



**Contaminated Land Inspection
Written Statement**

Gravel Hill,
West Winch
King's Lynn

Reference no. s103100038893

January 2018

Environmental Health and Housing
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Executive Summary

The Borough Council of King's Lynn and West Norfolk (BCKLWN) has an obligation to inspect its district for potentially contaminated land under Part 2A of the Environmental Protection Act 1990. As such it has produced a list of potential sites in the district which require a detailed inspection under Section 3 of the statutory guidance (Contaminated Land Statutory Guidance, April 2012).

A former oil shale production facility was has been identified within the district of King's Lynn. Part of this area was an open cast mine (now ponds) and two mine shafts which are assessed in this report. The open cast mine and mine shaft are situated in an agricultural and a grazing field respectively to the west of the A10 at Setchey, with the mines and open cast mines on both sides of the Puny Drain. Given the former site usage and the potential vulnerability of the surrounding area an initial assessment of the site has been undertaken to assess the potential for harm to human health, property, the environment and ground/surface waters under Part 2A.

To gather information of the site's history a Preliminary Site Assessment has been carried out by the Environmental Quality Team. From the evidence gathered during the assessment of the site history and a site walkover, the following can be stated:

- The site had a series of historic activities which include an open cast mine and mine shafts.
- The site is now being used as agricultural fields.
- From the site walkover the following was noted.
 - The mine shafts have been backfilled.
 - Two ponds in the area of the backfilled open cast mine has evidence of being used as a watering hole for cattle.
- The conceptual site model indicated that the only plausible linkage was for property. Cattle grazing the pit site have access to the ponds within the backfilled open cast mine.
- Chemical analysis of the water of one of the ponds indicated that no risk existed to the cattle should they use the pond for drinking.

Given the above information the Potential Hazard and the Risk associated with the site has been reassessed. This reassessment returned a Potential Risk Rating of Very Low for the site. Therefore the site has been assigned a Category 4 for human health and is not considered to be a risk to controlled waters, the environment or property.

On the basis of its assessment, the authority has concluded that the land does not meet the definition of contaminated land under Part 2A and is not considered contaminated land.

1. Introduction

This report details a review of information and written statement about a potential contamination at a former oil shale field at Gravel Hill, West Winch, King's Lynn and provides a conclusion on the risk to human health, property, groundwater and the wider environment.

The Contaminated Land Statutory Guidance (DEFRA, 2012) suggests that where the authority has ceased its inspection and assessment of land as there is little or no evidence to suggest that it is contaminated land the authority should issue a written statement to that effect. This report forms that statement.

2. Desk Study Information

Location

The site's location is shown in Appendix B. The grid reference for the centre of the site is 562702, 314586 and the nearest postcode is PE33 0BX.

Initial Prioritisation Score

The site was initially assessed as having a 'Medium' Potential Hazard Rating due to the risk to surface water and property.

Previous Site Usage

The site (drawing s103100038893/101) was a former open cast mine and mine.

Present Site Usage

Its present use comprises a pond and backfilled mine shafts located in a grazing field and an agricultural field as depicted on the site plan in Appendix B.

Ownership

Enquiries have been made to establish land ownership. This report will be made available to the site owners.

Environmental Setting

Geology

The Solid and Drift Geology Sheet 160, 1:50,000, 1999 and Regional Hydrological Characteristics Sheet 1 1:125 000 shows the site surface is approximately to vary between 3 and 4 meters above ordnance datum (maOD).

The bedrock geology is Kimmeridge Clay Formation – Mudstone and the superficial geology is Tidal Flat Deposits- Clay and Silt. Both these formations are generally impermeable which will restrict the migration of the any contaminants.

(BGS website: <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>).

Hydrogeology

The bedrock on the site is classified as a Non-Aquifer or unproductive strata and as such has no Vulnerability and is not within a Source Protection Zone.¹

Hydrology

The nearest major water feature is the Puny Drain. The open cast mine and backfilled mine shafts are separated by the Puny Drain.

No private water exists on site or within 500m. Three Environment Agency licenced abstractions exist within 500m of the site. These are:

- Licence Number - 6/33/56/*S/0246, THARROS LTD, Spray Irrigation – Direct for General Agriculture.
- Licence Number - 6/33/58/*S/0003, PAUL RACKHAM LTD, General Use Relating To Secondary Category (Medium Loss) for Other Industrial/Commercial/Public Services.
- Licence Number - 6/33/58/*S/0187, THARROS LTD, Spray Irrigation – Direct for General Agriculture.

Local Authority Pollution Prevention and Control Regulations

No LAPPC processes are on or within 500m of the site.

The Environment Agency Web site records

The Environment Agency Web site records the following:

- The site is vulnerable to flooding, although it partially benefits from flood defences.
- The site is within a Priority Waters Area, is vulnerable to Nitrate (surface waters) and is at risk from agricultural sediment.
- The bedrock is classified as a Non-Aquifer.
- The superficial deposits in the western portion of the site are not classified as having any aquifer designation.
- The Puny Drain is defined as having a good ecological status but being at risk.

MAGIC website records

MAGIC website records the following

- The site is covered by the Marine Management Organisation Marine Areas (England).
- The open cast mine area is classified as Refined Coastal and Floodplain Grazing Marsh (England).
- The site is part of an area designated as a Countryside Stewardship Water Quality Priority Area (England) (Medium Priority).

¹ (Environment Agency Website: <http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=357683&y=355134&scale=1&layerGroups=default&ep=map&textonly=off&lang=e&topic=groundwater>)

- The site is part of an area designated as an area which is on the Sediment Issues Priority (England) (Medium Priority).
- The site is part of an area designated as an area which is on the Phosphate Issues Priority (England) (Medium Priority).
- The site is covered with the Flood Risk Management Priorities (England) classified as High Priority.
- The mines are covered by the Woodland – Water Quality (England) (Lower Spatial Quality).
- The site is part of an area covered by the Priority Catchment of the Former Catchment Sensitive Farming Priority Areas 2001-2015 (England) designation.
- The site is part of an area is covered by a Nitrate Vulnerable Zone (England) (Surface Waters).
- The site forms habitat for:
 - Yellow Wagtail.
 - Snipe.
 - Grey Partridge.
 - Grassland Assemblage Farmland Birds (England) Grade 2.
- The site is part of the Higher Level Stewardship Theme.

Historic Maps

E-map Explorer²

Enclosure Map 1800 - 1850 – Not available

Tithe map circa 1840– The site comprised a series of fields and a Common, with one building being shown in the east against the road in field No. 311.

Ordnance Survey 1st Ed. 1879-1886 – Not available

Historic Maps on file at the Borough Council of King's Lynn and West Norfolk

1843 – 1893: The site remains a series of fields

1891 – 1912: The site was as depicted above.

1904 – 1939: The site was as depicted above with the exception of the following.

On the western side of the Puny Drain was a mine, comprising a series of buildings and two 'shafts'. On the eastern side of the Puny Drain there appeared to be a quarry or pit with four buildings. The two sites were connected by a railway track which connects to the Clarke's Drove Siding to the west.

1919 – 1943: Not available.

1945 – 1970: The site was as depicted above with the exception of the following.

² <http://historic-maps.norfolk.gov.uk/>

The buildings and mine shafts were no longer present. The excavations associated with the open cast mine were still shown as being present, although a further excavation was shown to the north which was labelled as 'water'.

1970 – 1996: Not available.

Aerial Photographs

1945 – 1946 MOD Aerial Photograph: In the northwest corner of the site the shafts and their associated buildings were not visible. However, what could be foundations are visible. The pits on the opposite side of the Puny Drain area were still visible, although it is possible that they may have been partially backfilled.

1988 Aerial Photograph: In the northwest corner of the site the area of the shafts now forms part of a field, but no sign of any structures were visible. The pits to the east are becoming overgrown with vegetation.

1999 Aerial Photograph: The site was generally as described above, with the exception that the area of the mine shafts had reverted to agriculture.

2006-09 Aerial Photograph: The site is generally the same as above.

Planning History

No planning applications exist on the site.

Environment Agency Records

Not consulted as the operations were undertaken and closed prior to the Environment Agency coming into existence.

Norfolk County Council Records

An e-mail was received from Charles Wright of the Closed Landfill Team of Norfolk County Council, with information regarding the potential for the open cast pit to have been used as a landfill. He stated that to the County Councils knowledge the site had been operated for the extraction of oil shale by the English Oilfields Company. The County Council provided a copy of a planning permission dated 22nd February 1950 for the 'Winning and Working of Oil Shale', although it is unknown if this planning permission was enacted.

History of the Site

Oil shale was first recorded in this area by William Smith on his geological map (1819). The area was then investigated by W Forbes Leslie and a pilot plant was set up at Setchey in about 1916 under the company name of English Oilfields. This expanded after 1919 with the excavation of an open cast mine and the sinking of two mine shafts, the construction of a railway between the mines and the retorts. The full scale retorts were never completed and the mines were abandoned by 1923. The amount and quality of the oil shale present had been significantly exaggerated making the business unprofitable. This would indicate that the level of contaminants potentially present would be lower than previously anticipated. The contaminants anticipated are hydrocarbons, polycyclic aromatic hydrocarbons, phenols, sulphides, Volatile Organic Compounds, metals and metalloids.

3. Site Walkover

A site visit was initially carried out by one of BCKLWN Environmental Quality Officers on 19/05/2014 and the following was noted. Photographs are presented in the Appendix A.

The open cast mine site was entered from the north via a path which ran along the edge of the Puny Drain. This formed part of a field which was being used to graze cattle. It was heavily vegetated with trees but clear cattle trails could be seen passing through the copse. Throughout the site there was clear evidence of excavations and backfilling from the depressions and mounds of soil.

There were also two ponds in the northern half of the site. The northernmost pond was surrounded by vegetation and had steep banks leading down to the water where rushes grew (Plate 4). There was evidence that the cattle have access to the pond area and could use this as a drinking hole, although with the steepness of the sides there was limited access for them to drink. The second pond was surrounded by trees (Plate 6) but no vegetation was noted to grow in the water. Also the water was of a much darker hue and when the surface was disturbed, iridescence was noted across its surface (Plate 7). This pond could also be used as a drinking hole for the cattle. From the hoof prints noted on the shallow sides it was frequented often.

The field in which the shafts had been dug was covered with a crop and as such was not accessed, and no visible traces of the shafts and their associated buildings could be seen from the fields' boundary (Plate 13).

A second site visit was undertaken on 13/07/2016 by two of BCKLWN Environmental Quality Officers to the former pit. The reason was for the site visit was to sample the water from the southern pond and the site visit only entailed a visit to the ponds. The ponds were generally as described in the previous site visit. The southern pond still appeared dark and lifeless, but no iridescence was noted on the surface of the water at this time. There was evidence of hoof prints indicating that the pond was still being used as a drinking hole for the cattle.

4. Assessment of Site Use

The western portion of the site was used to sink two mine shafts and an open cast mine associated with the extraction of oil shale, which is now being used as agricultural fields for growing crops and grazing cattle respectively.

