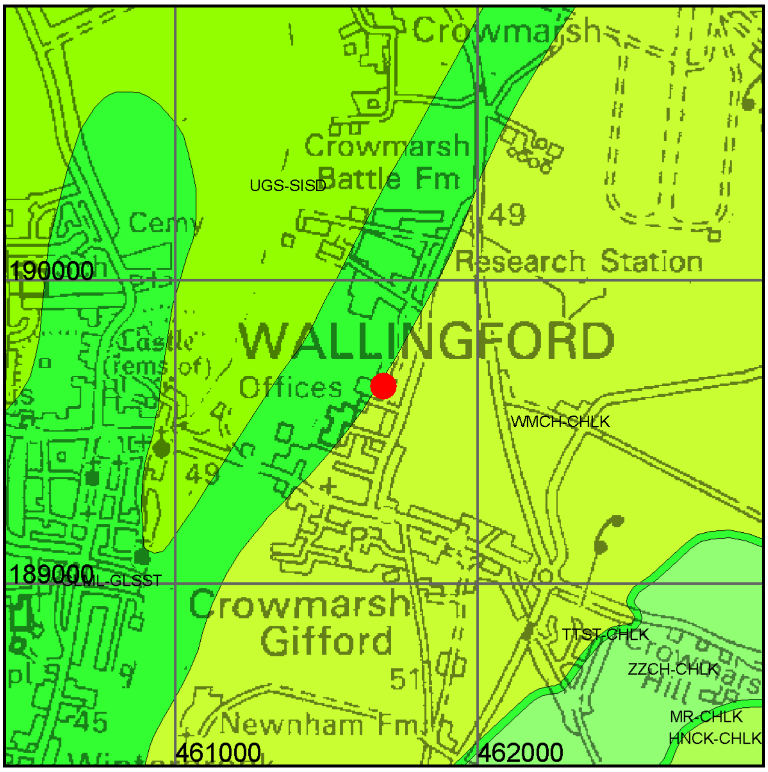
Search area indicated in red

Key to Superficial deposits:

Map colour	Computer Code	Name of geological unit	Composition
	ALV-XCZSV	ALLUVIUM	CLAY, SILT, SAND AND GRAVEL
	SURA-XSV	SUMMERTOWN-RADLEY SAND AND GRAVEL MEMBER	SAND AND GRAVEL
	NO1A-XSV	NORTHMOOR SAND AND GRAVEL MEMBER, LOWER FACET	SAND AND GRAVEL
	NO1B-XSV	NORTHMOOR SAND AND GRAVEL MEMBER, UPPER FACET	SAND AND GRAVEL

Bedrock

Bedrock forms the ground underlying the whole of an area, commonly overlain by superficial deposits, landslide deposits or artificial deposits, in any combination. The bedrock formations were formerly known as the 'Solid Geology'.



Search area indicated in red

Fault

Coal, ironstone or mineral vein

Note: Faults are shown for illustration and to aid interpretation of the map. Because these maps are generalised from more detailed versions not all such features are shown and their absence on the map face does not necessarily mean that none are present. Coals, ironstone beds and mineral veins occur only in certain rock types and regions of the UK; if present here, they will be described under 'bedrock' below.

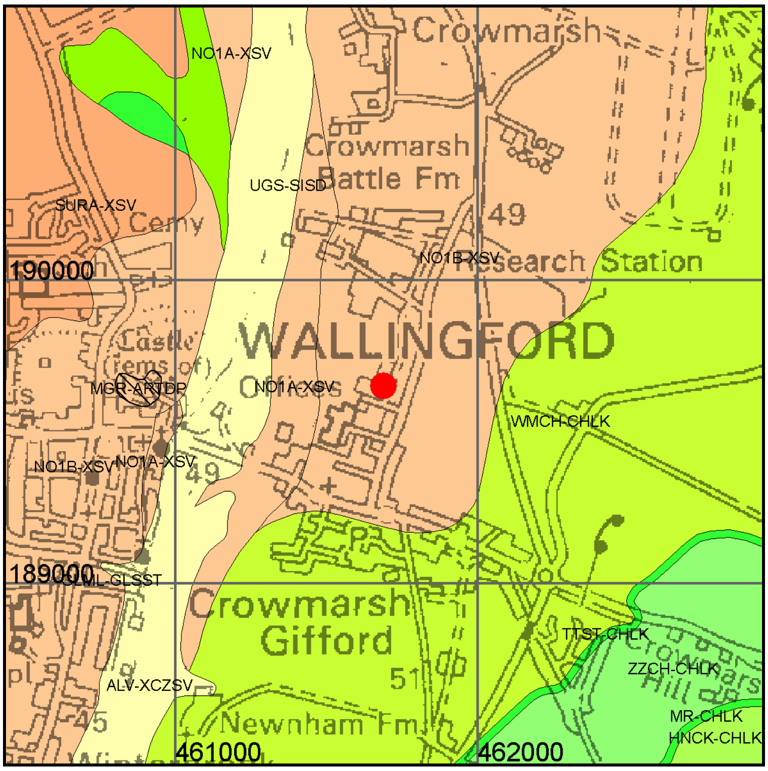
Scale: 1:25 000 (1cm = 250 m)

Key to Bedrock geology:

Map colour	Computer Code	Name of geological unit	Rock type
	HNCK-CHLK	HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED)	CHALK
	MR-CHLK	MELBOURN ROCK MEMBER	CHALK
	ZZCH-CHLK	ZIG ZAG CHALK FORMATION	CHALK
	TTST-CHLK	TOTTERNHOE STONE MEMBER	CHALK
	WMCH-CHLK	WEST MELBURY MARLY CHALK FORMATION	CHALK
	GLML-GLSST	GLAUCONITIC MARL MEMBER	GLAUCONITIC SANDSTONE
	UGS-SISD	UPPER GREENSAND FORMATION	SILTSTONE AND SANDSTONE

Combined 'Surface Geology' Map

This map shows all the geological themes from the previous four maps overlaid in order of age.



Scale: 1:25 000 (1cm = 250 m)

Search area indicated in red

Please see the Keys to the Artificial, Landslide, Superficial and Bedrock geology maps.

