Borough Council of
King's Lynn &
West Norfolk

Environment and Planning

Contaminated Land Inspection Report

Thorpland House
Downham Road
Runcton Holme
King's Lynn

October 2017

Reference no. CL203

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Executive Summary

The Borough Council of King's Lynn and West Norfolk (BCKLWN) has an statutory duty to inspect its district for potentially contaminated land under Part 2A of the Environmental Protection Act 1990. The contaminated land inspection strategy has identified Thorpland House, Downham Road, Runcton Holme as a site which requires detailed inspection.

This site is a former landfill which forms part of a field adjacent to some residential properties within the district of King's Lynn. An initial assessment of the site was undertaken to assess the potential for harm to human health, controlled water and property under Part 2A.

To gather information of the site's history a desk study and preliminary risk assessment were carried out by the Environmental Quality Team. From the evidence gathered during the desk study of the site history and a site walkover, the following can be stated:

- The site is recorded as a former landfill.
- The landfill was potentially filled with phosphogypsum from the West Norfolk Fertiliser Limited who had the licence to operate the landfill. Phosphogypsum contains naturally radioactive material and metals.
- The site is now being used as a paddock.
- The former landfill is in the Tottenhill Gravel member which is a Secondary A Aquifer.
- The site is adjacent to residential properties.

The potential hazards and the risks associated with the site were assessed. The initial overall risk rating was that there could be a moderate risk for radioactivity and metals affecting human health.

Following the initial assessment it was concluded that additional information was required to characterise and categorise the site. Further site investigation was required to assess whether phosphogypsum waste is present and if so what risk that could pose to relevant receptors.

A site investigation was undertaken in December 2016 using a radiation monitor to quantify the level of radiation at the surface of the site. The levels of radiation detected were not statistically different from the recorded natural background levels of radiation. No evidence of waste material was noted at the site's surface. The revised overall risk rating was low. This indicated that the site in its current use is unlikely to pose a significant risk to human health or property. There is not a strong case for taking action under Part 2A EPA 1990 and the therefore the site has been classified into category 4 regarding the risk to human health from radioactivity and metals/metalloids. No evidence was found of significant pollution or significant possibility of such pollution of controlled waters.

Therefore the site is not considered to be contaminated land under Part 2A of the Environmental Protection Act 1990.

1. Introduction

This report details a review of information and written statement about land at Thorpland House, Thorpland, 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 document provides that written 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 561672, 308595 and the nearest postcode is PE33 0AF.

Initial Prioritisation Score

This site was prioritised for inspection following information provided by Norfolk County Council when a planning application was received relating to the site. This planning application has subsequently been refused on unrelated grounds.

Previous Site Usage

The site (drawing CL203/001) was a gravel pit, which was subsequently used as a landfill under licence from Norfolk County Council, additional information indicated that the landfill has the potential to have been used to deposit phosphogypsum from West Norfolk Fertilisers Ltd.

Present Site Usage

Its present use comprises a paddock with residential properties to the north, west and south. An open field is to the east and southeast. This is depicted on the plan in Appendix B.

Ownership

Land Registry enquiries showed that the land is owned by Mr Flint who also owns Thorpland House adjacent to the site. This report will be made available to the site owner.

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 4 meters above ordnance datum (maOD).

The bedrock geology is Kimmeridge Clay Formation - Mudstone. The superficial geology is Tottenhill Gravel Member - Gravel.[1]

[1] 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 (SPZ). The Tottenhill Gravel Member is classified as a Secondary A Aquifer with a High Vulnerability.

Hydrology
The nearest major water feature is a stream which is approximately 120m to the north of the site. This drains into the Relief Channel west of the site.

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

- Licence Number – 6/33/56/*S/0233, W & P CALEY LTD, Spray Irrigation - Storage.

Local Authority Pollution Prevention and Control Regulations

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

The Environment Agency Web site records

The Environment Agency Web site records the following:

- The stream to the north of the site is vulnerable to flooding, but the site is not impacted.
- The site is part of an area classified as a Nitrate Vulnerable Zone for Surface Waters.
- The site is not designated as a landfill (either historic or current).
- A historic landfill is recorded approximately 500m to the south (Runcton Holme), which has been assessed via Part 2A under a separate cover.
- No pollution incidents are recorded at the site.

MAGIC website records

MAGIC website records the following

- The site is covered by the MMO Marine Areas (England).
- The site is part of a Farm Wildlife Package Area.
- The site is part of a Countryside Stewardship Water Quality Priority Area (Medium Priority).
- The site is part of a Phosphate Issues Priority Area (England)(Medium Priority)
- The site is part of an area under Keeping Rivers Cool (England).
- The site is a Nitrate Vulnerable Zones (Surface Water)(England).
- The area is an area which is habitat for:
    - Arable Assemblage Farmland Birds (England) (Zone 6).
    - Grassland Assemblage Farmland Birds (England) (Zone 2).
    - Corn Bunting.
    - Grey Partridge.
    - Lapwing.
    - Stone Curlew.

    - Tree Sparrow.
    - Turtle Dove.
    - Yellow Wagtail.
- The site is covered by an Environmental Stewardship Agreement (England) - Entry Level plus Higher Level Stewardship.
- The site is part of an area covered by a Environmental Stewardship Agreement (England) – Higher Level Stewardship Themes (England).

Historic Maps

E-map Explorer

Enclosure Map 1800 - 1850 – Not available.

Tithe map circa 1840 – Not available.

Ordnance Survey 1st Ed. 1879-1886 – The site was a field, to the north east and west are fields. To the south is a residential property. Adjacent to the north-western corner of the site is a feature which is considered to represent a pond.

Historic Maps on file at the Borough Council of King's Lynn and West Norfolk (Presented in Appendix B)

1843 – 1893: The site was depicted as part of a field stretching east and west with a depression (pond) adjacent to the north western corner. A residential property is located to the south of the site, and a series of properties located to the north of the site beyond a track.

1891 – 1912: The site was as depicted above.

1904 – 1939: The site was as depicted above.

1919 – 1943: Not available.

1945 – 1970: The site was shown as a gravel pit (disused). The pond adjacent to the northwest corner of the site is no longer depicted. The track to the north is depicted as Thorpland Lane. The residential building to the south is named as North farm.

Aerial Photographs

1945 – 1946 MOD Aerial Photograph - The site was as depicted on the 1904 – 1939 map.

1988 Aerial Photograph – The site is shown as a field. A residential housing estate is now located to the west of the site and additional houses have been developed to the north. The surrounding area is generally as previously described.

1999 Aerial Photograph – The site was generally as described above.

2006-09 Aerial Photograph – The site was generally as described above.

Planning History

One planning application exists on the site:

- 16/00405/OM – Outline Major Application: Residential development. (Refusal)

Four applications exist adjacent to the site:

- 2/97/1445/F – Extension to dwelling.
- 2/02/1142/F – Conservatory and store room extensions to detached games room.
- 13/00936/F – Extension to front of bungalow.
- 16/00163/F – Two storey extension to provide new garage at ground floor and dressing room and en suite above following demolition of existing single storey garage.

Environment Agency Records

Mr Wojtek Koryczan of the Environment Agency was consulted on the 19th October 2016. He did not have any information available regarding the landfill. But he did indicate that groundwater would be considered to be Controlled Waters. No permit exist relating to the landfill as it predates the establishment of the Environment Agency.