No signs of vegetative stress were noted in the crops on the land associated with mine shafts.

One of the ponds in the field where the cattle were grazing was noted to have an iridescent sheen on its surface. Both of the ponds on site are used by the cattle for drinking water. Anecdotal evidence in the form of a photograph was found on the internet, which depicted what is considered to be the pond with the sheen, full of barrels (Photograph 9 in the appendix, <http://www.kingslynn-forums.co.uk/viewtopic.php?f=14&t=1738&start=60>). There were also suggestions that the site had been seeded with oil by the Setch Oil Field developer to make it appear more profitable.

Very few humans have access to the area due to the cattle on site.

The area of the strip mining is overgrown with trees and a high level of ecological diversity was noted in the area.

5. Assessment of probability of a contamination event

Human Health

The northern part of the site comprised an open cast mine and two mine shafts with associated infrastructure, which has been assigned a Low Potential Hazard. The mine shafts are in the middle of an agricultural field, being used to grow crops. The probability of humans accessing this is considered to be restricted to the farmers and their operatives and then only on a transient basis in farm vehicles. Therefore the probability of exposure from potential contamination associated with the mine shafts is considered to be UNLIKELY by direct contact.

The open cast mine can be accessed relatively easily by the general public (e.g. dog walkers) but it is considered that this would be a rare occurrence due to the cattle grazing in the field, the lack of footpaths and the distance from the residential properties. Therefore the probability of the hazards to human health from potential contamination associated with the mine shafts is considered to be UNLIKELY.

Property

The mine shafts and their associated buildings are no longer present. From research the mine shafts were not very long lived and did not generate large quantities of oil shale. No engines or other power assistance were known to be present on site and as such very few potential sources of contamination are considered to be present. This area is now being used as agricultural land to grow crops. No signs of vegetative stress were noted during the site walkover or on the aerial photographs; although a slight depression can be seen on the aerial photographs where one of the mine shafts was located. Therefore the probability is considered to be UNLIKELY.

The cattle in the field containing the open cast mine are potentially at risk from potential contamination within the pond which they are using as a watering hole. This pond is considered potentially to be the same pond which a photograph depicts containing old oil drums (Photograph 9 in the appendix, <http://www.kingslynn-forums.co.uk/viewtopic.php?f=14&t=1738&start=60>) which is the remains of the open cast mine which anecdotal evidence indicates was seeded with oil, and which had a slight iridescence on its surface indicating some level of hydrocarbon contamination. Therefore the probability is considered to be LIKELY.

Due to potential exposure pathway of the cattle drinking the pond water further assessment of the risk was required. This comprised sampling and analysis of a water sample from the pond. The analysis of which is presented in the Chemical Analysis of Pond Water below.

Environment

The site and area does not contain any of the receptors stipulated in Table 1 of the Statutory Guidance (SSSI's, RAMSAR etc.). As such the probability of a contamination event affecting the environment has been classified as UNLIKELY.

Controlled Water

Groundwater

This area of the site is classified as being a Non-Aquifer, therefore there is considered to be no risk to the groundwater. Therefore the probability is assumed to be UNLIKELY.

Surface water

The backfilled open cast mine has two ponds and the mine shafts and the open cast mine are split by the Puny Drain. The ponds positioned directly on top of the former open cast pit and are not considered to be classified as controlled waters, as defined by the Water Resources Act 1991, and as such do not represent receptors. The soils separating the mines and the Puny Drain from the area are generally impermeable and given the distance to the Puny Drain the probability is assumed to be Unlikely.

Assessment of Hazard

The risks posed by the site have been assessed under the Contaminated Land Statutory Guidance. The source of contamination has been identified as oil Shale, which contains a variety of contaminants which include variable quantities of Hydrocarbons (Aromatic and Aliphatic), Polycyclic Aromatic Hydrocarbons, Sulphates, Phenols, Volatile Organic Compounds and metals³. These contaminants can be irritants, toxic, very toxic and carcinogenic. This is discussed further below:

Human Health

The hazard to humans coming into contact with the site is considered to be MEDIUM due to the potential direct contact or ingestion of potentially contaminated water in the pond.

Property

Contaminated water in the ponds could be used as drinking by the cattle which graze the field. As such it is considered that there is a MEDIUM risk to the cattle.

Environment

The site does not contain any receptors as defined within Table 1 of the Contaminated Land Statutory Guidance. As such no risk to this receptor is considered to exist.

³ Department of Industry Profile: Oil refineries and bulk storage of crude oil and petroleum products.
<http://webarchive.nationalarchives.gov.uk/20140328161230/http://cdn.environment-agency.gov.uk/scho0195bjlc-e-e.pdf>

Controlled Waters

Groundwater

The site is on an area designated as a non-aquifer, therefore no risk to this receptor is considered to exist on site.

Surface waters

The Puny Drain flows between the open cast mine and mine shafts. The potential contamination which could arise from the site could impact on the water quality of the Puny Drain. Therefore the hazard to surface water is considered to be MEDIUM.

Conceptual site model

The conceptual site model (Table 1) shows the sources, pathways and receptors identified and the subsequent risk classification.

Table 1: Preliminary conceptual site model

Source	Pathway	Receptor	Probability	Hazard	Risk
Hydrocarbons, metals and sulphates.	Direct contact	Humans	Unlikely	Medium	Low
	Inhalation				
Hydrocarbons, metals and sulphates.	Direct Contact	Property (Cattle and Crops)	Likely	Medium	Moderate
	Inhalation				
Hydrocarbons, metals and sulphates.	Direct contact	Environment	Unlikely	Low	Very Low
Hydrocarbons, metals and sulphates.	Direct contact	Controlled water	Unlikely	Medium	Low

Chemical Analysis of Pond Water

During the second site visit a sample of water from the northern pond was taken and dispatched to a UKAS accredited laboratory for analysis. The analytes tested for included hydrocarbons, metals, polycyclic aromatic hydrocarbons (PAHs) and Volatile Organic Compounds (VOCs) and were chosen to represent the assumed contaminants associated with shale oil. The results of which are presented below (only analytes which exceeded the limit of detection have been presented). No hydrocarbons, polycyclic aromatic hydrocarbons and very few VOCs were detected.

Table 2: Comparison of chemical analysis

Analyte	Result (ug/l)	DWS (ug/l)	EQS (ug/l)	USEPA (ug/l)	WHO (ug/l)	Exceedances
pH	7.99			6.5-8.5		No
Arsenic	3.14	10		10	10	No
Aluminium	100	200		50-200	200	No
Copper	1	2,000	12	1,300	2,000	No
Nickel	2.53	20			20	No
Barium	58.2			200	700	No
Boron	100	1,000			500	No
Calcium	167					1
Iron	763	200	1000	300	300	No
Magnesium	10.9					1
Manganese	288	50	30		400	Yes
Potassium	19.7					No
Sodium	18.4	200,000			200,000	No
Strontium	487			1,500		No
Sulphate as SO ₄	28.8	250,000		250,000		No
Carbon Disulphide (Disulfide)	0.140					1, 2
3-methylphenol (m-Cresol)	0.0976					1, 3
Phenol	0.0877	0.5				No
Toluene	0.120	700	50		700	No
Notes:						
1. No DWS (The Water Supply (Water Quality) Regulations 2016) or EQS limit (withdrawn).						
2. No standard but naturally occurring level recorded between 00054µg/l and 0.4µg/l. ⁴						
3. Drinking Water Criteria Spreadsheet - Minnesota Pollution Control records 30µg/l for 3-methylphenol (m-Cresol). ⁵						

The results indicate that four of the recorded analytes do not have a standard with which to compare them and one result exceeds the chosen screening value. These are discussed further below.

Discussion.

The chemical analysis indicated that one analyte (Manganese) was elevated above the drinking water standard (DWS) and environmental quality standard (EQS) but

⁴ Concise International Chemical Assessment Document 46 - Carbon Disulfide World Health Organisation.

(http://www.who.int/ipcs/publications/cicad/cicad46_rev_1.pdf)

⁵ <https://www.pca.state.mn.us/sites/default/files/c-w3-01.xls>

can occur at naturally high levels. Four analytes (Calcium, Magnesium, Carbon Disulphide and 3-Methylphenol) recorded values for which there are no DWS or EQS values. Therefore a Detailed Quantitative Risk Assessment (DQRA) was undertaken to assess the potential risk human health and to Property (Cattle). This is presented in appendix D. Following the DQRA it was concluded that no significant risk was present with regards to human health or property (Cattle).

The concentration of contaminants detected in the pond water was generally low which the majority of the analytes being below either the EQS (freshwater) or other adopted standard. This would indicate that there is not a significant risk to surface water.

Outcome of Preliminary Risk Assessment

No significant source pathway receptor linkage was identified as no source of contamination has been identified over the adopted screening values. Therefore further investigation is not considered necessary.

Updated Conceptual site model

The CSM (table 4 below) has been updated based on the site investigation findings.

Table 3: Updated conceptual site model

Source	Pathway	Receptor	Probability	Hazard	Risk
Hydrocarbons, metals and sulphates.	Direct contact	Humans	Unlikely	Low	Very Low
	Inhalation				
Hydrocarbons, metals and sulphates.	Direct Contact	Property	Unlikely	Low	Very Low
Hydrocarbons, metals and sulphates.	Direct contact	Environment	Unlikely	Low	Very Low
Hydrocarbons, metals and sulphates.	Direct contact	Controlled water	Unlikely	Low	Very Low

No evidence was noted of significant harm and there is not a strong case to consider that the risks from the land are of sufficient concern that the land poses a significant possibility of significant harm to Humans (via direct contact, ingestion and inhalation), Property, Environmental Receptors or Controlled Water as defined in the statutory guidance. CIRIA C552 states that on a site with a low risk classification 'It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.

6. Conclusion

Plausible source pathway receptor linkages were identified. A very low risk was identified for human health, controlled water and environmental receptors as set out in the Statutory Guidance.

Human Health

There was no evidence of harm or significant possibility of significant harm to the receptors identified in the conceptual site model. Therefore the site is assessed as Category 4: Human Health⁶ as set out in the Statutory Guidance.

Controlled Waters

It is considered that there is no reasonable possibility that a significant contaminant linkage exists as set out in the Statutory Guidance⁷. No significant pollution or significant possibility of such pollution.

Environment

The site does not contain any receptors as defined within Table 1 of the Contaminated Land Statutory Guidance. Therefore no plausible linkage exists.

Property

Following an assessment of the results of the chemical analysis of the waters from the pond within the backfilled open cast mine no significant risk to property (cattle) was noted.

⁶ (Contaminated Land Statutory Guidance April 2016) Category 4: Human Health.

4.20 The local authority should not assume that land poses a significant possibility of significant harm if it considers that there is no risk or that the level of risk posed is low. For the purposes of this Guidance, such land is referred to as a "Category 4: Human Health" case. The authority may decide that the land is a Category 4: Human Health case as soon as it considers it has evidence to this effect, and this may happen at any stage during risk assessment including the early stages.