Borehole Prognosis

This module provides an evaluation of the expected geological sequence beneath a site to a depth appropriate for the specified use. This interpretation is based on the information available in the surrounding area. Due to natural geological variation the conditions encountered on drilling may differ. This module does not cover the possibility of artesian conditions or gas being encountered. (Information on artesian conditions is included in the 'Groundwater abstraction' and 'Hydrogeology – non abstraction' modules).

Setting:

The site lies at an elevation of about 48 m above Ordnance Datum (OD) on the edge of the village of Crowmarsh Gifford. The proposed borehole site lies about 450 m east of the River Thames that flows approximately north to south at an elevation of about 44 m above OD. The site is about 300 m east of the Thames flood plain. There are open drains in places on the nearby flood plain, and also a longer open drain flowing from east to west, about 500 m north of the site.

Geology

It is anticipated that the following succession of strata will be encountered in a deep borehole below the site:

Unit	Typical composition	Potential for difficult ground i.e. possible running sands, possible undermining or possible dissolution	Thickness in metres	Depth to the base of the unit in metres
Artificial ground				
Made Ground	Unknown		Up to 1 m	Less than 1 m
Superficial deposits				
Northmoor Sand and Gravel Member (upper facet)	Sand and gravel	Possible running sands	Up to 5 m	Less than 6 m
Bedrock (below rockhead)				
West Melbury Marly Chalk Formation	Grey marly (clay-rich) chalk with thin limestone beds		Up to 2 m	Less than 8 m
Glauconitic Marl Member	Pale brownish-grey clay-rich chalk marl with grains of glauconite; commonly contains phosphatic pebbles		Up to 2 m	Less than 10 m
Upper Greensand Formation	Dark green glauconitic sand and sandstone with a clay matrix underlain by whitish, micaceous, calcareous siltstone and fine-grained sandstone with some chert and siliceous sandstone (‘malmstone’)	Possible running sands	About 15 m	Less than 25 m

Gault Formation	Grey, silty mudstone; silty towards top, gravelly at base		About 60 m	Less than 85 m
Lower Greensand Group	Coarse-grained, ferruginous, quartzose sand with small quartzite pebbles; locally passes into sandy clay	Possible running sands	Less than 8 m	Less than 93 m
Portland Formation	Sand and limestone	Possible running sands	Probably absent	
Kimmeridge Clay Formation	Silty mudstones, some sandy		About 35 m	Less than 128 m
Corallian Group	Sand, sandstone, limestone and mudstone	Possible running sands	About 25 m	Less than 153 m
West Walton and Oxford Clay Formations	Mudstone		Over 90 m	More than 243 m

The blue line in this table indicates 'rockhead', which is the base of superficial deposits. This is the 'geological rockhead', as distinct from the 'engineering rockhead', which is the base of 'engineering soil' (in the sense of BS5930:1999).

For further definitions of stratigraphic terms that appear in the table above, on our maps and in our publications please see 'The BGS Lexicon' www.bgs.ac.uk/lexicon.

Information on the distribution of contaminated land is not held by BGS but by the relevant Local Authority.

Potential drilling hazards considered at your site

This section of the report only describes geological hazards that might be directly encountered by drilling at this site.

Running conditions hazard

Running sand conditions occur when loosely-packed sand moves as a result of water flowing through the spaces between the sand grains. The pressure of the flowing water reduces the contact between the grains and they are carried along by the flow. Excavations or boreholes in water-saturated sand are likely to encounter running conditions: the sand will tend to flow into the void. This can lead to subsidence of the surrounding ground.

Groundwater Abstraction

This module is designed for users proposing to drill a water borehole for the abstraction of groundwater supplies and/or to inject water into an aquifer.

It contains an evaluation of the geological formations beneath the site in terms of aquifer potential including groundwater yields, water levels and groundwater quality. It also contains recommendations on the design of the proposed water borehole and information on the legal requirements.

Proposed yield is up to 20 m^3/d (cubic metres per day)
Proposed use is for a smallholding including a potable supply

Groundwater Potential
A yield of 20 m^3/d is equivalent to 0.56 l/s (2 m^3/hr) pumping for 10 hours/day.

The Northmoor Sand and Gravel Member is likely to be partially saturated, with a rest water level about 2 m below ground surface (about 46 m above OD), indicating that a saturated thickness of about 3 m is present below the site. The superficial deposits should be capable of supplying a reasonable yield as the base of the deposit is likely to lie below river level and hence it will be in hydraulic continuity with the River Thames. A borehole adjacent to the river at Howbery Park [SU 6135 9007] is 5.2 m deep and is assumed to abstract from the superficial deposits, it was pumped at 18.9 l/s (68 m^3/hr) for 2.1 m of drawdown after an unknown period of pumping.

The West Melbury Marly Chalk Formation and underlying Glauconitic Marl Member are both thin at this site and unlikely to provide any significant supply of water. Several of the boreholes in the area obtain their supplies from a mixture of the superficial sand and gravel deposits and underlying Upper Greensand Formation. The record for the production borehole at Hydraulics Research at Howbery Park [SU 614 900] appears to indicate that the borehole has plain casing installed to 6 m, with no casing between 6 m and 9 m through 2 m of clay and 1 m of gravels and sands (superficial deposits), and then a further metre of gravels and sands and the Upper Greensand both had slotted casing installed against them. Another recent borehole [SU 6166 8986] at Howbery Park had slotted casing installed between 5 and 23 m, through the basal 4 m of the superficial sand and shingle and the whole of the Upper Greensand. The borehole was drilled at 500 mm diameter and fitted with 330 mm diameter slotted casing and a sand pack. The blowout yield was 12.6 l/s.

The Glauconitic Marl may be of low permeability and this could hydraulically separate groundwater in the River Terrace Deposits from that in the Upper Greensand. One of the existing boreholes on the site [SU 6154 8964] struck water in the superficial deposits at a depth of 2.8 m and also in the Upper Greensand at a depth of 6 m. It was cased to a depth of 11 m and is currently generally artesian, implying that at this site, the superficial deposits are not in hydraulic continuity with the Upper Greensand, the borehole recorded a 1.8 m thick clayey, sandy and glauconitic silt between 4.4 m and 6.2 m below ground (presumably Glauconitic Marl).