Norfolk County Council Records

After a consultation with Norfolk County Council, additional information was provided which indicated that the former quarry was used by the West Norfolk Fertiliser Limited as a landfill for the deposition of phosphogypsum. No information has been received regarding the depth of cover for the site, however similar landfilling operations were required to place a 18inch (450mm) cover across the site as part of restoration.

3. Site Walkover

A site visit was carried out by Environmental Quality Officers of the Borough Council of King's Lynn and West Norfolk on 16/12/2016 and the following was noted. Photographs are presented in the Appendix A.

The site was a paddock, which was being used to graze horses. Information provided by Mr Flint (the owner) indicated that the field had also been used to graze

cattle for a significant number of years. Mr Flint also indicated that the quarry at one point also extended into the rear garden of Thorpland House. Subsequently the survey was extended into this area.

The site was roughly vegetated with coarse grass, stinging nettles and tussocks of grass. Numerous molehills were noted on the site but no evidence of phosphogypsum was noted in the earth brought up by the moles.

4. Assessment of Site Use

From the assessment of the site using County Council data, historic maps, aerial photography and a site walk over it has been possible to conclude that the site has been used for mineral extraction and has been backfilled and restored to agricultural use under a planning permission from Norfolk County Council.

Assessment of probability of a contamination event

From information received from Norfolk County Council it is considered that there is the potential for a source of contamination to be present on site. The potential source is a former landfill which was operated by West Norfolk Fertiliser Company.

Radioactive Contamination

The site is understood to have been used to deposit waste phosphogypsum from the fertiliser works in King's Lynn and potentially soil and beet washings from the sugar beet factory in King's Lynn. Phosphogypsum is a by-product of the fertiliser production and is known to contain radioactive material and metals. The radio-nuclei have the potential to either be accumulated within the vegetation on the surface of the site or to be leached from the landfill into the groundwater. Additionally if the cover material has become eroded some powdered phosphogypsum may become available for inhalation either by the horses who use the paddock or the humans who tend the horses. Therefore it is considered that the probability of humans inhaling phosphogypsum particles is LIKELY.

One of the radioactive particles which can be present within phosphogypsum is Radium, which due to radioactive decay can degrade into Radon gas. However, it is considered that as there are no buildings on site any Radon gas which is generated would be dispersed to the air without any adverse effects on human health. Therefore it is considered that the probability of humans inhaling Radon is UNLIKELY.

The landfill is situated within the Tottenhill Gravel which is highly permeable. This would indicate that any contamination would be able to migrate offsite. No potable water abstractions exist within 500m of the site. Therefore it is considered that the probability of humans ingesting or coming into contact with radioactive particles is UNLIKELY.

As there is considered to be a potential source of contamination and plausible pathways, a contaminant-pathway-receptor relationship could exist. The probability of a contamination event was assessed as LIKELY.

Metal Contamination

During the processing of gypsum into phosphogypsum any metal contamination present within the gypsum is concentrated into the phosphogypsum. As it is known that phosphogypsum is likely to exist within the landfill it is considered that metal contamination is likely to exist within the landfill. Therefore it is considered that the probability of a contamination event effecting human health (via direct contact or inhalation), the environment or groundwater is considered LIKELY.

Assessment of Hazard

The risks posed by the site have been assessed separately under the separate statutory guidance, the Radioactive Contaminated Land Statutory Guidance and the Contaminated Land Statutory Guidance. This is discussed further below:

Human Health

Radioactive Contaminated Land Statutory Guidance, April 2012.

The site is a landfill which had planning permission granted by Norfolk County Council. The planning permission was provided (Appendix B) so it is known that the landfill was used to deposit phosphogypsum. Therefore it has been assumed that radioactive particles are available for direct contact or inhalation by the humans who use the site. The hazard to vulnerable receptors has been classified as MEDIUM.

Radon is known to be a chronic hazard to human health as such the hazard is considered to be MEDIUM.

Contaminated Land Statutory Guidance (April 2012)

The phosphogypsum deposited in the landfill is assumed to contain elevated levels of metals from the concentration of natural occurring metals within the gypsum. The level of metal contamination within the phosphogypsum has to be considered to be elevated sufficiently to represent a chronic hazard to human health via direct contact and inhalation. As such the hazard to vulnerable receptors has been classified as MEDIUM.

Property

The site is a paddock used to graze horses and is adjacent residential properties. As the landfilled material is considered to be covered by approximately 450mm and the vegetation is shallow rooted, there is considered to be a limited potential for contaminants located within the landfill to be absorbed by the vegetation on site and thereby be ingested by the horses or cattle grazing on the site. As such the hazard to the above property receptors has been classified as LOW.

The landfill is considered to be potentially located within the groundwater which is perched within the Tottenhill Gravel Member. This would allow for leaching of any materials within the landfill into the groundwater but only one abstraction is located in the vicinity of the landfill is this is for a reservoir for agricultural spraying. As such the hazard to above property receptors has been classified as LOW.

Environment

The site is a former quarry and landfill, which is now being used as a paddock. 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 hazard to the environment has been classified as LOW.

Controlled Water

Groundwater

The metals which may be within the landfilled material are not considered to be a hazard to the Tottenhill Gravel Member which is a Secondary A Aquifer with a High Vulnerability as it is not within a Source Protection Zone (SPZ). The hazard to groundwater has been classified as LOW.

Surface waters

There are no surface waters on site or within 100m. The hazard to surface water receptors has been classified as LOW.

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
Radiation from Phosphogypsum waste Metals and metalloids within waste material	Direct contact & Inhalation	Humans	Likely	Medium	Moderate
Radiation from Phosphogypsum waste Metals and metalloids within waste material	Direct Contact Inhalation (horses)	Property	Low likelihood	Low	Low
Radiation from Phosphogypsum waste Metals and metalloids within waste material	Direct contact	Environment	Low likelihood	Low	Low
Radiation from Phosphogypsum waste Metals and metalloids within waste material	Direct contact	Controlled water	Low likelihood	Low	Low

Outcome of Preliminary Risk Assessment
A plausible source pathway receptor linkage was identified and a moderate risk from contamination within the waste was identified to humans using the site. Therefore further site investigation was considered necessary to establish if phosphogypsum waste material was present in near surface soils and to further quantify the risks to humans.

5. Site Investigation

The site investigation was designed in accordance with the 'Briefing Note' 'Contaminated Land (Part 2A) and Radioactivity'[2] produced by the Environment Agency which states 'Inspecting potential radioactive land may involve desk studies, site visits for visual inspection and limited analysis of surface deposits for radiation.'

The sampling strategy was designed on a grid structure using non-targeted sampling in accordance with guidance within CIRIA C552 'Contaminated Land Risk Assessment'.

The investigation took place on 16th December 2016. A Tracerco T410 was hired from Nuclear Engineering & Environmental Services Ltd (NEES Ltd) and an assessment of the radioactivity was undertaken across the surface of the suspected landfill. After discussion of the material to be assessed (Phosphogypsum) with Mr A Scougall of NEES Ltd it was decided that as the most likely radioactive contaminant in phosphogypsum was Radium 226. Therefore the setting for Radium 226 (wet) was chosen as the radio-nuclei to be tested for. Given the highly vegetated surface of the site, a spade was used to lift the vegetation which was mostly grass. Readings were taken close to the bare soil.

