



Geotechnical and
Geoenvironmental
Consultants

40 Home Close, Wootton, Abingdon, Oxon OX13 6DD

Tel 01865 326011

Web: www.gis-geotec.com

e-mail: info@gis-geotec.com

GROUND INVESTIGATION SERVICES (Southern) Ltd

Our Ref: S.6155

Your Ref:

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Michael Woods Esq
Property Services
General Fund
Oxford City Council
Oxford Town Hall
OX1 1BX

Dear Michael

HINKSEY LAKE, OXFORD: WATER ANALYSIS

Ground Investigation Services (Southern) Ltd (GIS) have been commissioned by Oxford City Council to undertake a laboratory water analysis of Hinksey Lake over the period October 2023 to August 2024.

It is understood the lake was a former gravel pit c1850, the minerals extraction from which was used to provide stabilisation to the new railway line sidings due west. The resultant void was left to refill from natural groundwater recharge and from partial hydraulic inflow from Hinksey Stream, located due west of the railway line. After construction of filter beds on neighbouring land (east) the reservoir was utilised for supply of potable water to denizens of Oxford.

Currently It is understood the lake is used as an amenity for swimming, and scuba diving.

SAMPLE COLLECTION AND SAMPLE PROTOCOLS

Upon instruction from Oxford City Council, GIS provided appropriate sample containers relevant to the anticipated determinants considered possible given the environmental location and history of the site.

Given that the water body is in close proximity to the railway line and Marshalling Yard and also within the locale of a former gas works the list of possible determinants, that may have migrated to the water body in the past and currently, is both detailed and extensive.

Therefore, GIS scheduled a comprehensive list of organic and inorganic contaminants as well as biological markers which are detailed overleaf.

Employees of OCC provided water samples at three core locations within the water body at two week intervals, the first of which took place on 1 November 2024. Sample containers were supplied by the environmental testing laboratories of Element Materials Technology Ltd and Mercian Science. *A sample Container Guide is illustrated to the rear of this report.*

The following list of determinants was originally scheduled as follows:

TABLE 1. Scheduled Determinants and Test Procedures

| Determinant | Test Method No. | Determinant | Test Method No. |
|---|-----------------|----------------------------------|-----------------|
| | | | |
| INORGANICS | | PETROLEUM HYDROCARBONS | |
| Dissolved Arsenic | TM30/PM14 | Aliphatics | |
| Dissolved Beryllium | TM30/PM14 | >C5-C6 | TM36/PM12 |
| Dissolved Boron | TM30/PM14 | >C6-C8 | TM36/PM12 |
| Total Dissolved Chromium | TM30/PM14 | >C8-C10 | TM36/PM12 |
| Dissolved Copper | TM30/PM14 | >C10-C12 | TM36/PM12 |
| Dissolved Lead | TM30/PM14 | >C12-C16 | TM36/PM12 |
| Dissolved Mercury | TM30/PM14 | >C16-C21 | TM36/PM12 |
| Dissolved Nickel | TM30/PM14 | >C21-C35 | TM36/PM12 |
| Dissolved Selenium | TM30/PM14 | Total aliphatics C5-35 | TM36/PM12 |
| Dissolved Vanadium | TM30/PM14 | Aromatics | |
| Dissolved Zinc | TM30/PM14 | >C5-EC7 | TM36/PM12 |
| Hexavalent Chromium | TM38/PM0 | >EC7-EC8 | TM36/PM12 |
| | | | |
| POLYCYCLIC AROMATIC HYDROCARBONS | | >EC8-EC10 | TM36/PM12 |
| | | >EC10-EC12 | TM36/PM12 |
| Naphthalene | TM4/PM8 | >EC12-EC16 | TM36/PM12 |
| Acenaphthylene | TM4/PM8 | >EC16-EC21 | TM36/PM12 |
| Acenaphthene | TM4/PM8 | >EC21-EC35 | TM36/PM12 |
| Fluorene | TM4/PM8 | Total aromatics C5-35 | TM36/PM12 |
| Phenanthrene | TM4/PM8 | | |
| Anthracene | TM4/PM8 | MTBE | TM36/PM12 |
| Fluoranthene | TM4/PM8 | Benzene | TM36/PM12 |
| Pyrene | TM4/PM8 | Toluene | TM36/PM12 |
| Benzo(a)anthracene | TM4/PM8 | Ethylbenzene | TM36/PM12 |
| Chrysene | TM4/PM8 | m/p-Xylene | TM36/PM12 |
| Benzo(bk)fluoranthene | TM4/PM8 | o-Xylene | TM36/PM12 |
| Benzo(a)pyrene | TM4/PM8 | POLYCHLORINATED BIPHENYLS | |
| Indeno(123cd)pyrene | TM4/PM8 | | |
| Dibenzo(ah)anthracene | TM4/PM8 | PCB 52 | TM17/PM30 |
| Benzo(ghi)perylene | TM4/PM8 | PCB 28 | TM17/PM30 |
| PAH 16 Total | TM4/PM8 | PCB 101 | TM17/PM30 |
| | | PCB 118 | TM17/PM30 |
| BIOLOGICAL PATHOGENS | | PCB 138 | TM17/PM30 |
| | | PCB 153 | TM17/PM30 |
| Escherichia Coli* | B2 | PCB 180 | TM17/PM30 |
| Intestinal Enterococci* | B6 | Total 7 PCBs | TM17/PM30 |
| BOD | TM58/PM0 | | |
| Total Coliforms | B2 | Total Phenols (HPLC) | TM26/PM0 |
| pH | TM73/PM0 | | |