Boreholes at Howbery Park have produced yields from the Upper Greensand of up to 15 l/s (54 m^3/hr) for an unknown drawdown and 11.8 l/s (42.5 m^3/hr) for 12.5 m of drawdown during a 24 hour test from 20.3 m of saturated aquifer [SU 6165 9023] and 13.6 l/s (49 m^3/hr) for 14.2 m of drawdown after 7 days pumping from 16 m of saturated aquifer [SU 6167 9015].

Water from two 16 m deep boreholes into the Upper Greensand at Wallingford Pumping Station [SU 6023 8951 and SU 6028 8947] had a total hardness of 370 mg/l and 513 mg/l (as $CaCO_3$), respectively. Water from a 14 m deep borehole into Upper Greensand at Tinker's Moon, Benson [SU 635 921] had a pH of 6.9, a total dissolved solids content of 363 mg/l, total hardness of 274 mg/l (as $CaCO_3$), permanent (non-carbonate) hardness of 52 mg/l (as $CaCO_3$), chloride of 21 mg/l, nitrate of 4.4 mg/l (as NO_3) and total iron of 0.5 mg/l, of which none was in solution. However, two analyses from boreholes at Fairmile Hospital, Wallingford (SU 5980 8604 and SU 5975 8607) both reported no iron.

Water in the Lower Greensand is confined by the overlying Gault and its level rose to 50 m above OD in a borehole at Warborough [SU 5975 9415] and overflowed (water level more than 48 m above OD) at Shillingford [SU 5956 9293]. This aquifer is likely to contain brackish water.

The borehole at Warborough produced groundwater with a total dissolved solids content of 7780 mg/l and that at Shillingford had a total dissolved solids content of 1396 mg/l, in both cases over half of this was attributable to sodium chloride. Wells at Newington [SU 6101 9640 and SU 6100 9684] also encountered poor quality water in the Lower Greensand (or Portland Formation).

The water at the base of the Corallian aquifer at a depth of 114 m at Shillingford [SU 5956 9293] was reported to be of acceptable quality ('palatable'), but the yield was insufficient. However, a borehole at Stadhampton [SU 6019 9854] overflowed with brackish water from the Corallian, yielding 1.4 l/s (5 m^3/hr) for a drawdown to 23 m below the surface after 2 days pumping. Whilst another borehole nearby [SU 6024 9853] overflowed at 0.2 l/s (0.7 m^3/hr) but again was not used due to the high salinity, this water had a total hardness of 143 mg/l (as $CaCO_3$), all temporary (carbonate).

Groundwater Vulnerability

The superficial deposits are highly permeable and will be vulnerable to contamination occurring at the ground surface. The shallow water table means that any contaminants are likely to be transported rapidly through the unsaturated zone of the aquifer to the water table.

Groundwater in the Upper Greensand could be protected from surface pollution by the presence of the overlying, less permeable, Glauconitic Marl; however this is thin and has been breached locally by boreholes. Where the potentiometric head is artesian, surface pollution is unlikely to enter this aquifer.

Conclusion

It is likely that a yield of 20 m^3/d would be available from a shallow borehole at this site. It is possible that this could be obtained from the superficial deposits (Northmoor Sand and Gravel Member), but due to the shallow water table and their high permeability, and hence vulnerability to pollution from the ground surface, combined with a requirement for a potable supply it may be preferable to case these deposits out and obtain the water from the underlying Upper Greensand. This will require a borehole, of 100 mm completed diameter, to a depth of about 30 m. The water should be of reasonable quality although iron may be present at elevated concentrations; this can be removed by aeration. A correctly designed and emplaced sand screen and filter pack will be required.

Borehole Location, Construction, Testing and Legal Obligations

Location:

It is good practice to site a borehole as far away as possible, and preferably upslope, from any potential sources of pollution, including septic or fuel tanks, soakaways, slurry pits and areas of intensive grazing. A minimum distance of 50 m between a water borehole and any potentially polluting activity is recommended.

Construction:

For boreholes abstracting from the superficial deposits, the top few metres should be cased out (the depth of plain casing depending on the aquifer thickness at the specific site). A borehole abstracting water from a bedrock aquifer should be sealed off through the superficial deposits by installing a length of plain casing to at least 5 m below the upper surface of the bedrock. The casing should be grouted effectively in order to minimise the risk of poor quality surface or shallow groundwater entering the borehole.

Testing:

Any new borehole should be subject to a pumping test to determine the yield and drawdown of the water level. For a borehole designed for a single domestic property, it is recommended that a pumping test of at least 3 hours duration, or at least as long as the anticipated daily pumping period, is carried out, during which both the pumping rate and water level are monitored. For domestic supplies for more than one property, a longer pumping test of at least 6 to 12 hours is more appropriate. For larger supplies the Environment Agency are likely to require a test of several days duration, as well as the monitoring of nearby water sources before, during and after test pumping.

Water quality:

It is recommended that a water sample, taken during the final stages of the pumping test, is sent for full analysis to a reputable laboratory. They, or if a potable private supply is envisaged the Environmental Health Officer of the local council, should be able to advise on the range of analyses to be undertaken, which would normally include pathogenic indicator bacteria, iron, manganese and nitrate. An adequate and well-maintained disinfection treatment would be considered advisable for any supply intended for potable use.

Legal requirements:

While BGS may assess the groundwater potential at this site, the prerogative of granting a licence rests with the Environment Agency, Thames Region. Currently all sources abstracting 20 m^3/d or more require an abstraction licence. A 'Consent to Investigate Groundwater' must be obtained prior to a licensable borehole being drilled. This consent permits drilling and pump testing. If a borehole to more than 15 m depth is drilled, there is a statutory requirement (Water Resources Act, 1991) for the driller to supply full information to the Wallingford office of the BGS for inclusion in the National Well Record Archive. A form for supplying the required information is enclosed.