A background reading was taken in the locality but away from the site to be assessed. The site was then analysed in a herringbone pattern based on a grid with 10m centres.

Results
No visual evidence was observed of waste material at the surface of the site. The results of the radiation survey are presented in table 2 below:

Table 2: Results of radiation survey

	Results in Becquerel's per cm^2 (Bq/cm^2)
Background	0.56
Peak	1.25
Lowest	0.56
Average	0.62
Standard Deviation	0.06
95^{th} Percentile	0.69

[2] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/296723/LIT_7924_904adc.pdf

Background radiation measurements were undertaken at a number of locations in the vicinity of the site and the results are presented in table 3 below.

Table 3: Results of background radiation survey

	Results in Becquerel's per cm^2 (Bq/cm^2)
Peak	0.88
Lowest	0.48
Average	0.71
Standard Deviation	0.11
95^{th} Percentile	0.69

Metal Contamination

To assess the likely composition of phosphogypsum waste, sampling results were reviewed from a previous site investigation undertaken on a phosphogypsum lagoon located in King's Lynn adjacent to the former fertilizer factory. In the King's Lynn investigation samples were taken from the phosphogypsum and analysed for selected analytes. This material was from the same source as waste deposited at Thorpland House.

The results from the King's Lynn analysis have been tabulated below in table 4 and compared to human health risk assessment criteria to determine the likely hazard to human health. The exposure assumed is for a residential with home grown vegetables scenario as this is the most conservative and would ensure the lowest level of risk to both human health and groundwater. Where UK risk levels for analytes were not available Dutch Target levels were chosen where available.

The majority of the analytes tested for have returned values either below the Limit of Detection or chosen Assessment Criteria where one was available.

Mercury exceeded the chosen assessment criteria. Five analytes (Bismuth, Magnesium, Manganese, Platinum and Strontium) have not been identified in technical guidance as priority contaminants and do not have any generic assessment criteria to which they can be compared. A further assessment of these five and mercury was undertaken, based on available literature and this indicated that these concentrations in soil were unlikely to pose a significant risk to human health. The further assessment of these analytes is presented in Appendix C.

Table 4: Results of laboratory analysis of waste from King's Lynn phosphogypsum lagoons

Sample / Analyte	Depth	Antimony[3]	Arsenic[4]	Barium[3]	Beryllium[4]	Bismuth	Cadmium[4]	Chromium[4]	Cobalt[3]	Copper[4]	Lead[5]	Magnesium	Manganese	Mercury[4]	Molybdenum[3]	Nickel[4]	Platinum	Selenium[4]	Silver[3]	Strontium	Tin[3]	Vanadium[4]	Zinc[4]
AC		3	37	160	1.7		11	910	9	2400	200			1.2	3	130		250	15		19	410	3700
AA5/16	0	0.2	0.5	63	N/A	N/A	0.31	1.7	N/A	N/A	17.7	1	1	1.69	0.5	0.5	N/A	3.59	1.1	389	1.7	2	3
AA5/16	1	N/A	0.6	77	N/A	N/A	0.2	2.3	N/A	N/A	25.4	13	1	0.86	0.5	0.5	N/A	5.66	1.3	509	1	2	3
AA5/120	0.5	N/A	0.8	76.9	N/A	N/A	0.29	0.37	N/A	N/A	31.3	251	1	1.01	0.5	0.5	N/A	3.96	0.5	509	0.6	2.6	3
AA7/119	0.5	N/A	1.3	104	N/A	0.2	0.4	5.9	N/A	N/A	29.7	416	1	1.18	0.5	0.5	N/A	4.32	0.8	613	0.5	5	5.4
AA7/071	0	0.4	0.8	61	N/A	0.2	0.65	2.9	N/A	N/A	23.4	8	1	3.19	0.5	0.5	N/A	3.37	0.7	472	3.5	2	3
AA7/071	1	0.3	0.8	72	N/A	N/A	0.36	2.4	N/A	N/A	19.2	6	1	4.69	0.5	0.5	N/A	3.52	0.7	514	1.8	2	3

Notes
1.
2. AC – Assessment Criteria.
N/A – Analyte not detected above the limit of detection.
3. Compared to the Dutch Target value as no other value exists in the UK[3].
4. Compared to the Suitable 4 Use Levels developed by CIEH and LQM[4].
5. Compared to the C4SL[5].
6. Shaded cells indicate levels which exceed the selected Assessment Criteria.

[3] http://www.esdat.net/Environmental%20Standards/Dutch/annexS_I2000Dutch%20Environmental%20Standards.pdf
[4] The LQM/CIEH S4ULs for Human Health Risk Assessment. ISBN 978-0-9931084-0-2
[5] file://homeserver/Users$/agrimmer/Downloads/12356_SP1010PolicyCompanionDocument%20(1).pdf

6. Conclusion

Radioactivity

From an assessment of the results of the radiation monitoring, the average recorded value for the site is below the average background value result and below the 95th percentile for the background monitoring. This would indicate that the values of radioactivity which were being recorded on site represented background radiation levels.

There was no visual evidence of waste material at the site's surface. The site was used to landfill both phosphogypsum and soil from washing sugar beet. Therefore, it can be been assumed that the phosphogypsum was buried at depth with a suitable cover of soil from the sugar beet washing placed on top of it and in accordance with the requirements of planning permission for other landfill sites being operated at this time.

Metals

Following an assessment of the levels of metals which are likely to be within phosphogypsum, these are not considered to pose a risk to human health, the environment or controlled waters.

Updated Conceptual site model

The CSM (table 5 below) has been updated based on the site investigation findings.

Table 5: Updated conceptual site model

Source	Pathway	Receptor	Probability	Hazard	Risk
Radiation from Phosphogypsum waste Metals and metalloids within waste material	Direct contact Inhalation	Humans	Low Likelihood	Low	Low
Radiation from Phosphogypsum waste Metals and metalloids within waste material	Direct Contact Inhalation (horses)	Property	Low likelihood	Low	Low
Radiation from Phosphogypsum waste Metals and metalloids within waste material	Direct contact	Environment	Low likelihood	Low	Low
Radiation from Phosphogypsum waste Metals and metalloids within waste material	Direct contact	Controlled water	Low likelihood	Low	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, 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 worse normally be mild'[6].

Human Health

Following the site investigation the site is assessed as Category 4: Human Health[7] as set out in the Statutory Guidance, as such no further assessment is considered necessary with regards to the risk to human health.

Controlled Waters

No further inspection is considered to be required with regards to controlled waters as it is considered that there is no reasonable possibility that a significant contaminant linkage exists as set out in the Statutory Guidance [8]. This assessment applies to the site's current use.

No further assessment of the site is considered necessary unless additional information is discovered or if the site is considered for redevelopment.

Part 2A status of the site

The site is not considered to be contaminated land under Part 2A of the Environmental Protection Act 1990.

[6] Contaminated land risk assessment. A guide to good practice. CIRIA C552, ISBN 0860175529.
[7] Appendix E sets out the categories of land in the Contaminated Land Statutory Guidance.
[8] (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.