4.21 The local authority should consider that the following types of land should be placed into Category 4: Human Health:

- (a) Land where no relevant contaminant linkage has been established.
- (b) Land where there are only normal levels of contaminants in soil, as explained in Section 3 of this Guidance.
- (c) Land that has been excluded from the need for further inspection and assessment because contaminant levels do not exceed relevant generic assessment criteria in accordance with Section 3 of this Guidance, or relevant technical tools or advice that may be developed in accordance with paragraph 3.30 of this Guidance.
- (d) Land where estimated levels of exposure to contaminants in soil are likely to form only a small proportion of what a receptor might be exposed to anyway through other sources of environmental exposure (e.g. in relation to average estimated national levels of exposure to substances commonly found in the environment, to which receptors are likely to be exposed in the normal course of their lives).

4.22 The local authority may consider that land other than the types described in paragraph 4.21 should be placed into Category 4: Human Health if following a detailed quantitative risk assessment it is satisfied that the level of risk posed is sufficiently low.

4.23 Local authorities may decide that particular land apparently matching the descriptions of paragraph 4.21 (b) or (d) immediately above poses sufficient risk to human health to fall into Categories other than Category 4. However, such cases are likely to be very unusual and the authority should take particular care to explain why the decision has been taken, and to ensure that it is supported by robust evidence.

⁷ (Contaminated Land Statutory Guidance April 2016)

2.13. If at any stage the local authority considers, on the basis of information obtained from inspection activities, that there is no longer a reasonable possibility that a significant contaminant linkage exists on the land, the authority should not carry out any further inspection in relation to that linkage.

Part 2A status of the site

Statutory Guidance states that 'If the authority considers there is little reason to consider that the land might pose an unacceptable risk, inspection activities should stop at that point.' In such cases the authority should issue a written statement to that effect. This report forms that written statement.

On the basis of its assessment, the authority has concluded that the land does not meet the definition of contaminated land under Part 2A and is not considered contaminated land.

Further Action

No further assessment of the site is considered necessary under Part 2A unless additional information is discovered or if changes are made to the site.

Appendices

Appendix A Site Photographs



Photograph 1. The entrance to the former extraction pit from the north.



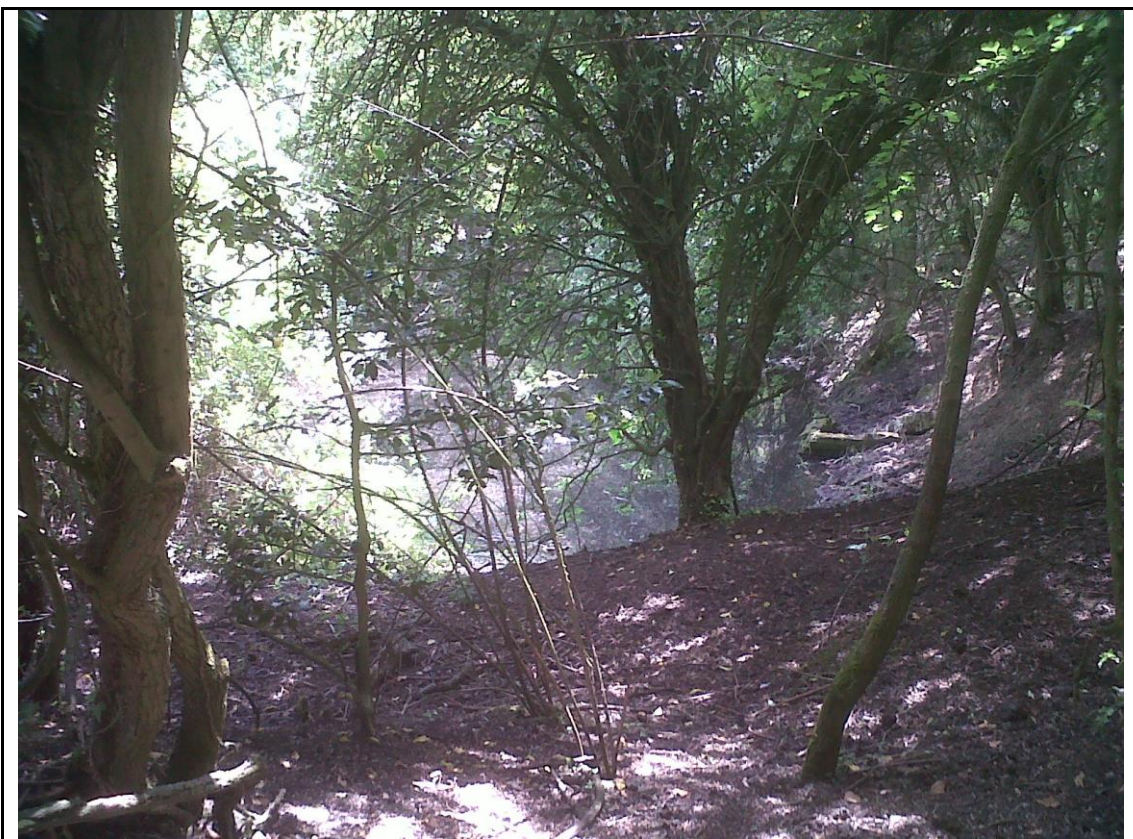
Photograph 2. A depression in the extraction area



Photograph 3. A mound in the extraction area which may have been backfilled.



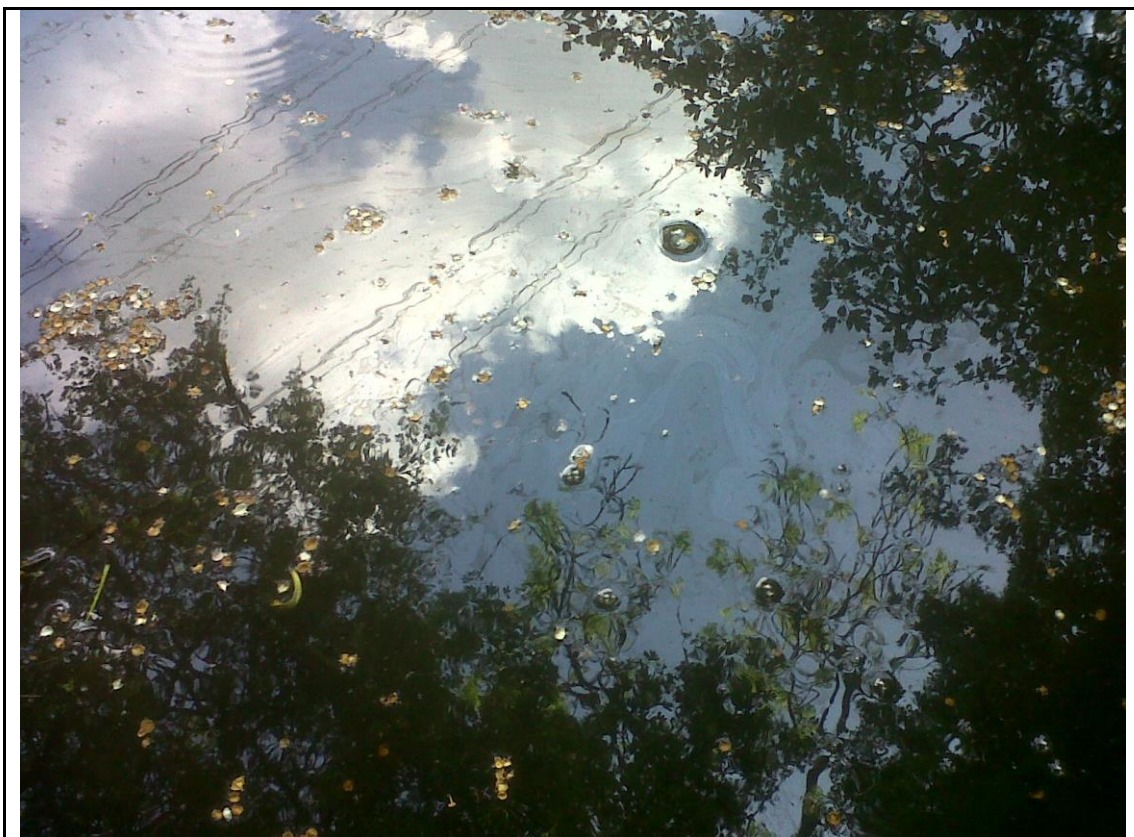
Photograph 4. A pond in the north of the site.



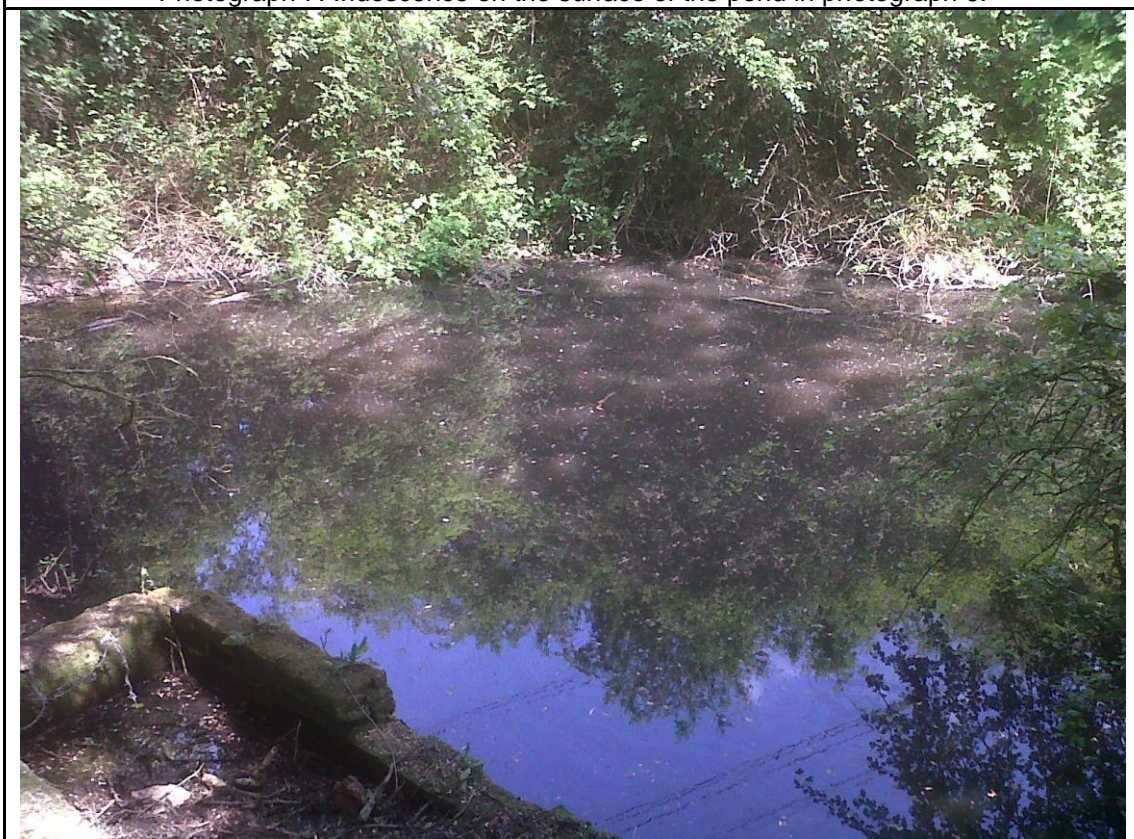
Photograph 5. Depressions from the extraction process.