Maximum admissible concentrations and values for parameters in private supplies under the Private Water Supplies Regulations 2009 (for England) and the Private Water Supplies Regulations (Wales) 2010

Parameter	Concentration or value
For small domestic supplies <10 m^3/day or serving <50 persons[i]	
pH	≥6.5 and ≤9.5
Electrical conductivity (SEC) @ 20°C (µS/cm)	2500
Turbidity (NTU)	4
Enterococci (number/100 ml)	0
Escherichia coli (E. coli) (number/100 ml)	0
Additional for larger, commercial or public premises supplies	
Odour and taste	Acceptable to consumers and no abnormal change
Colour (mg/l Pt/Co)	20
Aluminium (µg/l)[ii]	200
Ammonium (mg/l)	0.5
Iron (µg/l)[ii]	200
Manganese (µg/l)[iii]	50
Nitrate (as mg/l NO_3)[iv]	50
Nitrite (as mg/l NO_2)[iv]	0.5
Clostridium perfringens (including spores) (number/100 ml)	0
Coliform bacteria (number/100 ml)	0
Colony counts @ 22°C	No abnormal change
Colony counts @ 37°C	No abnormal change
Selected other parameters based on risk assessment	
Arsenic (µg/l)	10
Benzene (µg/l)	10
Bromate (µg/l)	10
Chloride (mg/l)	250
Chromium (µg/l)	50
Copper (µg/l)	2
Fluoride (mg/l)	1.5
Lead (µg/l) (10 µg/l after 25/12/2013)	25
Nickel (µg/l)	20
Pesticides-individual (µg/l) [v]	0.1
Pesticides-total (µg/l)	0.5
Polycyclic aromatic hydrocarbons (µg/l)	0.1
Sodium (mg/l)	200
Sulphate (mg/l)	250
Tetrachloromethane (carbon tetrachloride) (µg/l)	3
Total trihalomethanes (µg/l)	100
Trichloroethene and tetrachloroethene (perchloroethylene) (µg/l)	10

Notes

[i] supplies to a single dwelling are excluded but may be monitored by the Local Authority at the request of the owner/occupier
[ii] when used as a flocculant or where the water is influenced by surface water
[iii] where the water is influenced by surface water
[iv] where water is disinfected by chloramination
[v] except aldrin, dieldrin, heptachlor and heptachlor epoxide where the limit is 0.03 µg/l

Temperature and Thermal Properties (Detailed)

This module provides temperature and interpreted thermal properties data for the geological units at depth.

Surface temperature

The temperature of the ground determines the temperature gradient within the collector loops of the ground source heat pump. The UK Meteorological Office collects and archives climate temperature data. Monthly and annual long-term average datasets have been generated for the periods 1961-1990 and 1971-2000. Mean annual air temperatures at sea level in mainland UK varies from north to south from about 8 – 12 °C and the January - July mean air temperature swing for much of the UK is less than 15 °C. Mean annual air temperatures show a general decrease eastwards and northwards from highest values in the south-west of England. Mean annual air temperatures are mainly affected by position and elevation. Since the contribution to surface temperature from the heat conducted upwards from the sub-surface is very small, the mean annual ground surface temperature should be close to the mean annual air temperature although often shows a variation of ± 1 °C. Mean site temperature has been estimated using a model based on the 30-year station averages published by the UK Meteorological Office (UKMO) web site www.met-office.gov.uk.

Sub-surface temperatures

Soil temperatures vary both diurnally and seasonally, the former variation fading out within a few 10s of cm and the latter at greater depths. At depths of about 15 m the temperature is approximately constant and equal to the mean annual air temperature. The temperature is transmitted down through the earth at a rate dependent on thermal diffusivity. Consequently the temperature in the near sub-surface has a progressive phase shift, i.e. at times of minimum air temperature ground temperatures are generally slightly higher and at times of maximum air temperatures ground temperatures are lower. Hence, at a depth of 3.5 m the minimum soil temperature is likely to be in the first two weeks of April and the maximum temperature about the end of October. The range of temperatures at 3.5 m depth is also likely to be about one quarter that at the surface. Soil temperatures at depth have been estimated using a soil diffusivity of 0.05 m^2 day^{-1}. Annual temperature swing is based on a model of the difference in mean January and July air temperatures derived from published UKMO long-term records.

At depths below about 15 m temperatures are affected by the small amount of heat conducted upwards from the sub-surface. In the UK this creates an increase of temperature with depth that has an average value of 2.6 °C per 100 m. This geothermal gradient will vary depending upon the nature of the rocks and their thermal properties. In addition moving groundwater can create warmer regions by transporting heat from depth, or cooler regions when cold water flows down from near the ground surface. Observed equilibrium temperature data for the UK indicate that some areas have stable ground temperatures of 15 °C at depths of 100 m. Conversely other regions show stable temperatures at 100 m depth of only 7 °C.

The mean observed equilibrium temperature for the UK at a depth of 100 m is close to 12 ±1.6 °C with a range of about 7-15 °C. Estimates of the temperatures at 100 and 200 m depths have been made from an estimate of the local heat flow and the thermal conductivity of the bedrock geology from the 1:250 000 scale geological map. It should be noted that anomalies caused by flowing groundwater are not included here.

Estimated temperature parameters of the site

Mean annual air temperature	10.1 °C
Mean annual temperature swing	8.3 °C
Estimated mean soil temperature	11.1 °C
Minimum annual soil temperature at 1 m	5.6 °C
Maximum annual soil temperature at 1 m	16.6 °C
Estimated temperature at 50 m depth	12 °C
Estimated temperature at 100 m depth	13 °C
Estimated temperature at 150 m depth	13.9 °C
Estimated temperature at 200 m depth	14.8 °C

Soil temperatures at 1 m estimated using a soil diffusivity of 0.05 m^2 day^{-1}.
Annual temperature swing based on mean January and July air temperatures.

Thermal properties

The rate at which heat is exchanged between the collector loop of the ground source heat pump and the ground is determined mainly by the thermal properties of the earth. Thermal conductivity is the capacity of a material to conduct or transmit heat, whilst thermal diffusivity describes the rate at which heat is conducted through a medium. For a horizontal loop system in a shallow (1-2 m) trench then the properties of the superficial deposits are important, whilst for a vertical loop system it is the properties of the bedrock geology that are important.