Appendices

Appendix A Site Photographs

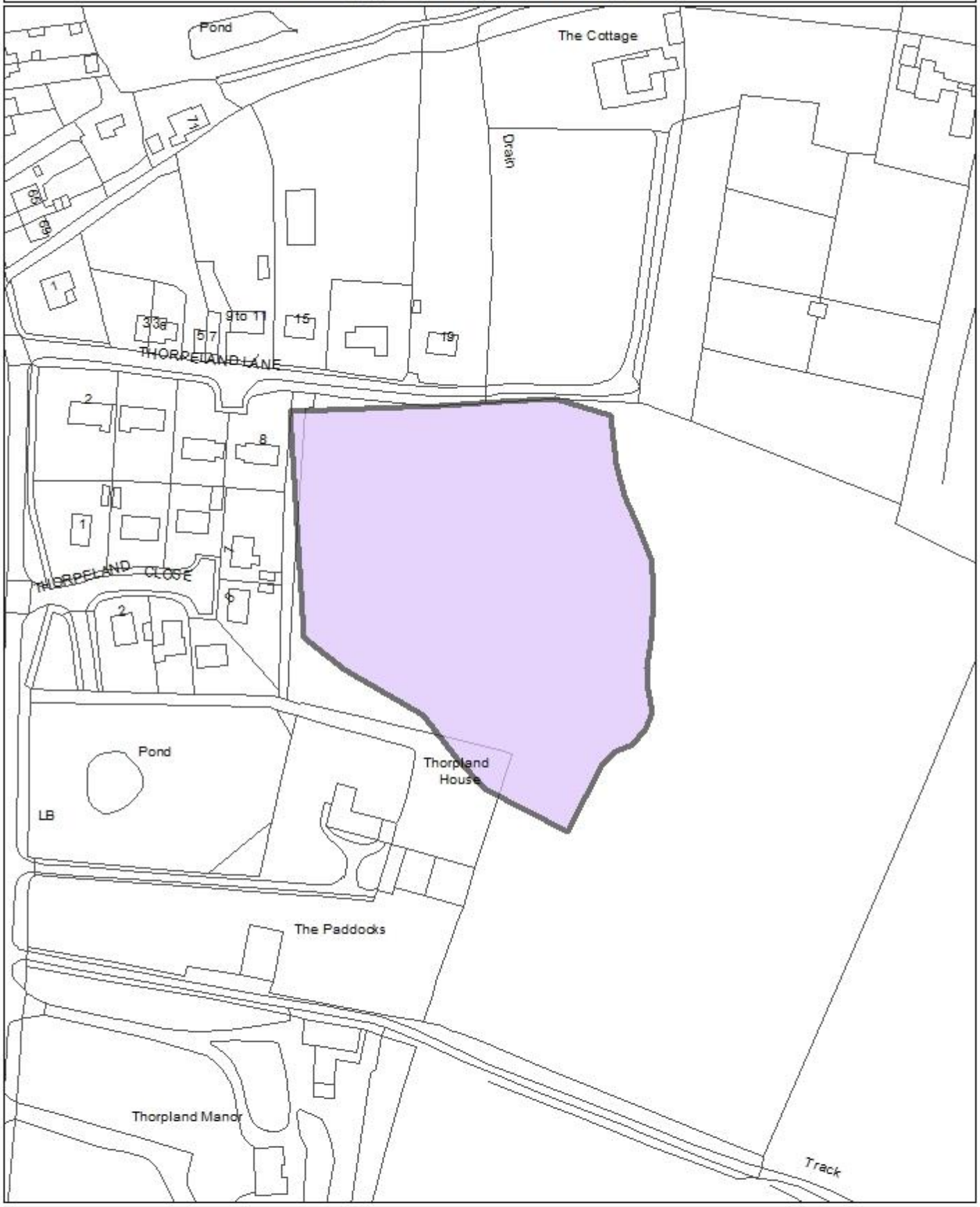
Photograph 1.

Photograph 2.