Photograph 6. A pond in the north of the site with a structure from when it was working.



Photograph 7. Iridescence on the surface of the pond in photograph 6.



Photograph 8. Vegetation on the far side of the pond in photographs 6 & 7.



Photograph 9. A photograph which was claimed to be from the pond on Setch oil fields
<http://www.kingslynn-forums.co.uk/viewtopic.php?f=14&t=1738&start=60>



Photograph 10. A part of what is assumed to be a former railway line leading to the pond in
 photograph 6, 7, 8 & 9.



Photograph 11. The eastern side of the landfill



Photograph 12. The Puny Drain



Photograph 13. The field where the mine shafts area located.

Appendix B Drawings



Borough Council of
**King's Lynn &
West Norfolk**



Tel. 01553 616200 - Fax. 01553 691663

Title
Site Plan

Project / Details
Gravel Hill, Setchey

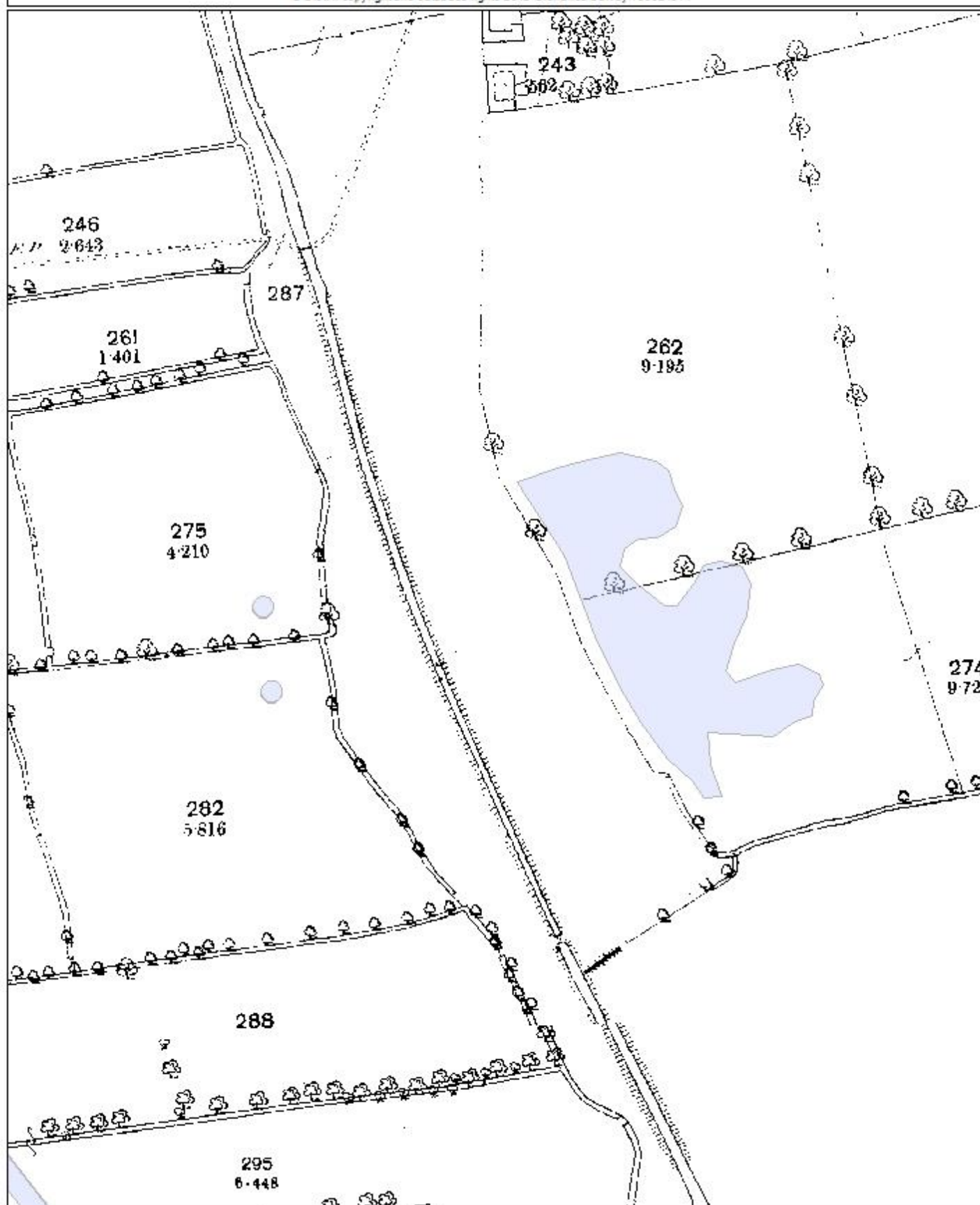


Scale
1:2,500

Date
November 2017

Drawn by
EH&H

Drawing / Reference Number
S560100033265/101



Borough Council of
**King's Lynn &
West Norfolk**



Tel. 01553 616200 - Fax 01553 691663

Title
Historic Plan 1843 - 1893

Project / Details
Gravel Hill, Setchey

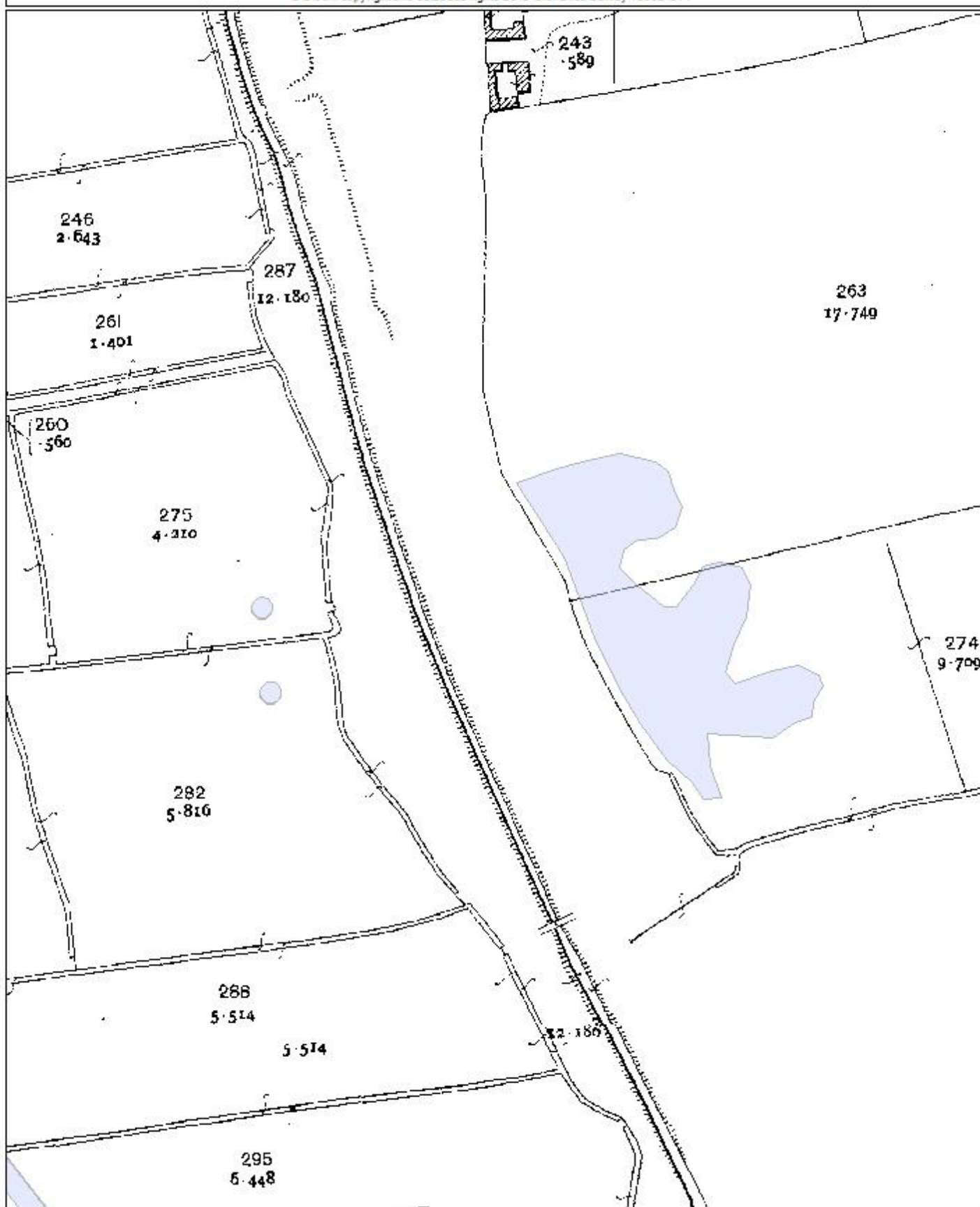


Scale
1:2,500

Date
November 2017

Drawn by
EH&H

Drawing / Reference Number
S560100033265/102



Borough Council of
**King's Lynn &
West Norfolk**



Tel. 01553 616200 - Fax 01553 691683

Title
Historic Plan 1891 - 1912

Project / Details
Gravel Hill, Setchey

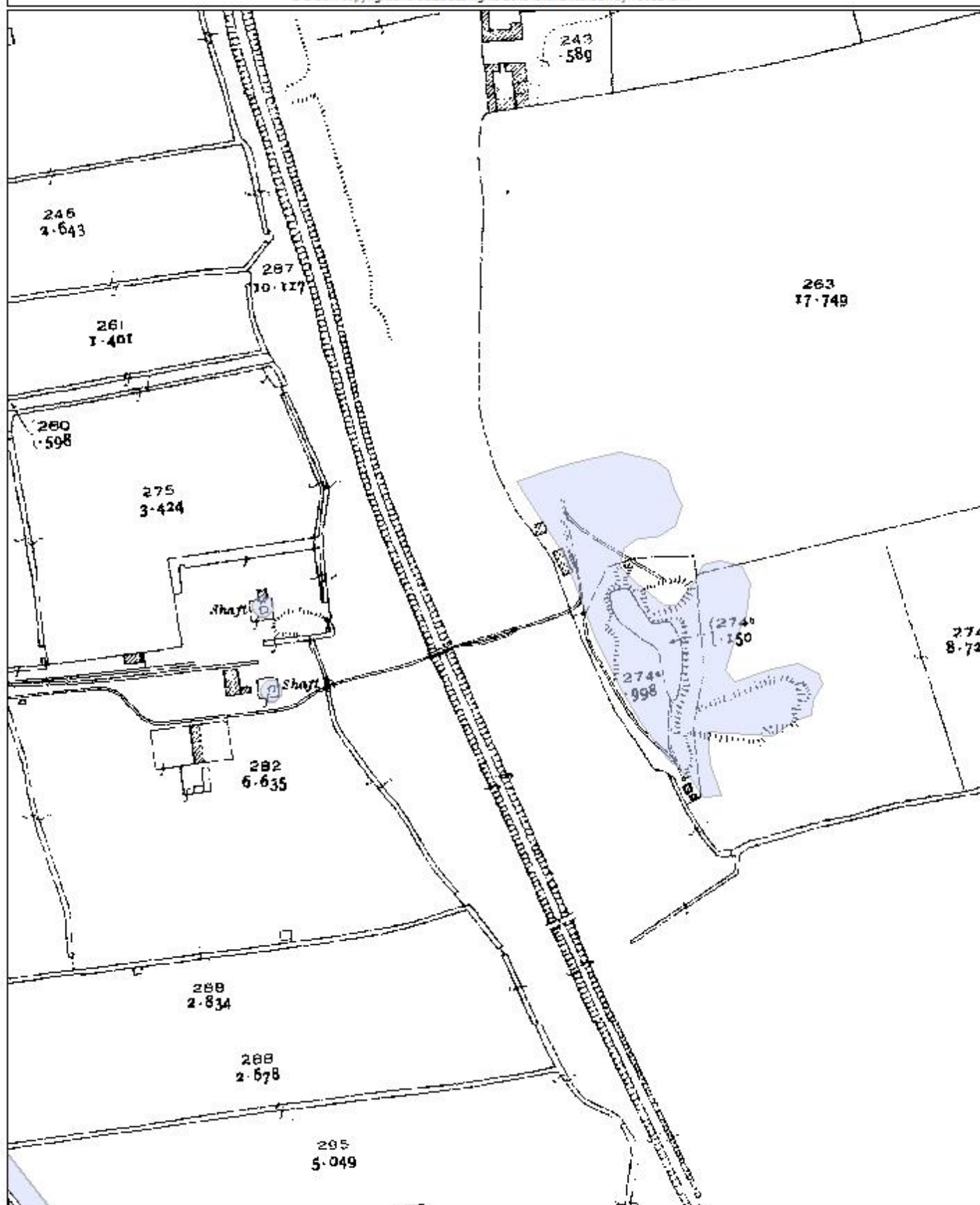


Scale
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Date
November 2017

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Borough Council of
**King's Lynn &
West Norfolk**



Tel. 01553 616200 - Fax 01553 691663

Title
Historic Plan 1904 - 1939

Project / Details
Gravel Hill, Setchey

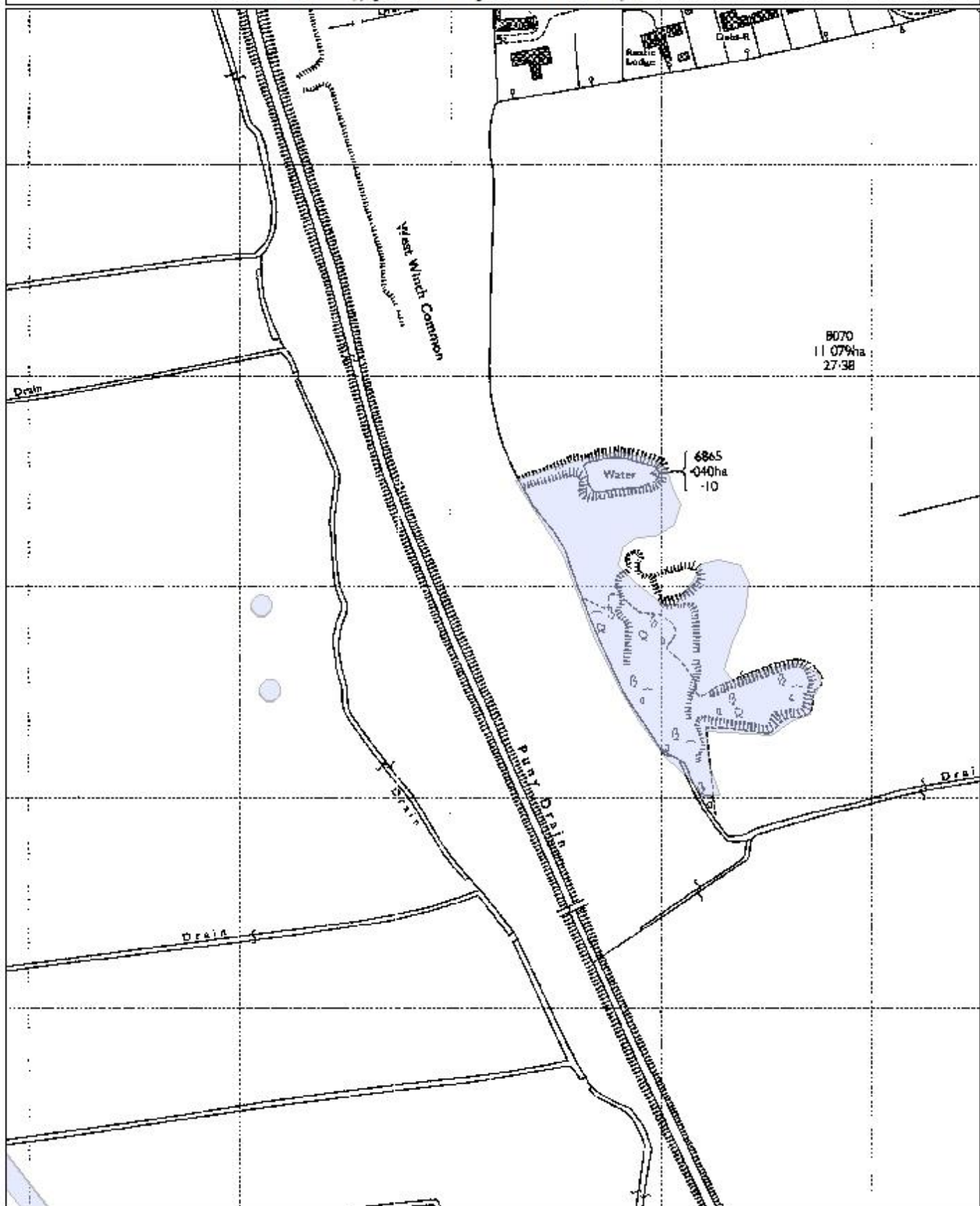


Scale
1:2,500

Date
November 2017

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Drawing / Reference Number
S560100033265/104



Borough Council of
**King's Lynn &
West Norfolk**



Tel. 01553 616200 - Fax. 01553 691663

Title
Historic Plan 1945 - 1970

Project / Details
Gravel Hill, Setchey



Scale
1:2,500

Date
November 2017

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S560100033265/105



Borough Council of
**King's Lynn &
West Norfolk**



Tel. 01553 616200 - Fax. 01553 691663

Title
Aerial Photograph 1940s

Project / Details
Gravel Hill, Setchey



Scale
1:2,500

Date
November 2017

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Drawing / Reference Number
S560100033265/106