Thermal conductivity

Thermal conductivity varies by a factor of more than two (1.5 - 3.5 W m^{-1} K^{-1}) for the range of common rocks encountered at the surface. Superficial deposits and soils are complex aggregates of mineral and organic particles and so exhibit a wide range of thermal characteristics. The thermal conductivity of superficial deposits and soils will depend on the nature of the deposit, the bulk porosity of the soil and the degree of saturation. An approximate guide to the thermal conductivity of a superficial deposit can be made using a simple classification based on soil particle size and composition. Deposits containing silt or clay portions will have higher thermal conductivities than those of unsaturated clean granular sand. Clean sands have a low thermal conductivity when dry but a higher value when saturated. For sedimentary rocks the primary control on thermal conductivity is the lithology of the sedimentary rock, porosity, and the extent of saturation. Mudstones have thermal conductivities in the range 1.2-2.3 W m^{-1} K^{-1}.

For chemical sediments and low porosity (<30%) shale, sandstone and siltstone the mean thermal conductivity is in the range 2.2-2.6 W m^{-1} K^{-1}. Water has a thermal conductivity of 0.6 W m^{-1} K^{-1} and air a thermal conductivity of 0.0252 W m^{-1} K^{-1}. A saturated quartz sandstone with 5% porosity might have a thermal conductivity of about 6.5 W m^{-1} K^{-1} but this would decrease to about 2.5 W m^{-1} K^{-1} if the rock had a porosity of 30%. Porosity is also the main influence on thermal conductivity of volcanic rocks. Low porosity tuffs, lavas and basalts may have values above 2 W m^{-1} K^{-1}, but at 10% porosity with water saturation this might reduce to about 1.5 W m^{-1} K^{-1}. For intrusive igneous rocks, which generally have a much lower porosity, the thermal conductivity variation is less. Intrusive rocks with low feldspar content (<60%), including granite, granodiorite, diorite, gabbro and many dykes, have a mean thermal conductivity of about 3.0 W m^{-1} K^{-1}. For metamorphic rocks, porosity is often very low and thermal conductivity can be related to quartz content. The thermal conductivity of quartzites is high, typically above 5.5 W m^{-1} K^{-1}. For schists, hornfels, quartz mica schists, serpentinites and marbles the mean thermal conductivity is about 2.9 W m^{-1} K^{-1}.

Thermal diffusivity

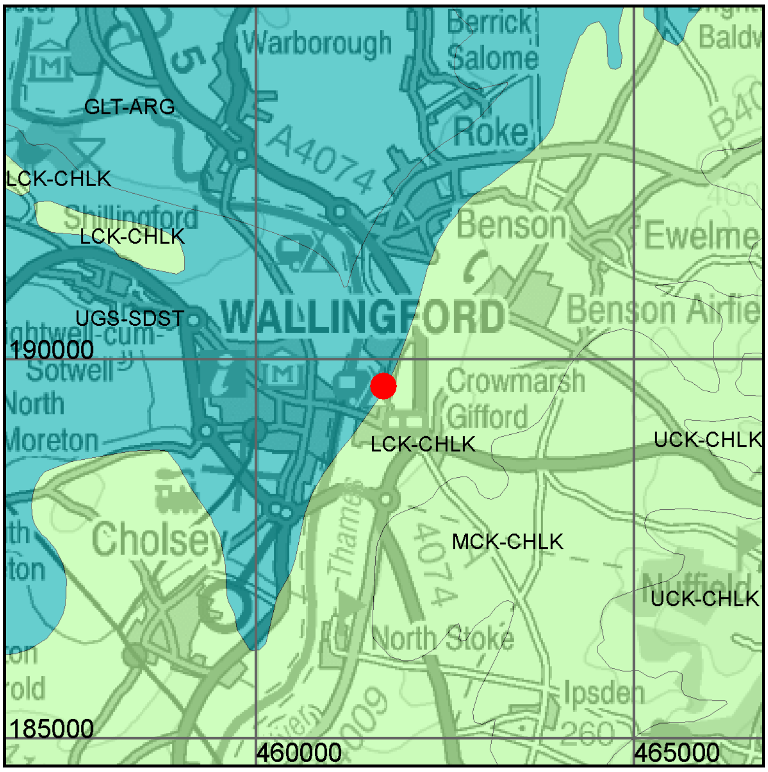
Typical rock thermal diffusivities range from about 0.065 m^2 day^{-1} for clays to about 0.17 m^2 day^{-1} for high conductivity rocks such quartzites. Many rocks have thermal diffusivities in the range 0.077–0.103 m^2 day^{-1}. Generally, thermal conductivity and specific heat are increased for saturated rocks and diffusivity is also enhanced.

Typical values of thermal conductivity and diffusivity for superficial deposits

Class	Thermal Conductivity W m^{-1} K^{-1}	Thermal diffusivity m^2 day^{-1}
Sand (gravel)	0.77	0.039
Silt	1.67	0.050
Clay	1.11	0.046
Loam	0.91	0.042
Saturated sand	2.50	0.079
Saturated silt or clay	1.67	0.056

W m^{-1} K^{-1} = Watts per Metre per Kelvin

Thermal conductivity-diffusivity (based on 1:250 000 Bedrock Geology map)



This product includes mapping data licensed from Ordnance Survey.

Scale: 1:100 000 (1cm = 1000 m)

Search area indicated in red

Key to Thermal conductivity-diffusivity:

Map colour	Computer Code	Geological unit	Composition	Thermal conductivity W m^{-1} K^{-1}	Thermal diffusivity m^2 day^{-1}
	UCK-CHLK	UPPER CHALK FORMATION	CHALK	1.67	0.0745
	MCK-CHLK	MIDDLE CHALK FORMATION	CHALK	1.67	0.0745
	LCK-CHLK	LOWER CHALK FORMATION	CHALK	1.67	0.0745
	UGS-SDST	UPPER GREENSAND FORMATION	SANDSTONE	2.59	0.111
	GLT-ARG	GAULT FORMATION	ARGILLACEOUS ROCKS, UNDIFFERENTIATED	2.18	0.098

This mapping is based on the BGS Digital Map of Great Britain at the 1:250 000 scale (DiGMapGB-250), so the linework and formation names displayed may differ to a certain extent from those shown in other modules that are based on 1:50 000 scale mapping.