Photograph 3

Photograph 4

Appendix B Drawings



Borough Council of
King's Lynn &
West Norfolk

Tel. 01553 616200 - Fax. 01553 691663

Title
Site Plan

N
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S

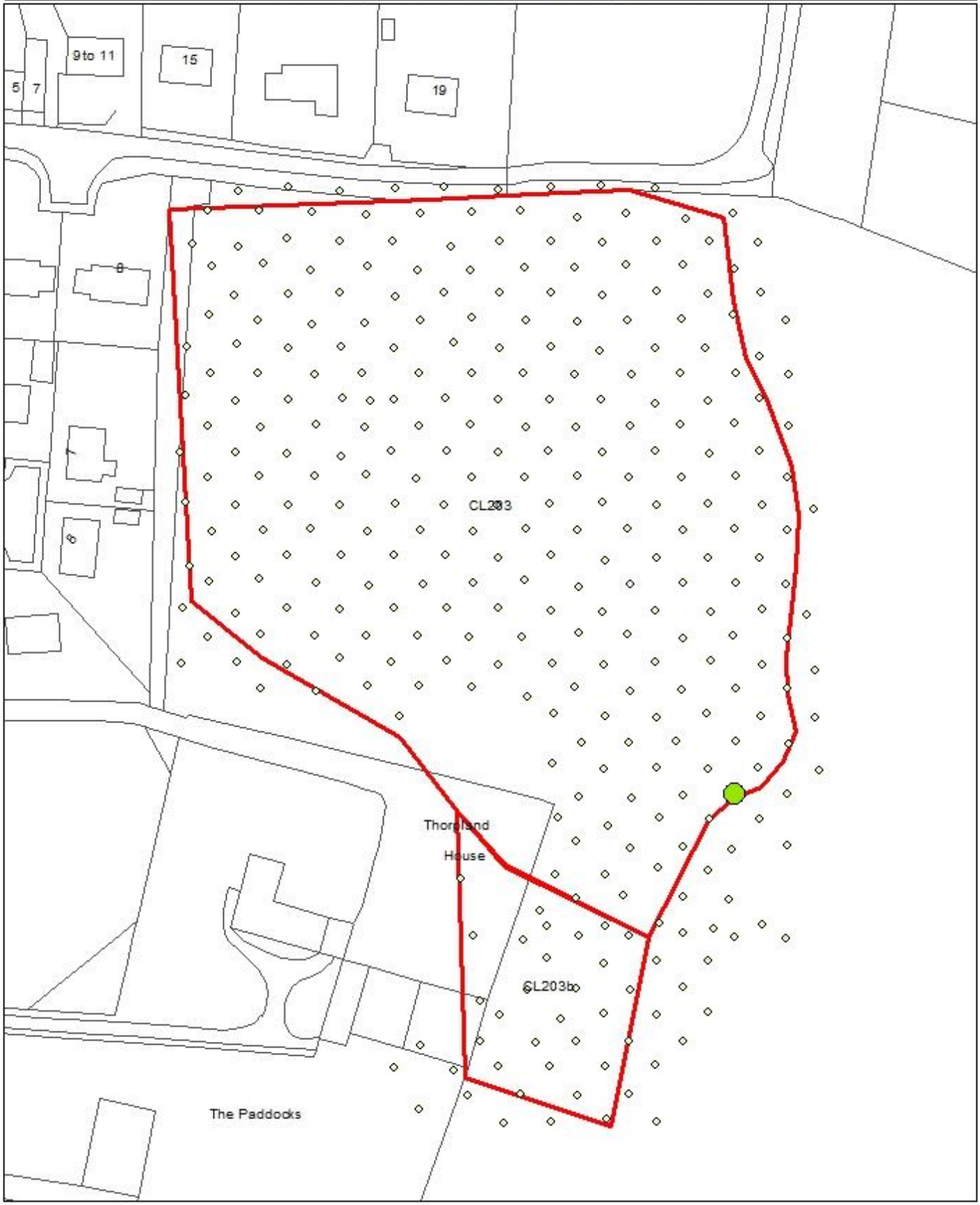
Scale
1:1,729

Date
February 2017

Project / Details
Land North of Thorpland House
Thorpland, King's Lynn

Drawn by
EH&H

Drawing / Reference Number
CL203/001



Borough Council of
King's Lynn &
West Norfolk

Tel. 01553 616200 - Fax. 01553 691663