Borough Council of
**King's Lynn &
West Norfolk**



Tel. 01553 616200 - Fax 01553 691663

Title
Aerial Photograph 1999

Project / Details
Gravel Hill, Setchey



Scale
1:2,500

Date
November 2017

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Drawing / Reference Number
S560100033265/107



Borough Council of
**King's Lynn &
West Norfolk**



Tel. 01553 616200 - Fax 01553 691663

Title
Aerial Photograph 2006-09

Project / Details
Gravel Hill, Setchey



Scale
1:2,500

Date
November 2017

Drawn by
EH&H

Drawing / Reference Number
S560100033265/108

Appendix C. Chemical Analysis

National
Laboratory
Service

Analytical Report

Final Report

Report ID - 20096397 - 1

Batch description: Setchey Surface Water Ad Hoc



Reported on:
02-Aug-2016

Tim Wilkins
Norfolk County Council
Attn: Tim Wilkins
ETD Strategic Waste Norfolk County Council
Floor 2, Bay 15, County Hall
Norwich
Norfolk
NR1 2SG

Dear Tim

Please find attached the results for the batch of 1 samples described below.

Samples Registered on:	14-Jul-2016
Analysis Started on:	15-Jul-2016
Analysis Completed on:	02-Aug-2016
Results for Batch Number	20096397
Your Purchase Order Number:	507770

You will be invoiced shortly by our accounts department.

If we can be of further assistance then please do not hesitate to contact us.

Yours sincerely

Vici Morgan
Customer Services Team Leader
Tel: (0113) 231 2177
nls@environment-agency.gov.uk

Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation. Details of analytical procedures and performance data are available on request. The date of sample analysis is available on request.

The Environment Agency carries out analytical work to high standards and within the scope of its UKAS accreditation, but has no knowledge of whether the circumstances or the validity of the procedures used to obtain the samples provided to the laboratory were representative of the need for which the information was required.

The Environment Agency and/or its staff does not therefore accept any liability for the consequences of any acts or omissions made on the basis of the analysis or advice or interpretation provided.

NLS Leeds
Olympia House
Gelderd Lane
Gelderd Road
Leeds LS12 6DD

NLS Nottingham
Meadow Lane
Nottingham
NG2 3HN

NLS Starcross
Staplake Mount
Starcross
Exeter
EX6 8FD



Page 1 of 6



Client: Norfolk County Council Project: 13546 Ad Hoc - Setchey
Quote Description: Setchey Surface Water
Folder No: 003605087 Sampled on: 13-Jul-16 @ 13:15
Comments: Setchey
Quote No: 13546 Matrix: Freshwater