Site specific thermal conductivity-diffusivity values based on the Borehole Prognosis

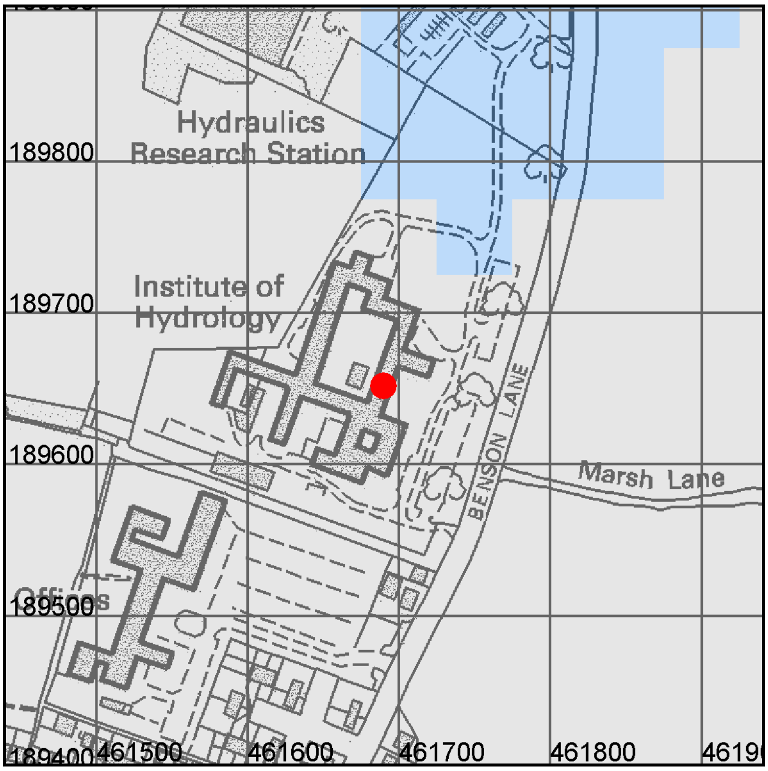
Unit	Thermal conductivity W m^{-1} K^{-1}	Thermal diffusivity m^2 day^{-1}	Thickness in metres
West Melbury Marly Chalk Formation	1.67	0.0745	Up to 2 m
Glauconitic Marl Member	1.67	0.0745	Up to 2 m
Upper Greensand Formation	2.59	0.1110	About 15 m
Gault Formation	2.18	0.0980	About 60 m
Lower Greensand Group	2.59	0.1110	Less than 8 m
Portland Formation	2.1	0.0882	Probably absent
Kimmeridge Clay Formation	1.30	0.0509	About 35 m
Corallian Group-limestone	2.00	0.0783	About 25 m
Corallian Group-sandstone	2.23	0.0917	
West Walton and Oxford Clay Formations	1.30	0.0509	Over 90 m

A typical 150 m deep borehole would therefore penetrate 5 m of Northmoor Sand and Gravel Member (of which the basal 3 m would be saturated), 1 m of West Melbury Marly Chalk Formation, 2 m of Glauconitic Marl Member, 15 m of Upper Greensand Formation, 60 m of Gault Formation, 6 m of Lower Greensand Group, 35 m of Kimmeridge Clay Formation, 15 m of Corallian Group limestone, 10 m of Corallian Group sandstone and 1 m of West Walton and Oxford Clay Formations. It will have an average thermal conductivity of 1.85 W m^{-1} K^{-1} and average thermal diffusivity of 0.0845 m^2 day^{-1}.

Most ground source heat pump design techniques are based on the assumption that the heat will be dissipated by conduction. If heat advection due to groundwater flow is significant at a site it is likely that this will have a beneficial effect. The significance of advection is controlled by the hydraulic gradient, the hydraulic conductivity and the thermal conductivity of the saturated rock. In most aquifers advection will be significant except where the groundwater gradient is low; e.g. in coastal plains or confined conditions.
At this site, the hydraulic gradient is generally low, but advection due to groundwater flow may improve heat transfer in the Northmoor Sand and Gravel Member and Upper Greensand Formation.

Superficial thickness

The following map is derived from a mathematical model of the thickness of Superficial Deposits produced by analysing information from approximately 600 000 borehole logs held in the BGS archives. It also uses the digital data on the extent of Superficial Deposits. As a model, the map is a guide only and may differ from the value for superficial deposits thickness given in the borehole prognosis above, but it indicates where thin superficial deposits are likely. In general, depending on the hardness of the bedrock, horizontal collector loops will be easier to install within superficial deposits.



This product includes mapping data licensed from Ordnance Survey.
© Crown Copyright and/or database right 2011. Licence number 100037272

Scale: 1:5 000 (1cm = 50 m)

Search area indicated in red

Key to Superficial thickness

Map colour	Expected Minimum Thickness (m)
	100
	70
	50
	40
	30
	20
	10
	5
	Thickness unknown, but > 1m