Title

Sample Locations

N
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Scale
1:1,000

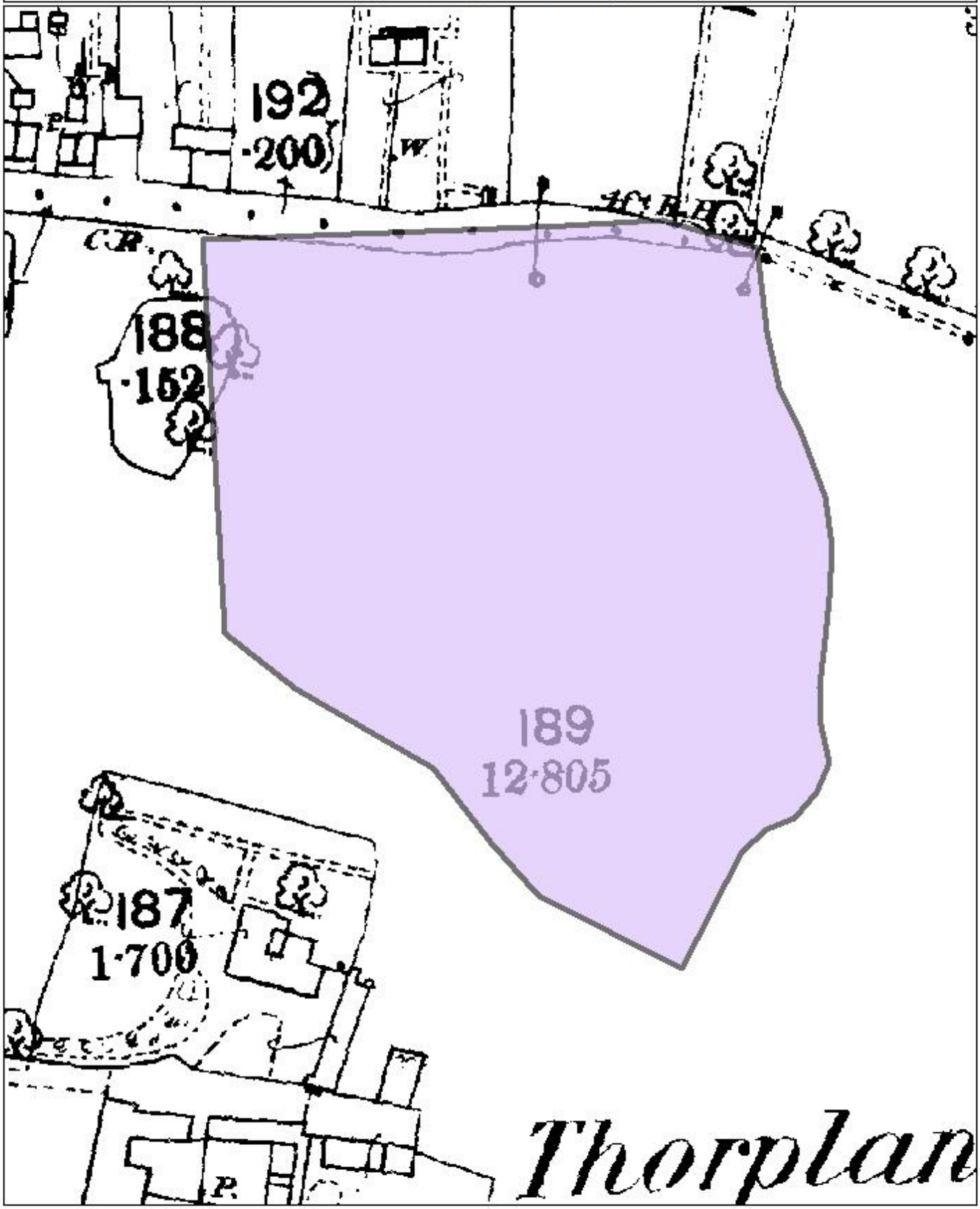
Date
21/02/2017

Project / Details

Land North of Thorpland House,
Thorpland, King's Lynn

Drawn by
EH&H

Drawing / Reference Number
CL203/002



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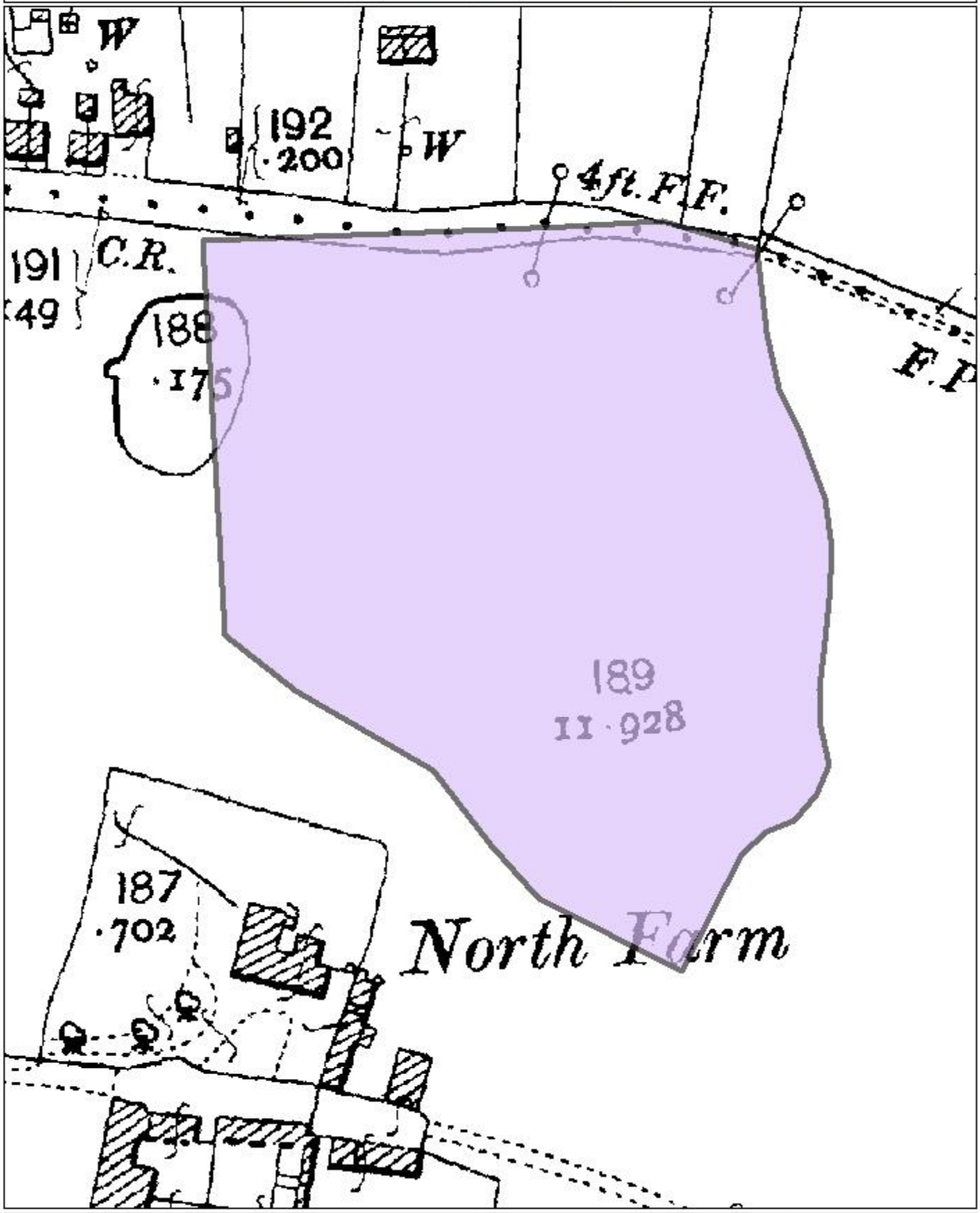
	Project / Details Land North of Thorpland House, Thorpland, King's Lynn		Drawn by EH&H Drawing / Reference Number CL203/003