Analyte	Result	Units	Flag	MRV	Accred	Lab ID, Testcode
Conductivity at 20C	850	uS/cm		10	UKAS	SX 9
pH	7.99	pH Units		0.05	UKAS	SX 9
Sulphide as S	<0.01	mg/l		0.01	UKAS	NM 230
Arsenic	3.14	ug/l		1	UKAS	SX 30
Aluminium	100	ug/l		10	UKAS	SX 34
Cadmium	<0.1	ug/l		0.1	UKAS	SX 34
Chromium	<0.5	ug/l		0.5	UKAS	SX 34
Copper	1.00	ug/l		1	UKAS	SX 34
Lead	<2	ug/l		2	UKAS	SX 34
Nickel	2.53	ug/l		1	UKAS	SX 34
Zinc	<5	ug/l		5	UKAS	SX 34
Barium	58.2	ug/l		10	UKAS	SX 38
Boron	100	ug/l		100	UKAS	SX 38
Calcium	167	mg/l		1	UKAS	SX 38
Iron	763	ug/l		30	UKAS	SX 38
Lithium	<100	ug/l		100	UKAS	SX 38
Magnesium	10.9	mg/l		0.3	UKAS	SX 38
Manganese	288	ug/l		10	UKAS	SX 38
Potassium	19.7	mg/l		0.1	UKAS	SX 38
Sodium	18.4	mg/l		2	UKAS	SX 38
Strontium	487	ug/l		20	UKAS	SX 38
Sulphate as SO4	28.8	mg/l		10	UKAS	SX 38
Acenaphthene	NoResult	ug/l		0.01	UKAS	SX 852
Acenaphthylene	<0.01	ug/l		0.01	UKAS	SX 852
Anthracene	NoResult	ug/l		0.01	UKAS	SX 852
Benzo(a)anthracene	<0.01	ug/l		0.01	UKAS	SX 852
Benzo(a)pyrene	<0.01	ug/l		0.01	UKAS	SX 852
Benzo(b)fluoranthene	<0.01	ug/l		0.01	UKAS	SX 852
Benzo(e)pyrene	NoResult	ug/l		0.01	UKAS	SX 852
Benzo(ghi)perylene	<0.01	ug/l		0.01	UKAS	SX 852
Benzo(k)fluoranthene	NoResult	ug/l		0.01	UKAS	SX 852
Chrysene	<0.01	ug/l		0.01	UKAS	SX 852
Dibenzo(ah)anthracene	<0.01	ug/l		0.01	UKAS	SX 852
Fluoranthene	NoResult	ug/l		0.01	UKAS	SX 852
Fluorene	NoResult	ug/l		0.01	UKAS	SX 852
Indeno(1,2,3-cd)pyrene	<0.01	ug/l		0.01	UKAS	SX 852

Naphthalene	NoResult	ug/l	0.01	UKAS	SX	852
Perylene	<0.01	ug/l	0.01	UKAS	SX	852
Phenanthrene	NoResult	ug/l	0.01	UKAS	SX	852
Pyrene	NoResult	ug/l	0.01	UKAS	SX	852
2,3,5,6-Tetrachlorophenol	<0.02	ug/l	0.02	UKAS	NM	62
2,3-Dichlorophenol	<0.02	ug/l	0.02	UKAS	NM	62
2,3-Dimethylphenol :- (2,3-Xylenol)	<0.02	ug/l	0.02	UKAS	NM	62
2,4,5-Trichlorophenol	<0.02	ug/l	0.02	UKAS	NM	62
2,4,6-Trichlorophenol	<0.02	ug/l	0.02	UKAS	NM	62
2,4-Dichlorophenol	<0.02	ug/l	0.02	UKAS	NM	62
2,4-Dimethylphenol :- (2,4-Xylenol)	<0.02	ug/l	0.02	UKAS	NM	62
2,5-Dichlorophenol	<0.02	ug/l	0.02	UKAS	NM	62
2,5-Dimethylphenol :- (2,5-Xylenol)	<0.02	ug/l	0.02	UKAS	NM	62
2,6-Dichlorophenol	<0.02	ug/l	0.02	UKAS	NM	62
2,6-Dimethylphenol :- (2,6-Xylenol)	<0.02	ug/l	0.02	UKAS	NM	62
2-Chlorophenol	<0.02	ug/l	0.02	UKAS	NM	62
2-Ethylphenol	<0.02	ug/l	0.02	UKAS	NM	62
2-Methylphenol :- (o-Cresol)	<0.02	ug/l	0.02	UKAS	NM	62
3,4-Dimethylphenol :- (3,4-Xylenol)	<0.02	ug/l	0.02	UKAS	NM	62
3,5-Dimethylphenol :- (3,5-Xylenol)	<0.02	ug/l	0.02	UKAS	NM	62
3-Chlorophenol	<0.02	ug/l	0.02	UKAS	NM	62
3-Methylphenol :- (m-Cresol)	0.0976	ug/l	0.02	UKAS	NM	62
4-Chloro-2-methylphenol :- (p-Chloro-o-cresol)	<0.02	ug/l	0.02	UKAS	NM	62
4-Chloro-3,5-dimethylphenol :- (PCMX)	<0.02	ug/l	0.02	UKAS	NM	62
4-Chloro-3-methylphenol :- (p-Chloro-m-cresol)	<0.02	ug/l	0.02	UKAS	NM	62
4-Chlorophenol	<0.02	ug/l	0.02	UKAS	NM	62
4-Methylphenol :- (p-cresol)	<0.02	ug/l	0.02	UKAS	NM	62
Pentachlorophenol	<0.02	ug/l	0.02	UKAS	NM	62
Phenol	0.0877	ug/l	0.06	UKAS	NM	62
1,1,1,2-Tetrachloroethane	<0.1	ug/l	0.1	UKAS	SX	1296
1,1,1-Trichloroethane	<0.1	ug/l	0.1	UKAS	SX	1296
1,1,2,2-Tetrachloroethane	<0.1	ug/l	0.1	UKAS	SX	1296
1,1,2-Trichloroethane	<0.1	ug/l	0.1	UKAS	SX	1296
1,1-Dichloroethane	<0.1	ug/l	0.1	UKAS	SX	1296
1,1-Dichloroethylene :- (1,1-Dichloroethene)	<0.1	ug/l	0.1	UKAS	SX	1296
1,1-Dichloropropylene :- (1,1-Dichloropropene)	<0.1	ug/l	0.1	UKAS	SX	1296
1,2,3-Trichlorobenzene	<0.1	ug/l	0.1	None	SX	1296
1,2,3-Trichloropropane	<0.5	ug/l	0.5	UKAS	SX	1296
1,2,3-Trimethylbenzene	<0.1	ug/l	0.1	UKAS	SX	1296
1,2,4-Trichlorobenzene	<0.1	ug/l	0.1	None	SX	1296
1,2,4-Trimethylbenzene	<0.1	ug/l	0.1	UKAS	SX	1296
1,2-Dibromo-3-chloropropane	<0.1	ug/l	0.1	UKAS	SX	1296
1,2-Dibromoethane	<0.1	ug/l	0.1	UKAS	SX	1296



1,2-Dichlorobenzene	<0.1	ug/l	0.1	UKAS	SX	1296
1,2-Dichloroethane	<0.1	ug/l	0.1	UKAS	SX	1296
1,2-Dichloropropane	<0.1	ug/l	0.1	UKAS	SX	1296
1,2-Dimethylbenzene :- (o-Xylene)	<0.1	ug/l	0.1	UKAS	SX	1296
1,3,5-Trichlorobenzene	<0.1	ug/l	0.1	None	SX	1296
1,3,5-Trimethylbenzene :- (Mesitylene)	<0.1	ug/l	0.1	UKAS	SX	1296
1,3-Dichlorobenzene	<0.1	ug/l	0.1	UKAS	SX	1296
1,3-Dichloropropane	<0.1	ug/l	0.1	UKAS	SX	1296
1,4-Dichlorobenzene	<0.1	ug/l	0.1	UKAS	SX	1296
2,2-Dichloropropane	<0.1	ug/l	0.1	UKAS	SX	1296
2-Chlorotoluene :- (1-Chloro-2-methylbenzene)	<0.1	ug/l	0.1	UKAS	SX	1296
3-Chlorotoluene :- (1-Chloro-3-methylbenzene)	<0.1	ug/l	0.1	UKAS	SX	1296
4-Chlorotoluene :- (1-Chloro-4-methylbenzene)	<0.1	ug/l	0.1	UKAS	SX	1296
4-Isopropyltoluene :- (4-methyl-Isopropylbenzene)	<0.1	ug/l	0.1	UKAS	SX	1296
Benzene	<0.1	ug/l	0.1	UKAS	SX	1296
Bromobenzene	<0.1	ug/l	0.1	UKAS	SX	1296
Bromochloromethane	<0.1	ug/l	0.1	UKAS	SX	1296
Bromodichloromethane	<0.1	ug/l	0.1	UKAS	SX	1296
Bromoform :- (Tribromomethane)	<0.1	ug/l	0.1	UKAS	SX	1296
Carbon Disulphide	0.140	ug/l	0.1	None	SX	1296
Carbon tetrachloride :- (Tetrachloromethane)	<0.1	ug/l	0.1	UKAS	SX	1296
Chlorobenzene	<0.1	ug/l	0.1	UKAS	SX	1296
Chlorodibromomethane	<0.1	ug/l	0.1	UKAS	SX	1296
Chloroform :- (Trichloromethane)	<0.1	ug/l	0.1	UKAS	SX	1296
Chloromethane :- (Methyl Chloride)	<0.5	ug/l	0.5	None	SX	1296
cis-1,2-Dichloroethylene :- (cis-1,2-Dichloroethene)	<0.1	ug/l	0.1	UKAS	SX	1296
cis-1,3-Dichloropropylene :- (cis-1,3-Dichloropropene)	<0.1	ug/l	0.1	UKAS	SX	1296
Dibromomethane	<0.1	ug/l	0.1	UKAS	SX	1296
Dichloromethane :- (Methylene Dichloride)	<0.5	ug/l	0.5	UKAS	SX	1296
Dimethylbenzene :- Sum of Isomers (1,3- 1,4-) :- (m+p xylene)	<0.2	ug/l	0.2	UKAS	SX	1296
Ethyl tert-butyl ether :- (ETBE)	<0.1	ug/l	0.1	UKAS	SX	1296
Ethylbenzene	<0.1	ug/l	0.1	UKAS	SX	1296
Hexachlorobutadiene	<0.1	ug/l	0.1	None	SX	1296
Hexachloroethane	<0.1	ug/l	0.1	None	SX	1296
Isopropylbenzene	<0.1	ug/l	0.1	UKAS	SX	1296
MTBE :- (Methyl tert-butyl ether)	<0.1	ug/l	0.1	UKAS	SX	1296
Naphthalene	<0.1	ug/l	0.1	None	SX	1296
n-Butylbenzene :- (1-Phenylbutane)	<0.1	ug/l	0.1	UKAS	SX	1296
n-Propylbenzene :- (1-phenylpropane)	<0.1	ug/l	0.1	UKAS	SX	1296
sec-Butylbenzene :- (1-Methylpropylbenzene)	<0.1	ug/l	0.1	UKAS	SX	1296
Styrene :- (Vinylbenzene)	<0.1	ug/l	0.1	UKAS	SX	1296
tert-Amyl methyl ether :- (TAME)	<0.1	ug/l	0.1	UKAS	SX	1296
tert-Butylbenzene :- ((1,1-Dimethylethyl)benzene)	<0.1	ug/l	0.1	UKAS	SX	1296