Geoscience Data List

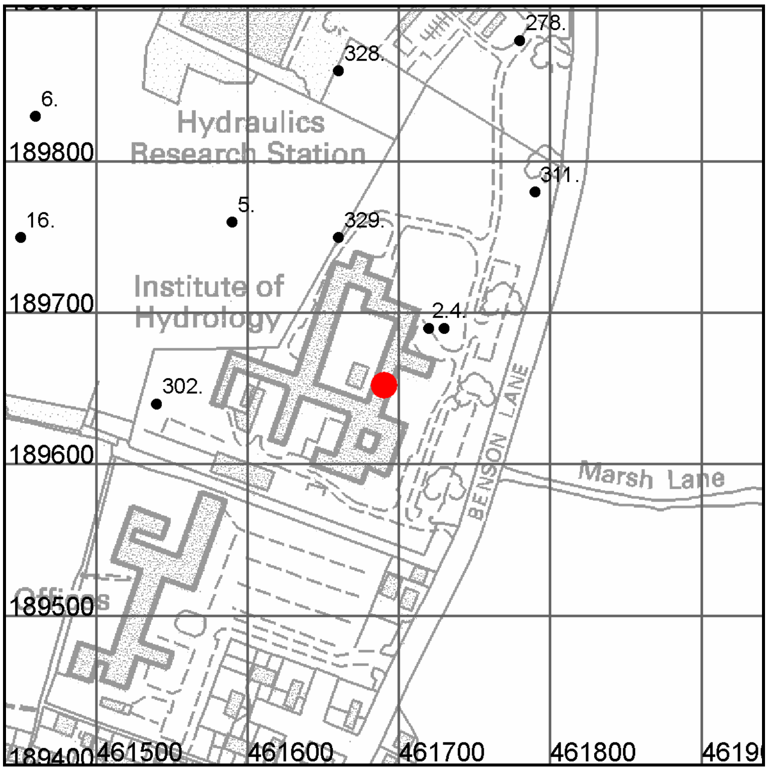
List of available geological data

This section lists the principal data sets held in the National Geoscience Records Centre that are relevant to your enquiry and explains how to obtain copies of the records. Users with access to computing facilities can make their own index searches using the BGS Internet (go to 'Online shops' at www.bgs.ac.uk). This will give access to the BGS Bookshop, Publications catalogue, GeoRecords (borehole browser) and GeoReports.

For current pricing see these internet pages or contact us using the list found at the back of this report.

Note that this report contains selective datasets and is not a definitive listing of all data held in BGS.

Borehole location map



This product includes mapping data licensed from Ordnance Survey.

Scale: 1:5 000 (1cm = 50 m)

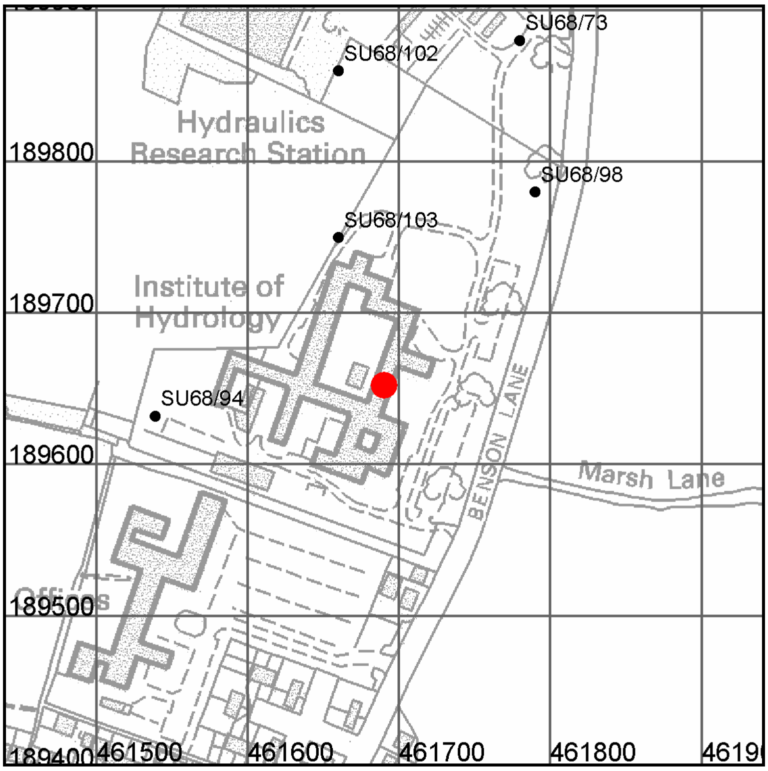
Borehole records

Number of records in map area: 10

In the following table a blank Length field indicates that the borehole is confidential or that no depth has been recorded digitally.
Enquiry staff may be able to provide you with contact details for the originator if you wish to seek release of confidential information.

Borehole registered no	Grid reference	Borehole name	Length (m)
SU68NW16	SU 61450 89750	HOWBERRY PARK CROWMARSH	4
SU68NW2	SU 61720 89690	HOWBERRY PARK BH6 BENSON OXON	8.83
SU68NW278	SU 61780 89880	HYDRAULICS RESEARCH STATION	2.59
SU68NW302	SU 61540 89640	WALLINGFORD TEST BORE, MACLEAN BUILDING	-1
SU68NW311	SU 61790 89780	HR WALLINGFORD, HOWBERY PARK OBH	30
SU68NW328	SU 61660 89860	H R WALLINGFORD, HOWBERRY PARK	25
SU68NW329	SU 61660 89750	MACLEAN BUILDING, CROWMARSH GIFFORD	6
SU68NW4	SU 61730 89690	HOWBERRY PARK TH4 BENSON OXON	3.04
SU68NW5	SU 61590 89760	HOWBERRY PARK TH5 BENSON OXON	2.43
SU68NW6	SU 61460 89830	HOWBERRY PARK TH6 BENSON OXON	4.26

Water Well location map



Scale: 1:5 000 (1cm = 50 m)

Water Well records

Number of records in search area: 5

All of these records are registered in the main Borehole Records collections (see Borehole Records Table and map above), but please note that some may be duplicate or part duplicate copies. This map shows records of water wells and boreholes in the National Well Record Archive held at Wallingford (WL) or Murchison House (MH). Each record has a Well Registration number which should be quoted when applying for copies.

Additional index information may be held for the Water Well Records as shown below, indicating the information that can be found on the well record itself. If fields are blank, then the well record has not been examined and its contents are unknown. A ‘Yes’ or a ‘No’ indicates that the well record has been examined and the information indicated is, or is not, present. This information should help you when requesting copies of records.