Borough Council of King's Lynn & West Norfolk Tel. 01553 616200 - Fax. 01553 691663	Title Historic Map 1891 - 1912	N W E S	Scale 1:1,000 Date May 2017
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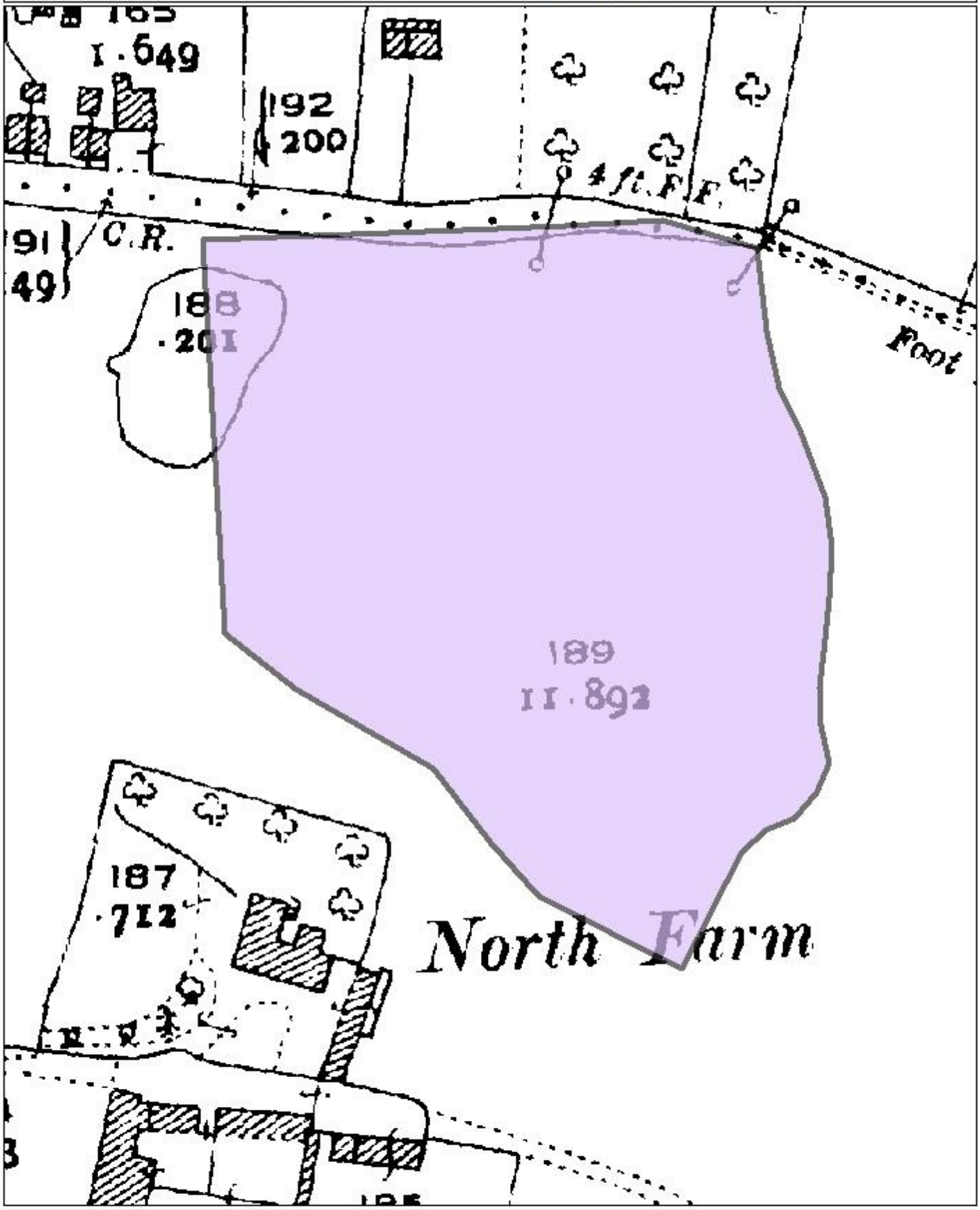
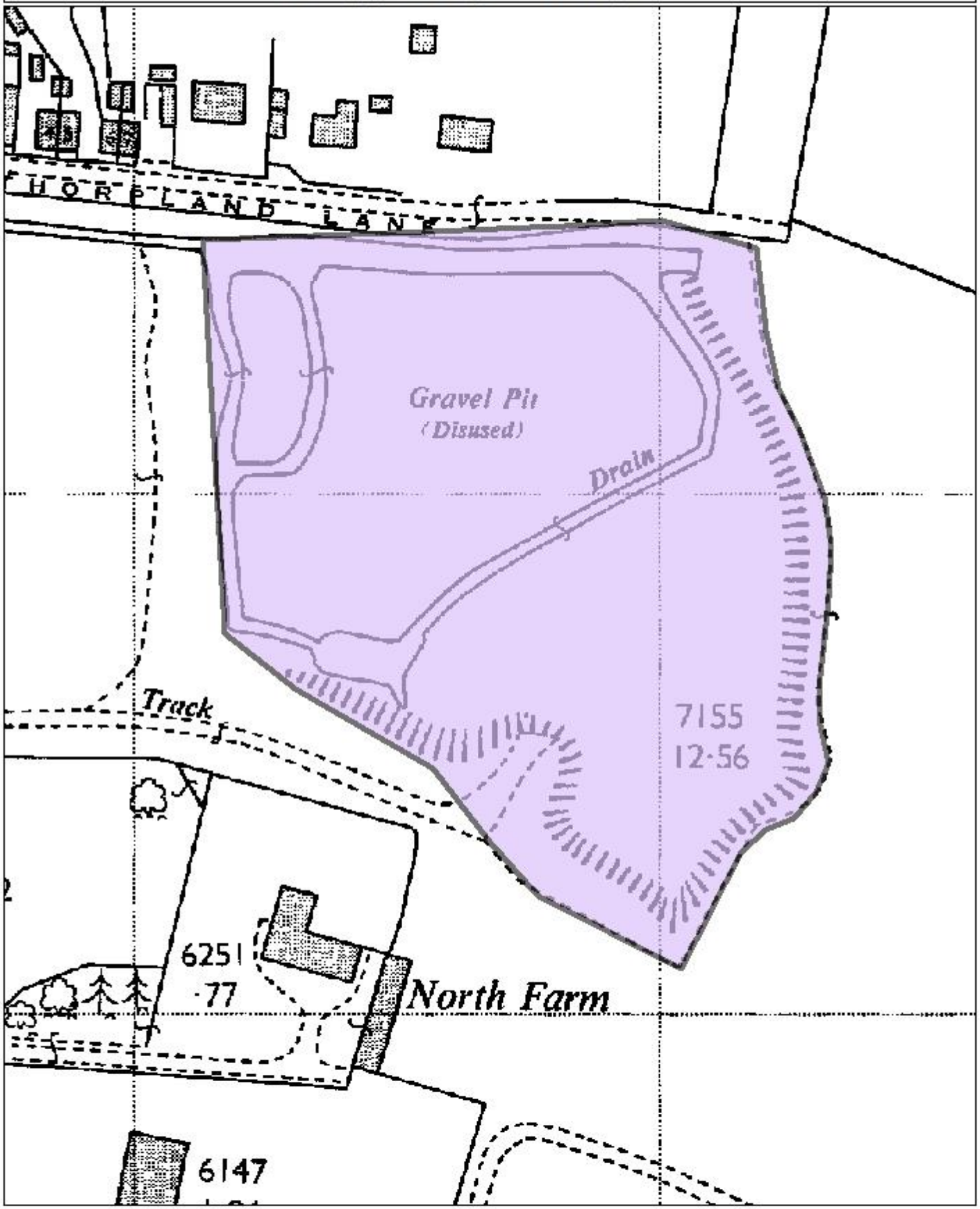
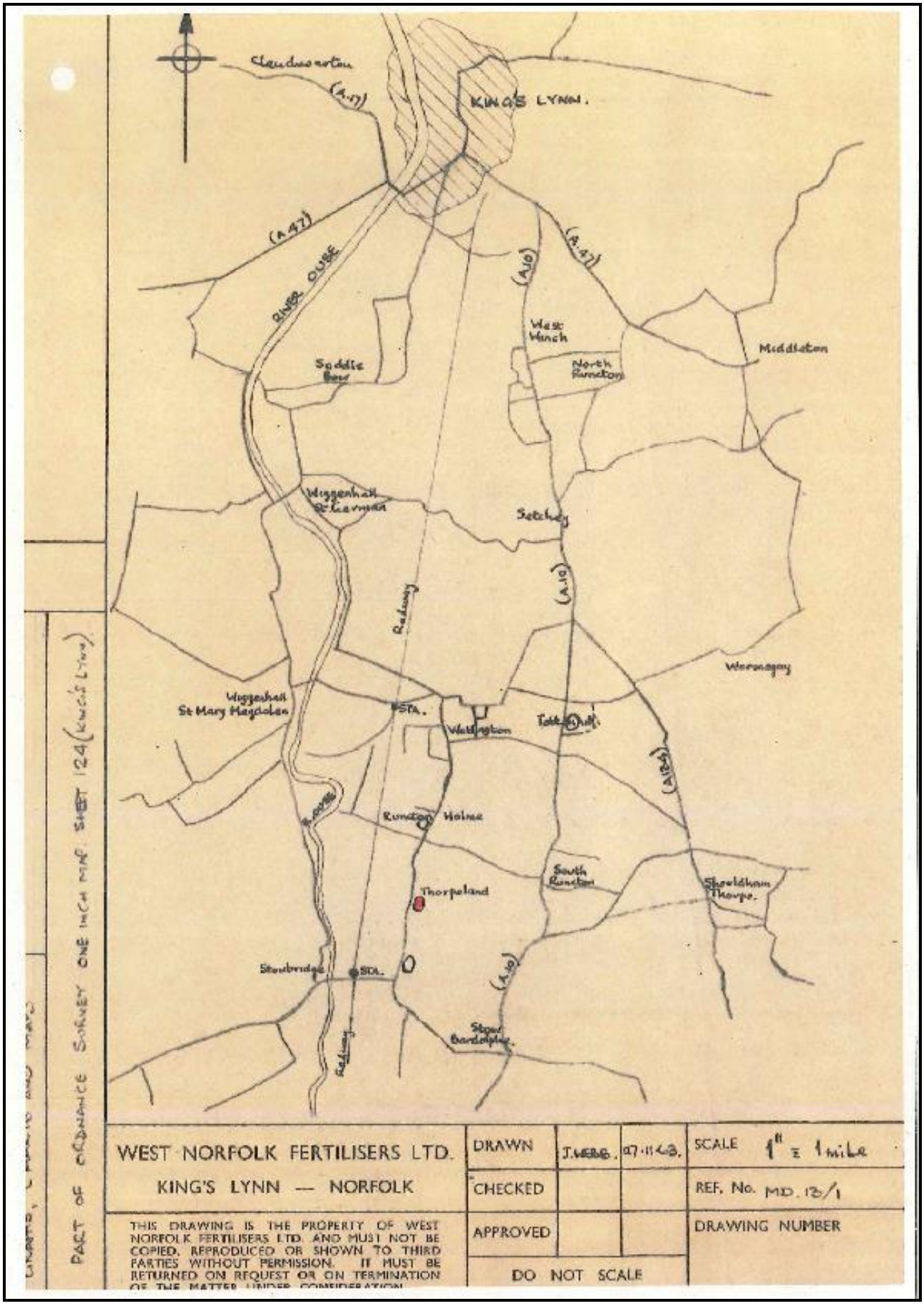