Tetrachloroethylene :- (Perchloroethylene)	<0.1	ug/l	0.1	UKAS	SX	1296
Toluene :- (Methylbenzene)	0.120	ug/l	0.1	UKAS	SX	1296
trans-1,2-Dichloroethylene :- (trans-1,2-Dichloroethene)	<0.1	ug/l	0.1	UKAS	SX	1296
trans-1,3-Dichloropropylene :- (trans-1,3-Dichloropropene)	<0.5	ug/l	0.5	UKAS	SX	1296
Trichloroethylene :- (Trichloroethene)	<0.1	ug/l	0.1	UKAS	SX	1296
Trichlorofluoromethane	<0.1	ug/l	0.1	UKAS	SX	1296
Vinyl Chloride :- (Chloroethylene)	<0.1	ug/l	0.1	UKAS	SX	1296
Carbon, Organic : Total as C :- (TOC)	18.8	mg/l	0.7	UKAS	SC	1318
Hydrocarbons >C10 - C20, Total	<100	ug/l	100	UKAS	SC	1048
Hydrocarbons >C20 - C40, Total	<100	ug/l	100	UKAS	SC	1048
Hydrocarbons >C6 - C10, Total	<100	ug/l	100	UKAS	SC	1048
Total Petroleum Hydrocarbons >C6 - C40	<100	ug/l	100	UKAS	SC	1048

Method Description Summary for all samples in batch Number 20096397

9	SX I pH EC Turbidity - pH; Conductivity; Turbidity - determined by automated electrode probe system
30	SX M Hydride As - Arsenic - acid digested; determined by Hydride - AAS
34	SX M ICPMS Routine - Metals - acid digested; determined by ICPMS
38	SX M ICPOES Routine - Metals - acid digested; determined by ICPOES
62	SX O PHENOLS or NM O PHENOLS - Phenols (speciated) - solvent extracted; PFB derivitised; determined by GCMS
230	NM I Sulphide - determined by spectrometry
852	SX O PAH - (speciated) - solvent extracted; determined by GCMS
1048	Sub-contract
1296	SX O Volatiles - direct aqueous injected; determined by P and T GCMS
1318	Sub-contract



James Trout
Laboratory Site Manager

All reporting limits quoted are those achievable for clean samples of the relevant matrix. No allowance is made for instances when dilutions are necessary owing to the nature of the sample or insufficient volume of the sample being available. In these cases higher reporting limits may be quoted and will be above the MRV.

Minimum Reporting Value (MRV). A minimum concentration selected for reporting purposes (i.e. the less than value), which is higher than the statistically derived method limit of detection.

Solid sample results are determined on a "dried" sample fraction except for parameters where the method description identifies that "as received" sample was used.

Key to Results Flags:

DC Analysis started outside of specified stability time. It is possible that the results may be compromised.

QB QC flag. Reported result not affected

The analysis start date specified is the date of the first test, dates for other analysis are available on request.

Please note all samples will be retained for 10 working days for aqueous samples and 30 working days for solid samples after reporting unless otherwise agreed with Customer Services

Key to Accreditation: UKAS = Methodology accredited to ISO/IEC 17025:2005, MCertS = Methodology accredited to MCertS Performance Standard for testing of soils, none = Methodology not accredited

Key to Lab ID: LE = Leeds, NM = Nottingham, SX = Starcross, SC = Sub-Contracted outside NLS, FI = Field Data - outside NLS, NLS = Calculated

Any subsequent version of this report denoted with a higher version number will supersede this and any previous versions

END OF TEST REPORT

Appendix D. Detailed Quantitative Risk Assessment

Calcium and Magnesium

Calcium and Magnesium are both related to the hardness of water. Given the hardness of the water in the area the levels detected are considered to be representative of the general environment. The publication Calcium and Magnesium in Drinking water – Public Health Significance⁸ by the World Health Organisation indicates that the Upper levels of intake (ULi) for Calcium and Magnesium was 2,500mg/day and 2,500mg/day respectively, based on the intake of an adult. As the recorded levels of the contaminants of concern (CoC) calcium and magnesium were 167µg/l and 10.9µg/l and adult would have to consume a volume (V) 14,970 litres and 229,357 litres to exceed the maximum daily intake for calcium and magnesium respectively. Given the average consumption of water, is approximately 2 litres/day, no significant risk is considered to be present for human health.

$$V_{(human)} = ULi / CoC$$

An adult human weighs on average 70kg which when calculated equates to an upper intake level of 35.7mg/kg/bw/day. As a cow weighs on average 600kg⁹ the Upper level of intake for cattle would be 21,426mg/day for both Calcium and Magnesium.

$$ULi_{(Cattle)} = 600(2,500 / 70)$$

The upper limit on the quantity of water drunk by cattle is quoted as being 30 gallons per day¹⁰ equivalent to 136litres. Calcium was recorded at 167µg/l and magnesium was recorded at 10.9µg/l which means that the maximum intake of calcium and magnesium is 5,010µg/day and 327µg/day respectively. Therefore it is considered that the levels of Calcium and Magnesium detected do not pose a risk to the cattle.

Manganese

The recorded value of Manganese exceeds both the UKDWS and the EQS, however it does not exceed the guidance value provided by the screening value calculated by the WHO. Therefore the level of Manganese detected is not considered to pose a risk to human health or cattle.

Carbon Disulphide (Disulfide)

No limits exist for Carbon Disulfide in the United Kingdom. The American Federal Government has set regulations to protect individuals from the possible health effects of eating, drinking, or breathing carbon disulfide. The Agency for Toxic Substances and Disease Registry (ATSDR) suggested that taking into your body each day an amount equal to 0.1mg of carbon disulfide per kg of your body weight

⁸ http://apps.who.int/iris/bitstream/10665/43836/1/9789241563550_eng.pdf

⁹ <http://www.dairymoos.com/how-much-do-cows-weight/>

¹⁰ <http://beef.unl.edu/amountwatercowsdrink>

is not likely to cause any significant (non-cancer) harmful health effects¹¹. This equates to 7mg of Carbon Disulphide for an adult. Given the recorded level recorded in the pond water (0.14ug/l) an adult human would have to ingest 50,000 litres of pond water to exceed the minimal risk level as stipulated by the ATSDR.

$$Water_{vol} = TDI / Water_{conc}$$

$$7mg / 0.00014 = 50,000$$

Therefore as the average water consumption of an adult is 2 litres no significant risk to human health is considered to exist.

$$600kg \times 0.1mg / kg / bw / day = 60mg / day$$

Taking the average weight of the cattle to be 600kg¹² (taken as an average of the average breed weight); this would indicate that the acceptable daily intake level of Carbon Disulphide is 60mg per day. This would equate to the having to drink 428,571 litres from the pond a day. Therefore, the level of Carbon Disulfide detected in the pond water is not considered to pose a risk to the cattle.

3-Methylphenol (m-Cresol)

3-methylphenol is a naturally occurring organic chemical within oil shale. Research into the toxicological effect of 3-Methylphenol indicates that the contaminant is toxic (hypo-activity, ataxia, twitches, tremors, prostration, urine stains, audible respiration, perioral wetness) at elevated levels. The lowest recorded No Observable Adverse Effect Level (NOAEL) was 30mg/kg/bw/day¹³. This would equate to 2,100mg for an average adult. As the recorded levels of 3-Methylphenol is 0.0976ug/l (0.0000976) this would require the adult to consume 21,516,393 litres of water. Therefore no significant risk is considered to be present to human health from 3-Methylphenol.

$$30mg / kg / bw / day \times 70kg = 2,100mg$$

$$2,100mg / 0.0000976mg / l = 21,516,393l$$

If it is assumed that the average weight of a cow is 600kg¹⁴ (taken as an average of the average breed weight), which would indicate that the adjusted NOAEL is 30mg/kg/bw/day x 600kg = 18,000mg/day. The upper limit on the quantity of water drunk by cattle is quoted as being 30 gallons per day¹⁵ equivalent to 136litres. The recorded level of 3-Methylphenol was 0.0976µg/l which indicates that at the maximum consumption rate of 3-Methylphenol is 13.02736µg. This means that the NOAEL exceeds the recorded value by over a factor of 6. As such the levels of 3-Methylphenol detected are not considered to pose a risk to the health of the cattle.

¹¹ PUBLIC HEALTH STATEMENT CARBON DISULFIDE (<https://www.atsdr.cdc.gov/ToxProfiles/tp82-c1-b.pdf>)

¹² <http://www.dairymoos.com/how-much-do-cows-weight/>

¹³ Inchem document. OECD SIDS M/P-Cresol Category. 2003. (<http://www.inchem.org/documents/sids/sids/m-p-cresols.pdf>)

¹⁴ <http://www.dairymoos.com/how-much-do-cows-weight/>

¹⁵ <http://beef.unl.edu/amountwatercowsdrink>

Appendix E. Risk Assessment Methodology

The Model Procedures for the Management of Land Contamination (CLR11¹⁶) provide the technical framework for applying a risk management process when dealing with contaminated land.

The Borough Council's Contaminated Land Strategy has identified priority sites based on mapping and documentary information. The Contaminated Land Inspection Report collates all the existing information on the site and develops a conceptual site model to identify and assess potential pollutant linkages and to estimate risk.

The risk assessment process focuses on whether there is an unacceptable risk, which will depend on the circumstances of the site and the context of the decision. The Council has used a process adapted from CIRIA C552, Contaminated Land Risk Assessment, a guide to good practice¹⁷ to produce the conceptual site model and estimate the risk of harm to defined receptors. This involves the consideration of the probability, nature and extent of exposure and the severity and extent of the effects of the contamination hazard should exposure occur.

The probability of an event can be classified as follows:

- Highly likely: The event appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution;
- Likely: It is probable that an event will occur, or circumstances are such that the event is not inevitable, but possible in the short term and likely over the long term;
- Low likelihood: Circumstances are possible under which an event could occur, but it is not certain even in the long term that an event would occur and it is less likely in the short term;
- Unlikely: Circumstances are such that it is improbable the event would occur even in the long term.

The severity of the hazard can be classified as follows:

- High: Short term (acute) risk to human health likely to result in 'significant harm' as defined by the Environment Protection Act 1990, Part IIA. Short term risk of pollution of sensitive water resources. Catastrophic damage to buildings or property. Short term risk to an ecosystem or organism forming part of that ecosystem (note definition of ecosystem in 'Contaminated Land Statutory Guidance, April 2012');
- Medium: Chronic damage to human health ('significant harm' as defined in 'Contaminated Land Statutory Guidance, April 2012'), pollution of sensitive water resources, significant change in an ecosystem or organism forming part of that ecosystem (note definition of ecosystem in 'Contaminated Land Statutory Guidance, April 2012');

¹⁶ <https://www.gov.uk/guidance/land-contamination-risk-management>

¹⁷ <https://www.brebookshop.com/samples/142102.pdf>

- Low: Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services ('significant harm' as defined in 'Contaminated Land Statutory Guidance, April 2012'). Damage to sensitive buildings, structures or the environment.

