**Folkestone and Hythe District Council**

# Former Gasworks, Ship Street Development

## Contaminated land evaluation in support of the planning application

Reference: SS12

Issue | 16 June 2025





Job number 293441

**Ove Arup & Partners Limited**
8 Fitzroy Street
London
W1T 4BJ
United Kingdom
arup.com

ARUP

# Document Verification

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| | | | **Prepared by** | **Checked by** | **Approved by** |
| | | **Name** | Rosie Holden | Nick Brown | Chris Barrett |
| | | **Signature** | [redacted] | | |
| | | **Filename** | | | |
| | | **Description** | | | |
| | | | **Prepared by** | **Checked by** | **Approved by** |
| | | **Name** | | | |
| | | **Signature** | | | |
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| | | | **Prepared by** | **Checked by** | **Approved by** |
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# 1. Introduction

## 1.1 Background

This contaminated land evaluation has been prepared by Ove Arup and Partners Limited ('Arup') on behalf of Folkestone and Hythe District Council Corporate Estates and Development Team ('the applicant') in support of an Outline Planning Application for the redevelopment of the Former Gasworks on Ship Street, Folkestone.

The site falls within the administrative area of the Folkestone & Hythe District Council ('FHDC') and therefore the FHDC Local Planning Authority ('FHDC LPA') will determine the planning application.

## 1.2 The proposal

This Outline planning application (with all matters reserved) is for the development of up to 135 homes (Use Class C3) at Former Gasworks site on Ship Street and up to 100sqm non-residential floorspace comprising flexible retail (Use Class E). The proposed development includes car parking, cycle parking, pedestrian and vehicular accesses; landscaping; refuse storage; servicing areas; and other associated infrastructure works.

Further details of the proposed development are set out in Section 2.2.

## 1.3 Purpose and structure

Arup has been commissioned to provide a summary of the status of ground contamination to support the submission of a planning application for development as residential and commercial use. It summarises the substantial previous investigations, assessments and remediation and sets out risk management and remedial options to enable safe and effective redevelopment once consent is granted. The report:

- provides a summary of previous works and likely requirements of further assessment;
- describes the way in which the proposed development has considered the site constraints and how these have been addressed within the scheme design;
- identifies potential risk management solutions and remedial options considering the current site condition, site constraints and proposed development; and,
- provides a roadmap for ground investigation, remediation and development actions that will be undertaken once consent is granted.

Arup has engaged with the Local Authority technical officer and Environment Agency on aspects relating to land contamination as summarised in Section 3.2.

The report is structured as follows:

- Section 1 sets out the scope of work.
- Section 2 describes the existing site and the proposed development.
- Section 3 describes the site background, including the site history, environmental setting and previous ground investigation and remediation works.
- Section 4 sets out a conceptual model.
- Section 5 sets out recommendations for additional ground investigation and risk assessment.

## 1.4 Scope of work

This report has been prepared to form part of the planning submission. The scope of works included:

- liaison with the Environment Agency and Local Authority;
- a review of reports detailing the previous remediation, groundwater and non-aqueous phase liquid (NAPL) monitoring and recent ground investigations;
- identifying data gaps or areas where additional investigation is required;
- review of the conceptual model and evaluation of potential contaminant linkages based on proposed redevelopment of the site for a residential led scheme;
- outlining the embedded measures within the proposed scheme which will break contaminant linkages; and,
- development of risk management and remedial options for additional remediation activities.

## 1.5 Limitations

This report has been prepared by Arup for use by FHDC in connection with the development of this site. It should not be relied upon by another other third party except as provided for in Arup's agreement with FHDC.

Arup has based this report on the sources detailed within the report text and believes them to be reliable but does not guarantee the authenticity or reliability of third-party information. Reasonable skill and care have been exercised in preparation of this report in accordance with the requirements of the agreed scope. Notwithstanding the efforts made by the professional team in undertaking this assessment it is possible that ground conditions other than those indicated by this report may exist at the site. Some of the ground investigation and monitoring data is old and may not be representative of current conditions and modern methods of analysis. Additional ground investigations and monitoring will be required.

This report considers the implications of ground contamination. It does not present a survey or assessment of the location, condition or liabilities associated with hazardous materials in the building fabric such as (but not limited to) asbestos containing materials, radiological sources, or lead.