SITE WORK

OCC employees attended site and obtained water samples (identified as A, B and C) at three undisclosed locations (identified as A, B and C) on the following dates

TABLE 2. Date of sampling and sample Nos.

| Date of sampling | Samples submitted to environmental Test Laboratory (No.) | Test results available Y/N |
|------------------|--|--|
| 16.10.23 | 3 (Sample A, B and C) | Y - metals/organics and bio' |
| 30.10.23 | 3 (Sample A, B and C) | Y - metals/organics and bio' |
| 15.11.23 | 2 (Sample A and C) | Y - metals/organics and bio' |
| 04.12.23 | 2 (Sample A and C) | Y - metals/organics and bio' |
| 10.01.24 | 2 (Sample A and C) | Y - metals/organics and bio' |
| 29.01.24 | 2 (Sample A and B) | Y - bio' |
| 12.02.24 | 3 (Sample A, B and C) | Y - bio' |
| 28.02.24 | 3 (Sample A, B and C) | Y - bio' |
| 13.03.24 | 3 (Sample A, B and C) | Y - bio' |
| 27.03.24 | 3 (Sample A, B and C) | Y - bio' |
| 10.04.24 | 3 (Sample A, B and C) | Y - bio' |
| 24.04.24 | 3 (Sample A, B and C) | Y - bio' |
| 10.05.24 | 3 (Sample A, B and C) | Y - bio' |
| 22.05.24 | 3 (Sample A, B and C) | N – Courier unable to deliver – samples exceeded storage times |
| 03.06.24 | 3 (Sample A, B and C) | N – Courier unable to deliver – samples exceeded storage times |
| 17.06.24 | 3 (Sample A, B and C) | Y - bio' |
| 03.07.24 | 3 (Sample A, B and C) | N – Courier unable to deliver – samples exceeded storage times |
| 29.07.24 | 3 (Sample A, B and C) | Y - bio' |
| 13.08.24 | 3 (Sample A, B and C) | Y - bio' |
| 28.08.24 | 3 (Sample A, B and C) | Y - bio' |

Bio – Biological determinants

On three occasions (22.05.24, 03.06.24 and 03.07.24) the samples were not received by the courier and testing aborted for these three visits.

The metals and organics suite was not continued after the 10 January 2024 upon request from the client.

Sampling was postponed for five weeks over the Christmas period and into the new year due to flooding.

CONTAMINATION ANALYSIS

Guidelines and Assessment Criteria

Appropriate Guidance (Surface water – metals and organics)

The results of the water analysis have been compared to appropriate Environmental Quality Standards (EQS) relevant to the environmental setting.

As the groundwater aquifer underlying the site is classified as a Secondary (A) Aquifer and the water body is used by members of the public the results will be compared with the Environmental Quality Standard (EQS) for freshwater and the UK Water Supply (Water Quality) Regulations 2001 for drinking water and the Surface Water (Abstraction for drinking Water) 1996 and World Health Organization Guidelines for drinking water. An extract of the relevant tables pertaining to the above guidance is presented to the rear of this report.