Borough Council of King's Lynn & West Norfolk Tel. 01553 616200 - Fax. 01553 691663	Title Historic Map 1904 - 1939	N W E S	Scale 1:1,000 Date May 2017
	Project / Details Land North of Thorpland House, Thorpland, King's Lynn		Drawn by EH&H Drawing / Reference Number CL203/005



Borough Council of King's Lynn & West Norfolk Tel. 01553 616200 - Fax. 01553 691663	Title Historic Map 1945 - 1970	N W E S	Scale 1:1,000 Date May 2017
	Project / Details Land North of Thorpland House, Thorpland, King's Lynn		Drawn by EH&H Drawing / Reference Number CL203/006

Location Plan from the Norfolk County Council Planning Permission



Appendix C – Further assessment of potential metal contamination.

Bismuth

Bismuth is a high-density, silvery, pink-tinged metal; its alloys with tin or cadmium have low melting points and are used in fire detectors and extinguishers, electric fuses and solders. It is weakly radioactive: its only primordial isotope, bismuth-209, decays via alpha decay with a half-life more than a billion times the estimated age of the universe.

The Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment report, COT Statement on the 2006 UK Diet of metals and Other Elements[9] reported that in the 'Safe upper levels for vitamins and minerals report of the Expert Group on Vitamins and Minerals[10] patients being treated with tripotassium dicitratobismuthate for 6 weeks, Gavey et al. found that a daily oral dose of 432 mg/day was without adverse effect. This dose is equivalent to approximately 7000 µg/kg body weight/day for a 60kg adult. The margin of exposure between this human therapeutic dose and the highest estimated dietary exposure (0.217 µg/kg body weight/day; high-level intake by preschool children) is 32300 (rounded to the nearest 100). This margin of exposure indicates a low concern for human health at the highest high-level dietary exposure. The Committee noted that doses used in medicines are very much larger than the estimated dietary exposure. The Committee concluded that dietary exposures to bismuth were unlikely to be of toxicological concern.'

The maximum recorded level of Bismuth was 0.2mg/kg (200µg/kg) which recorded in two samples only and equates to a 27th of the annual dietary intake of the average of pre-school children. As such the levels of bismuth present are not considered to represent a significant risk to human health, controlled waters or the environment.

Magnesium

Magnesium is a naturally occurring mineral and is essential for health. Magnesium is the eighth most abundant element in the Earth's crust, but does not occur uncombined in nature. It is found in large deposits in minerals such as magnesite and dolomite.

The recommended daily intake of magnesium is between 270mg and 300mg but having up to 400mg day is unlikely to cause any harm[11]. Therefore as the highest level of magnesium recorded is marginally over this at 416mg/kg it is considered that the level of magnesium within the phosphogypsum is not of significant concern to human health, controlled waters or the environment.

Manganese

Manganese is an essential element in all known living organisms. Manganese is the fifth most abundant metal in the Earth's crust. Its minerals are widely distributed, with pyrolusite (manganese dioxide) and rhodochrosite (manganese carbonate) being the most common. Some soils have low levels of manganese and so it is added to some fertilisers and given as a food supplement to grazing animals.

[9] https://cot.food.gov.uk/sites/default/files/cot/cotstatementtds200808.pdf
[10] https://cot.food.gov.uk/sites/default/files/vitmin2003.pdf
[11] http://www.nhs.uk/Conditions/vitamins-minerals/Pages/Other-vitamins-minerals.aspx#magnesium

The Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment report, COT Statement on the 2006 UK Diet of metals and Other Elements[12] the COT state; 'The EVM (Expert Group on Vitamins and Minerals[13]) considered that, based on the results of epidemiological studies of neurological effects associated with concentrations of manganese in drinking water, total manganese intakes of 12.2 mg/day for the general population (equivalent to 200 µg/kg body weight/day for a 60kg adult) and 8.7 mg/day for older people (equivalent to 150 µg/kg body weight/day) would not result in adverse health effects.'

Therefore as the highest level of Manganese detected was 1mg/kg the levels of Manganese present within the phosphogypsum is not considered to be a risk to human health, controlled waters or the environment.

Mercury
Mercury has no known biological role, but is present in every living thing and widespread in the environment. Mercury rarely occurs in a pure state in nature mostly as cinnabar (mercuric sulphide).

The Suitable 4 Use Level scenario Residential with home-grown vegetables is calculated using the inhalation of indoor vapours as the main driver for the risk assessment. On this site it is considered that the main risk drivers would be soil and dust ingestion. Therefore a more suitable scenario for the site has been chosen. The scenarios, allotments, and public open spaces (adjacent to residential properties (POSresi) and parkland (POSpark)), use the soil and dust ingestion pathway as their main risk driver. Therefore the scenario which provides the most conservative value (POSresi – 16mg/kg) has been chosen as a more suitable value to compare the results against.[14]

This would indicate that the levels of mercury are all below the assessment criteria, as such is not considered to be a risk to human health, controlled waters or the environment.

Platinum
Platinum was not recorded above the limit of detection, as such is not considered to be a risk to human health, controlled waters or the environment.

Strontium
Strontium is a naturally occurring element which commonly occurs in gypsum. It is an alkaline earth metal, strontium is a soft silver-white or yellowish metallic element that is highly reactive chemically.

Naturally occurring Strontium is generally none radioactive and in the Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment report, COT Statement on the 2006 UK Diet of metals and Other Elements[15] the COT state; 'There are no epidemiological data concerning the health effects of strontium, although there

[12] https://cot.food.gov.uk/sites/default/files/cot/cotstatementtds200808.pdf
[13] https://cot.food.gov.uk/sites/default/files/vitmin2003.pdf
[14] The LQM/CIEH S4ULs for Human Health Risk Assessment. ISBN 978-0-9931084-0-2
[15] https://cot.food.gov.uk/sites/default/files/cot/cotstatementtds200808.pdf

is a long history of clinical use of strontium in the treatment and prevention of osteoporosis, and relatively high levels of strontium (1700 mg/day) have been given without any clear evidence of toxicity. This dose is equivalent to 28 mg/kg body weight/day for a 60kg adult. The Medicines and Healthcare products Regulatory Agency (MHRA) issued a warning in November 2007 related to hypersensitivity reactions to the molecule, strontium ranelate (also known as protelos), a drug used to treat postmenopausal osteoporosis. The mechanism of this hypersensitivity is unknown and therefore it is uncertain whether it is related to the strontium ion, the molecule as a whole or a specific component. In rat studies, NOAELs of 190 mg/kg body weight/day (bone changes, 20-day study) and 15 mg/kg body weight/day (increased thyroid and pituitary weights, and increased thyroid activity, 90-day study) have been reported. The margin of exposure between the human therapeutic dose and the highest estimated dietary exposure (71.1 µg/kg body weight/day; high-level intake by pre-school children) is 400 (rounded to the nearest 10). The Committee concluded that current dietary exposures to strontium were unlikely to be of toxicological concern.'

As such the levels of Strontium detected in the samples of phosphogypsum are not considered to represent a significant risk to human health, groundwater or the environment.

Appendix D. Risk Assessment Methodology

The Model Procedures for the Management of Land Contamination (CLR11[16]) 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 practice[17] 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

[16] https://www.gov.uk/guidance/land-contamination-risk-management
[17] https://www.brebookshop.com/samples/142102.pdf

organism forming part of that ecosystem (note definition of ecosystem in 'Contaminated Land Statutory Guidance, April 2012');

- 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	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 This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High Risk	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. 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.
Moderate risk	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.
Moderate/Low risk	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.
Low Risk	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.
Very Low Risk	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.

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

Human Health

Category	
1	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. Land should be deemed to be a Category 1: Human Health case where: (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	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.
3	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.

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
Any ecological system, or living organism forming part of such a system, within a location which is: • 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.	The following types of harm should be considered to be significant harm: • 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. 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.	Conditions would exist for considering that a significant possibility of significant harm exists to a relevant ecological receptor where the local authority considers that: • 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. 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.

Property effects

Relevant types of receptor	Significant harm	Significant possibility of significant harm
Property in the form of: • 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.	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. 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. In this section, this description of significant harm is referred to as an "animal or crop effect".	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.
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.	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. 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. In this Section, this description of significant harm is referred to as a "building effect".	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.

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: (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.