Water Well records

Well Reg No.	BH Reg No.	Name	Easting	Northing	Depth (m)	Date	Aquifer	G	C	W	Ch
SU68/73	SU68NW278/BJ	HYDRAULICS RESEARCH STATION	461780	189880	2.6		UNKNOWN	No	Yes	Yes	No
SU68/94	SU68NW302/BJ	INSTITUTE OF HYDROLOGY, CROWMARSH GIFFORD	461539	189632	0	1979	UPPER GREENSAND FORMATION	Yes	Yes	Yes	No
SU68/98	SU68NW311/BJ	H R WALLINGFORD, HOWBERY PARK OBH	461790	189780	0	2004	NOT ENTERED				
SU68/102	SU68NW328/BJ	HOWBERRY PARK, WALLINGFORD	461660	189860	0	2008	NOT ENTERED				
SU68/103	SU68NW329/BJ	MACLEAN BUILDING, CROWMARSH GIFFORD	461660	189750	0		NOT ENTERED				

KEY:
Aquifer = The principal aquifer recorded in the borehole
G = Geological Information present on the log
C = Borehole construction information present on the log
W = Water level or yield information present on the log
Ch = Water chemistry information present on the log

Boreholes with water level readings

Number of records in search area: 1

Reference	Easting	Northing	Location	Start_date	End_date	Readings
SU68/73	461780	189880	HYDRAULICS RESEARCH STATION	1960	1971	15

Locations with aquifer properties

Number of records in search area: 0

BGS holds no locations with aquifer properties for the selected area

Site investigation reports
Number of records in search area: 4

Additional laboratory and test data may be available in these reports, subject to any copyright and confidentiality conditions. The grid references used are based on an un-refined rectangle and therefore may not be applicable to a specific site. Borehole records in these reports will be individually referenced within the borehole records collection, described above.

Number	Site investigation title
13340	WHITE CROSS FARM, WALLINGFORD
36074	PRIORY MEADOWS CROWMARSH
39056	HOWBERRY FARM CROWMARSH
54083	STATION ROAD INDUSTRIAL ESTATE WALLINGFORD

National Grid geological maps (1:10 000 and 1:10 560 scale)
Number of records in search area: 1

Map	Type	Survey
SU68NW	C	1974

County Series geological maps (1:10 560 scale)
Number of records in search area: 2

Map	Type	Published
Berkshire16SE		1910
Oxfordshire49SE	C	0

New Series medium scale geological maps (1:50 000 and 1:63 360 scale)
Number of records in search area: 2

Sheet number	Sheet name	Type	Published
254	Henley-on-Thames	C	1980
254	Henley-on-Thames	C	1905

Old Series one inch geological maps (1:63 360 scale)
Number of records in search area: 1

Sheet number	Sheet name	Type	Published
13	Bampton	S	1859

Hydrogeological maps (various scales)
Number of records in search area: 1

Map	Scale
South West Chilterns	1:100,000

Geological Memoirs

Number of records in search area: 1

Geological memoir	Date
Henley on Thames & Wallingford	1908

Technical reports

Technical reports may be available for this area. Please email sales@bgs.ac.uk for further information.

Waste sites

Number of records in search area: 0

Listing of some 3500 waste sites for England and Wales identified by BGS as part of a survey carried out on behalf of the Department of the Environment in 1973. Later information may be available from the Local authority.
BGS holds no records of waste sites for the selected area

Mining plans

Number of records in search area: 1

This listing includes plans of various types, principally relating to mining activity including abandonment plans. The coverage is not comprehensive; however that for Scotland is most complete.

Record Type	Plan No.	Title
KP	18191	WESTPHALIAN A & B OF THE COALFIELDS OF ENGLAND & WALES (INCLUDING CANONBIE)

Contact Details

Keyworth (KW) Office
British Geological Survey
Kingsley Dunham Centre
Keyworth
Nottingham
NG12 5GG
Tel: 0115 9363143
Fax: 0115 9363276
Email: enquiries@bgs.ac.uk

Wallingford (WL) Office
British Geological Survey
Maclean Building
Wallingford
Oxford
OX10 8BB
Tel: 01491 838800
Fax: 01491 692345
Email: hydroenq@bgs.ac.uk

Murchison House (MH) Office
British Geological Survey
Murchison House
West Mains Road
Edinburgh
EH9 3LA
Tel: 0131 650 0282
Fax: 0131 650 0252
Email: enquiry@bgs.ac.uk

Terms and Conditions

General Terms & Conditions

This Report is supplied in accordance with the GeoReports Terms & Conditions available on the BGS website at www.bgs.ac.uk/georeports and also available from the BGS Central Enquiries Desk at the above address.

Important notes about this Report

- The data, information and related records supplied in this Report by BGS can only be indicative and should not be taken as a substitute for specialist interpretations, professional advice and/or detailed site investigations. You must seek professional advice before making technical interpretations on the basis of the materials provided.
- Geological observations and interpretations are made according to the prevailing understanding of the subject at the time. The quality of such observations and interpretations may be affected by the availability of new data, by subsequent advances in knowledge, improved methods of interpretation, and better access to sampling locations.
- Raw data may have been transcribed from analogue to digital format, or may have been acquired by means of automated measuring techniques. Although such processes are subjected to quality control to ensure reliability where possible, some raw data may have been processed without human intervention and may in consequence contain undetected errors.
- Detail, which is clearly defined and accurately depicted on large-scale maps, may be lost when small-scale maps are derived from them.
- Although samples and records are maintained with all reasonable care, there may be some deterioration in the long term.
- The most appropriate techniques for copying original records are used, but there may be some loss of detail and dimensional distortion when such records are copied.
- Data may be compiled from the disparate sources of information at BGS's disposal, including material donated to BGS by third parties, and may not originally have been subject to any verification or other quality control process.
- Data, information and related records, which have been donated to BGS, have been produced for a specific purpose, and that may affect the type and completeness of the data recorded and any interpretation. The nature and purpose of data collection, and the age of the resultant material may render it unsuitable for certain applications/uses. You must verify the suitability of the material for your intended usage.
- If a report or other output is produced for you on the basis of data you have provided to BGS, or your own data input into a BGS system, please do not rely on it as a source of information about other areas or geological features, as the report may omit important details.
- The topography shown on any map extracts is based on the latest OS mapping and is not necessarily the same as that used in the original compilation of the BGS geological map, and to which the geological linework available at that time was fitted.
- Note that for some sites, the latest available records may be quite historical in nature, and while every effort is made to place the analysis in a modern geological context, it is possible in some cases that the detailed geology at a site may differ from that described.

Report issued by
BGS Enquiry Service