Appropriate Guidance (Bathing waters – Biological Determinants)

In addition, biological determinants will be assessed including *Escherichia coli*, Intestinal Enterococci Total Coliforms and biological Oxygen demand. The results will be compared to the relevant [Bathing Water Directive \(2006/7/EC\)](#) as implemented by the Environment Agency.

Application of Limit of Detection

Analytical techniques operate within a limit of detection (LOD). The LOD equates to a concentration below which the technique cannot detect the presence of a chemical. Accepted UK best practice is that where a concentration of a chemical is below the LOD of the technique, the LOD is adopted as the chemical concentration.

Contamination Test Results

The following tables demonstrates the appropriate guideline values and recorded range in values of contaminants tested where these exceed the guideline values.

Summary of Test Results (Metals and Organics)

The following table demonstrates the appropriate guideline values and recorded range in values of contaminants tested where these exceed the guideline values.

TABLE 3. SUMMARY OF GROUNDWATER TEST RESULTS

| Tabulated Results For Groundwater Samples | | | | |
|--|-------|------------|------------------|---------------------------------------|
| Determinant | Units | EQS Source | EQS Level | Sample where EQS Level was exceeded |
| Arsenic | ug/l | DWS/WHO | 10/10 | None |
| Cadmium | ug/l | DWS/WHO | 5/3 | None |
| Beryllium | Ug/l | USEPA/WHO | 4 | None |
| Chromium | ug/l | DWS/WHO | 50/50 | None |
| Copper | ug/l | DWS/WHO | 2000 | None |
| Nickel | ug/l | DWS/WHO | 20/20 | None |
| Lead | ug/l | DWS/WHO | 10/10 | None |
| Mercury | ug/l | DWS/WHO | 1 | None |
| Selenium | ug/l | DWS/WHO | 10/10 | None |
| Zinc | ug/l | DWS | 5000 | None |
| Boron | ug/l | FW/DWS/WHO | 2000/1000/500 | None |
| Vanadium | ug/l | FW | 20-60 | None |
| Cyanide | ug/l | DWS/WHO | 50/70 | None |
| Sulphates | Ug/l | DWS/WHO | 20/250 | None |
| Polycyclic Aromatic Hydrocarbons | | | | |
| Naphthalene | ug/l | DWS | 10(100)* | None |
| Benzo(a)pyrene | ug/l | DWS/WHO | 0.01/0.7 | None |
| Total PAH | ug/l | DWS | 0.1 * | <0.0173 in all samples in each report |
| Total Petroleum Hydrocarbons and Organics | | | | |
| Total Petroleum Hydrocarbons | ug/l | DWS | 10 | None |
| BTEX | ug/l | DWS/WHO | 1/10 | <5 |
| PCBs (total) | ug/l | USEPA | 0.5 | <0.7 in all samples in each report |
| PCBs (individual) | ug/l | USEPA | 0.1 | <0.1 in all samples in each report |
| Total Phenols | Mg/l | DWS/FW | 0.0005/0.03-0.30 | <0.15 in all samples in each report |
| MTBE | ug/l | USEPA | 11 | None |
| Notes | | | | |
| DWS = UK Drinking Water Standards WSR = Water Supply Regulations (Water Quality) 1989 SW = Surface Waters (Abstraction for Drinking Water) 1996 FW = Freshwater standard WHO = World Health Organization Guidelines for drinking water USEPA = United States Environmental Protection Agency * EQS for Total PAH 0.1ug/l but no EQS for individual PAH isomers except Benzo(a)pyrene and Naphthalene # hardness of 80-365mg/l CaCO ₃ () in parenthesis maximum peak value | | | | |

Summary of Test Results (Biological determinants)

The following table demonstrates the appropriate guideline values and recorded range in values of contaminants tested where these exceed the guideline values.