Once the probability of an event occurring and hazard severity has been classified, a risk category can be assigned from the table below:

		Hazard		
		High	Medium	Low
Probability	High Probability	Very High Risk	High Risk	Moderate Risk
	Likely	High Risk	Moderate Risk	Moderate/Low Risk
	Low Probability	Moderate risk	Moderate/Low Risk	Low Risk
	Unlikely	Moderate/Low Risk	Low Risk	Very Low Risk
Very High Risk		<p>There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening</p> <p>This risk, if realised, is likely to result in a substantial liability.</p> <p>Urgent investigation (if not undertaken already) and remediation are likely to be required.</p>		
High Risk		<p>Harm is likely to arise to a designated receptor from an identified hazard.</p> <p>Realisation of the risk is likely to present a substantial liability.</p> <p>Urgent investigation (if not undertaken already) if required to clarify the risk and to determine the potential liability. Some remedial work may be required in the longer term.</p>		
Moderate risk		<p>It's possible that harm could arise to a designated receptor from an identified hazard. However, it is relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that harm would be relatively mild.</p>		
Moderate/Low risk		<p>It is possible that harm could arise to a designated receptor from an identified hazard. However, if any harm were to occur it is more likely that harm would be relatively mild.</p>		
Low Risk		<p>It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.</p>		
Very Low Risk		<p>There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is unlikely to be severe.</p>		

Appendix F. Determination of contaminated land – Contaminated Land Statutory Guidance, April 2012

Human Health

Category	
1	<p>The local authority should assume that a significant possibility of significant harm exists in any case where it considers there is an unacceptably high probability, supported by robust science-based evidence that significant harm would occur if no action is taken to stop it. For the purposes of this Guidance, these are referred to as “Category 1: Human Health” cases.</p> <p>Land should be deemed to be a Category 1: Human Health case where:</p> <ul style="list-style-type: none"> (a) The authority is aware that similar land or situations are known, or are strongly suspected on the basis of robust evidence, to have caused such harm before in the United Kingdom or elsewhere; or (b) The authority is aware that similar degrees of exposure (via any medium) to the contaminant(s) in question are known, or strongly suspected on the basis of robust evidence, to have caused such harm before in the United Kingdom or elsewhere; (c) The authority considers that significant harm may already have been caused by contaminants in, on or under the land, and that there is an unacceptable risk that it might continue or occur again if no action is taken. Among other things, the authority may decide to determine the land on these grounds if it considers that it is likely that significant harm is being caused, but it considers either: (i) that there is insufficient evidence to be sure of meeting the “balance of probability” test for demonstrating that significant harm is being caused; or (ii) that the time needed to demonstrate such a level of probability would cause unreasonable delay, cost, or disruption and stress to affected people particularly in cases involving residential properties.
2	<p>Land should be placed into Category 2 if the authority concludes, on the basis that there is a strong case for considering that the risks from the land are of sufficient concern, that the land poses a significant possibility of significant harm, with all that this might involve and having regard to Section 1. Category 2 may include land where there is little or no direct evidence that similar land, situations or levels of exposure have caused harm before, but nonetheless the authority considers on the basis of the available evidence, including expert opinion, that there is a strong case for taking action under Part 2A on a precautionary basis.</p>
3	<p>Land should be placed into Category 3 if the authority concludes that the strong case described in 4.25(a) does not exist, and therefore the legal test for significant possibility of significant harm is not met. Category 3 may include land where the risks are not low, but nonetheless the authority considers that regulatory intervention under Part 2A is not warranted. This recognises that placing land in Category 3 would not stop others, such as the owner or occupier of the land, from taking action to reduce risks outside of the Part 2A regime if they choose. The authority should consider making available the results of its inspection and risk assessment to the owners/occupiers of Category 3 land.</p>

Category

- 4** The local authority should consider that the following types of land should be placed into Category 4: Human Health:
- (a) Land where no relevant contaminant linkage has been established.
 - (b) Land where there are only normal levels of contaminants in soil, as explained in Section 3 of this Guidance.
 - (c) Land that has been excluded from the need for further inspection and assessment because contaminant levels do not exceed relevant generic assessment criteria in accordance with Section 3 of this Guidance, or relevant technical tools or advice that may be developed in accordance with paragraph 3.30 of this Guidance.
 - (d) Land where estimated levels of exposure to contaminants in soil are likely to form only a small proportion of what a receptor might be exposed to anyway through other sources of environmental exposure (e.g. in relation to average estimated national levels of exposure to substances commonly found in the environment, to which receptors are likely to be exposed in the normal course of their lives).

Ecological system effects

Relevant types of receptor	Significant harm	Significant possibility of significant harm
<p>Any ecological system, or living organism forming part of such a system, within a location which is:</p> <ul style="list-style-type: none"> • A site of special scientific interest (under section 28 of the Wildlife and Countryside Act 1981) • A national nature reserve (under s.35 of the 1981 Act) • A marine nature reserve (under s.36 of the 1981 Act) • An area of special protection for birds (under s.3 of the 1981 Act) • A "European site" within the meaning of regulation 8 of the Conservation of Habitats and Species Regulations 2010 • Any habitat or site afforded policy protection under paragraph 6 of Planning Policy Statement (PPS 9) on nature conservation (i.e. candidate Special Areas of Conservation, potential Special Protection Areas and listed Ramsar sites); or • Any nature reserve established under section 21 of the National Parks and Access to the Countryside Act 1949. 	<p>The following types of harm should be considered to be significant harm:</p> <ul style="list-style-type: none"> • Harm which results in an irreversible adverse change, or in some other substantial adverse change, in the functioning of the ecological system within any substantial part of that location; or • Harm which significantly affects any species of special interest within that location and which endangers the long-term maintenance of the population of that species at that location. <p>In the case of European sites, harm should also be considered to be significant harm if it endangers the favourable conservation status of natural habitats at such locations or species typically found there. In deciding what constitutes such harm, the local authority should have regard to the advice of Natural England and to the requirements of the Conservation of Habitats and Species Regulations 2010.</p>	<p>Conditions would exist for considering that a significant possibility of significant harm exists to a relevant ecological receptor where the local authority considers that:</p> <ul style="list-style-type: none"> • Significant harm of that description is more likely than not to result from the contaminant linkage in question; or • There is a reasonable possibility of significant harm of that description being caused, and if that harm were to occur, it would result in such a degree of damage to features of special interest at the location in question that they would be beyond any practicable possibility of restoration. <p>Any assessment made for these purposes should take into account relevant information for that type of contaminant linkage, particularly in relation to the ecotoxicological effects of the contaminant.</p>

Property effects

Relevant types of receptor	Significant harm	Significant possibility of significant harm
<p>Property in the form of:</p> <ul style="list-style-type: none"> • Crops, including timber; • Produce grown domestically, or on allotments, for consumption; • Livestock; • Other owned or domesticated animals; • Wild animals which are the subject of shooting or fishing rights. 	<p>For crops, a substantial diminution in yield or other substantial loss in their value resulting from death, disease or other physical damage. For domestic pets, death, serious disease or serious physical damage. For other property in this category, a substantial loss in its value resulting from death, disease or other serious physical damage.</p> <p>The local authority should regard a substantial loss in value as occurring only when a substantial proportion of the animals or crops are dead or otherwise no longer fit for their intended purpose. Food should be regarded as being no longer fit for purpose when it fails to comply with the provisions of the Food Safety Act 1990. Where a diminution in yield or loss in value is caused by a contaminant linkage, a 20% diminution or loss should be regarded as a benchmark for what constitutes a substantial diminution or loss.</p> <p>In this section, this description of significant harm is referred to as an “animal or crop effect”.</p>	<p>Conditions would exist for considering that a significant possibility of significant harm exists to the relevant types of receptor where the local authority considers that significant harm is more likely than not to result from the contaminant linkage in question, taking into account relevant information for that type of contaminant linkage, particularly in relation to the ecotoxicological effects of the contaminant.</p>
<p>Property in the form of buildings. For this purpose, “building” means any structure or erection, and any part of a building including any part below ground level, but does not include plant or machinery comprised in a building, or buried services such as sewers, water pipes or electricity cables.</p>	<p>Structural failure, substantial damage or substantial interference with any right of occupation. The local authority should regard substantial damage or substantial interference as occurring when any part of the building ceases to be capable of being used for the purpose for which it is or was intended.</p> <p>In the case of a scheduled Ancient Monument, substantial damage should also be regarded as occurring when the damage significantly impairs the historic, architectural, traditional, artistic or archaeological interest by reason of which the monument was scheduled.</p> <p>In this Section, this description of significant harm is referred to as a “building effect”.</p>	<p>Conditions would exist for considering that a significant possibility of significant harm exists to the relevant types of receptor where the local authority considers that significant harm is more likely than not to result from the contaminant linkage in question during the expected economic life of the building (or in the case of a scheduled Ancient Monument the foreseeable future), taking into account relevant information for that type of contaminant linkage.</p>

Controlled waters

Significant pollution of controlled waters

The following types of pollution should be considered to constitute significant pollution of controlled waters:

- (a) Pollution equivalent to “environmental damage” to surface water or groundwater as defined by The Environmental Damage (Prevention and Remediation) Regulations 2009, but which cannot be dealt with under those Regulations.
- (b) Inputs resulting in deterioration of the quality of water abstracted, or intended to be used in the future, for human consumption such that additional treatment would be required to enable that use.
- (c) A breach of a statutory surface water Environment Quality Standard, either directly or via a groundwater pathway.
- (d) Input of a substance into groundwater resulting in a significant and sustained upward trend in concentration of contaminants (as defined in Article 2(3) of the Groundwater Daughter Directive (2006/118/EC)⁵).

Significant possibility of significant pollution of controlled waters

Category

1	This covers land where the authority considers that there is a strong and compelling case for considering that a significant possibility of significant pollution of controlled waters exists. In particular this would include cases where there is robust science-based evidence for considering that it is likely that high impact pollution (such as the pollution described in paragraph 4.38) would occur if nothing were done to stop it.
2	This covers land where: (i) the authority considers that the strength of evidence to put the land into Category 1 does not exist; but (ii) nonetheless, on the basis of the available scientific evidence and expert opinion, the authority considers that the risks posed by the land are of sufficient concern that the land should be considered to pose a significant possibility of significant pollution of controlled waters on a precautionary basis, with all that this might involve (e.g. likely remediation requirements, and the benefits, costs and other impacts of regulatory intervention). Among other things, this category might include land where there is a relatively low likelihood that the most serious types of significant pollution might occur
3	This covers land where the authority concludes that the risks are such that (whilst the authority and others might prefer they did not exist) the tests set out in Categories 1 and 2 above are not met, and therefore regulatory intervention under Part 2A is not warranted. This category should include land where the authority considers that it is very unlikely that serious pollution would occur; or where there is a low likelihood that less serious types of significant pollution might occur.
4	This covers land where the authority concludes that there is no risk, or that the level of risk posed is low. In particular, the authority should consider that this is the case where: <ul style="list-style-type: none"> (a) No contaminant linkage has been established in which controlled waters are the receptor in the linkage; or (b) The possibility only relates to types of pollution described in paragraph 4.40 above (i.e. types of pollution that should not be considered to be significant pollution); or (c) The possibility of water pollution similar to that which might be caused by “background” contamination as explained in Section 3.