TABLE 4. SUMMARY OF GROUNDWATER TEST RESULTS

| Determinant | units | Sample taken date | Concentrations and sample location | | |
|------------------------|------------|-------------------|------------------------------------|----------|----------|
| | | | Sample A | Sample B | Sample C |
| Escherichia coli | MPN/100mls | 16.10.23 | 89 | 128 | 116 |
| Intestinal Enterococci | Cfu/100mls | | 7 | 6 | 4 |
| Escherichia coli | MPN/100mls | 30.10.23 | 13 | 3 | 4 |
| Intestinal Enterococci | Cfu/100mls | | | | |
| Escherichia coli | MPN/100mls | 15.11.23 | <1 | | 1 |
| Intestinal Enterococci | Cfu/100mls | | 0 | | 1 |
| Escherichia coli | MPN/100mls | 04.12.23 | 38 | | 63 |
| Intestinal Enterococci | Cfu/100mls | | 14 | | 15 |
| Total Coliforms | MPN/100mls | | 108 | | <201 |
| Escherichia coli | MPN/100mls | 10.01.24 | >201 | >201 | |
| Intestinal Enterococci | Cfu/100mls | | 66 | 78 | |
| Total Coliforms | MPN/100mls | | >201 | >201 | |
| Escherichia coli | MPN/100mls | 29.01.24 | 1 | 8 | |
| Intestinal Enterococci | Cfu/100mls | | 2 | 13 | |
| Total Coliforms | MPN/100mls | | 13 | 25 | |
| Escherichia coli | MPN/100mls | 12.02.24 | 9 | 2 | 9 |
| Intestinal Enterococci | Cfu/100mls | | 0 | 0 | 5 |
| Total Coliforms | MPN/100mls | | 1 | 11 | 32 |
| Escherichia coli | MPN/100mls | 28.02.24 | 1 | 0 | 10 |
| Intestinal Enterococci | Cfu/100mls | | 0 | 3 | 6 |
| Total Coliforms | MPN/100mls | | 7 | 3 | 17 |
| Escherichia coli | MPN/100mls | 13.03.24 | 2 | 1 | 0 |
| Intestinal Enterococci | Cfu/100mls | | 0 | 0 | 3 |
| Total Coliforms | MPN/100mls | | 9 | 5 | 3 |
| Escherichia coli | MPN/100mls | 27.03.24 | 0 | 0 | 0 |
| Intestinal Enterococci | Cfu/100mls | | 4 | 0 | 0 |
| Total Coliforms | MPN/100mls | | 0 | 2 | 0 |
| Escherichia coli | MPN/100mls | 10.04.24 | 23 | 1 | 1 |
| Intestinal Enterococci | Cfu/100mls | | 2 | 40 | 0 |
| Total Coliforms | MPN/100mls | | 23 | 4 | 100 |
| Escherichia coli | MPN/100mls | 24.04.24 | 4 | 1 | 0 |
| Intestinal Enterococci | Cfu/100mls | | 1 | 0 | 0 |
| Total Coliforms | MPN/100mls | | 4 | 1 | 10 |
| Escherichia coli | MPN/100mls | 10.05.24 | 3 | 0 | 1 |
| Intestinal Enterococci | Cfu/100mls | | >200 | 7 | >200 |
| Total Coliforms | MPN/100mls | | >200 | 21 | >201 |
| Escherichia coli | MPN/100mls | 17.06.24 | 0 | 1 | 0 |
| Intestinal Enterococci | Cfu/100mls | | 0 | 0 | 0 |
| Total Coliforms | MPN/100mls | | 78 | 56 | 56 |
| Escherichia coli | MPN/100mls | 29.07.24 | 23 | 18 | 0 |
| Intestinal Enterococci | Cfu/100mls | | 0 | 1 | 0 |
| Total Coliforms | MPN/100mls | | 23 | 18 | 13 |

TABLE 4. SUMMARY OF GROUNDWATER TEST RESULTS - continued

| Determinant | units | Sample taken date | Concentrations and sample location | | |
|------------------------|------------|-------------------|------------------------------------|----------|----------|
| | | | Sample A | Sample B | Sample C |
| Escherichia coli | MPN/100mls | 13.08.24 | 14 | 53 | 8 |
| Intestinal Enterococci | Cfu/100mls | | 8 | 67 | 4 |
| Total Coliforms | MPN/100mls | | <201 | >201 | >201 |
| Escherichia coli | MPN/100mls | 28.08.24 | 1 | 0 | 14 |
| Intestinal Enterococci | Cfu/100mls | | 0 | 0 | 0 |
| Total Coliforms | MPN/100mls | | 12 | 12 | 23 |

* *Biological Oxygen Demand (BOD) ranged between <1-2mg/l*

TEST RESULTS AND INTERPRETATION

Metals and organics

The results of the water analyses revealed that all determinants, except Total PAH, PCBs (total) and Total Phenols fell below their respective Environmental Quality Standards EQS FW, WHO and DWS values.

The recorded values are based on the laboratory limit of detection (LOD) and do not necessarily denote the presence of elevated contamination.

Given that these values are marginally above the EQS which is the highly conservative drinking water standard it is considered that the concentrations do not warrant further investigation or remedial work as the risk to water body, i.e. bathers and ecological receptors is very low.

Biological Indicators

BOD levels – Generally these values are indicative of very good quality water i.e. there will very little organic matter present. Potable water is deemed suitable for drinking in this range.

Reference to the Department for Environment and Rural Affairs in their Bathing Water Quality Open source data [Bathing Water Quality](#) classify surface water in terms of cleanliness for bathing as :

- [Excellent](#) – the highest, cleanest water quality
- [Good](#) – generally good water quality
- [Sufficient](#) – the water meets the minimum standard
- [Poor](#) – the water has not met the minimum standard. Work to improve quality at Poor sites are detailed in the site's profile.

The relevant document also states the following:

'A sample tells us the quality of the water at that specific time, but water can change even over the course of one day. In each sample we test for bacteria that indicate whether there is [faecal matter](#) in the water. These bacteria are known as faecal indicator organisms or FIOs and the specific ones that we test for are:'

- [Escherichia coli](#) or E. coli (EC)
- [Intestinal enterococci](#) (IE)

'These bacteria can come from many sources including sewage, agricultural livestock, wildlife, birds and road drainage.'

'When more of these FIOs are present in a bathing water they can indicate greater risks to a bathers' health. The standards we use for levels of FIOs are specified in the [Bathing Water Regulations](#) and [Bathing Water Directive \(2006/7/EC\)](#) are based on World Health Organisation research which recorded the frequency of stomach upsets in people bathing in differing water quality.'

'The annual classification uses the samples taken over four years to build an assessment of typical water quality and is a good way to compare bathing water locations.'

'There are no pass/fail standards for individual water samples, instead the classification is based on a statistical measure of all samples, known as a percentile. Percentiles use the range of all samples taken to estimate the probability of higher results occurring. The classification uses either the 95% or 90% percentile depending on the classification'.

The thresholds for classifications are as follows:

| Inland Bathing Waters | |
|-----------------------|--|
| Excellent | EC: ≤500 cfu/100ml ; IE: ≤200 cfu/100ml (95th percentile) |
| Good | EC: ≤1000 cfu/100ml ; IE: ≤400 cfu/100ml (95th percentile) |
| Sufficient | EC: ≤900 cfu/100ml ; IE: ≤330 cfu/100ml (90th percentile) |
| Poor | means that the values are worse than the sufficient |

Key EC: Escherichia coli, IE: Intestinal enterococci, cfu: [Colony Forming Units](#)

Given the relative paucity of data on each sampling occasion (i.e. two or three samples per visit) it is not possible to determine a true mean upper confidence limit 95th percentile or 90th percentile of the data. We would require a minimum of four samples to gain confidence to determine a true mean average value.

Assessment of test results indicate the concentrations of E Coli exceeded the maximum measured laboratory concentration (201cfu/100ml) on just one test period (10.01.24) in all samples while Intestinal enterococci also exceeds this maximum value on 10.05.24 in Sample A and C.

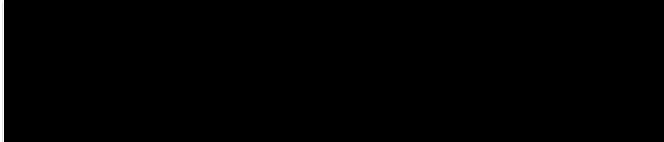
Total Coliforms do not pose risks to human health. They are used to indicate whether other potentially harmful bacteria may be present. These were in exceedance of the maximum measured laboratory concentration (201MPN/100ml) on the 10.01.24 (all samples), 10.05.24 (Sample A and C) and 13.08.24 (all samples).

Apart from these sample periods of elevated fecal coliforms, concentrations were generally low or absent throughout the period of monitoring.

GIS cannot establish a causal relationship between concentrations and likely sources of pollution other than to suggest an increase in fecal coliforms may be the result of increased surface runoff during periods of elevated precipitation.

Should you have any queries with regard to the report, please do not hesitate to contact the undersigned.

For and on behalf of
Ground Investigation Services (Southern) Ltd
Yours sincerely



Martyn P Boughton (Director)

Email: martyn@gis-geotec.com

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Laboratory test results