This report has been prepared based on current legislation, statutory requirements, planning policy and industry good practice prevalent at the time of writing. Any subsequent changes or new guidance may require the findings, conclusions and recommendations made in this report to be reassessed in the light of the circumstances.

# 2. The site

## 2.1 Site description

The site is located between Folkestone Central Station, north of the town centre and harbour area. It is a 1.5 hectare (ha) site centred at National Grid Reference E622585 N136459 as shown in Figure 1 below.

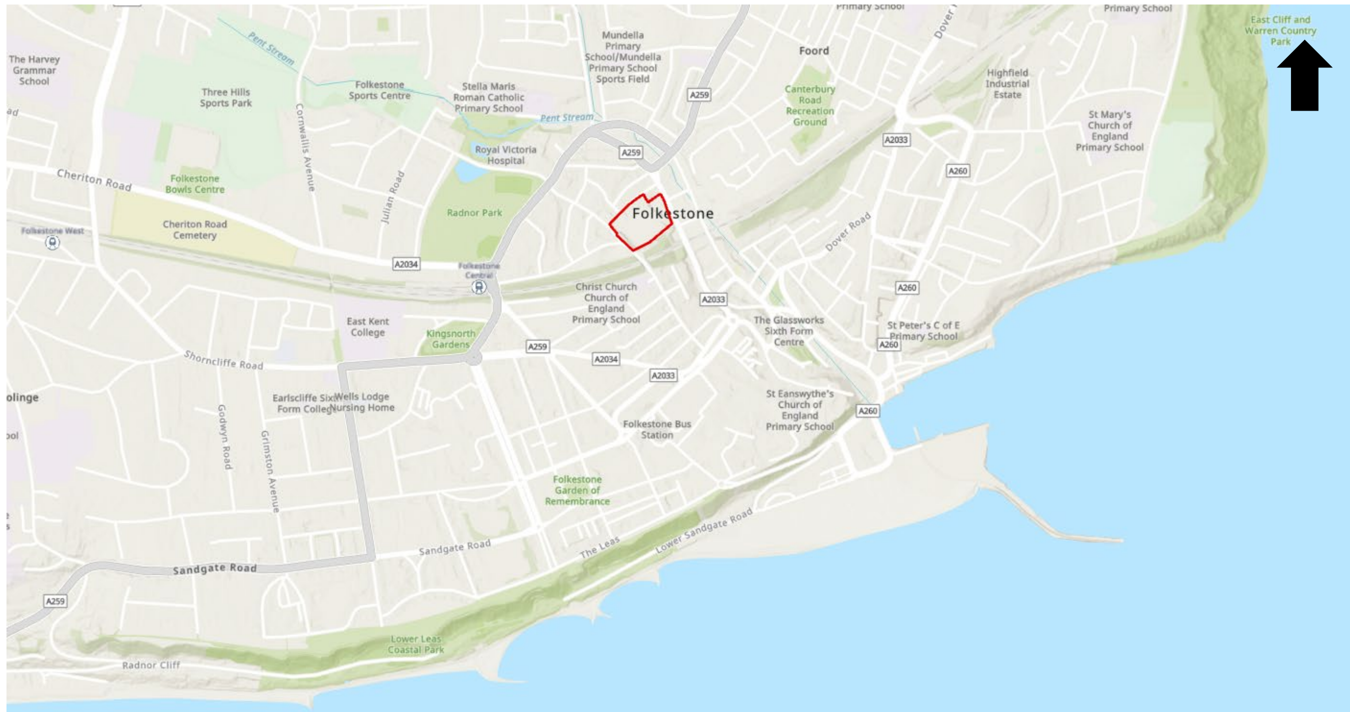



Figure 1 Site location

The site was historically a gas works, which has been mostly decommissioned and partially remediated. The site is currently vacant shrubland arranged over two levels. Features remaining onsite include brick retaining walls which create a series of level platforms and border the site and an operational Scotia Gas Networks (SGN) governor compound including an electrical substation in the northeast as shown in Figure 2.

The elevation varies from approximately 23.5m Ordnance Datum (OD) in the west and centre of the site on the higher level and approximately 18m OD on the lower level in the east. A ramp is present in the centre of the higher level leading to a gate on the northern boundary and in the southwest behind the retaining wall is a vegetated strip of land at approximately 31m OD. Ramps are present in the southeastern corner of the site one leading down to the lower level, and one larger ramp leading to the higher level.

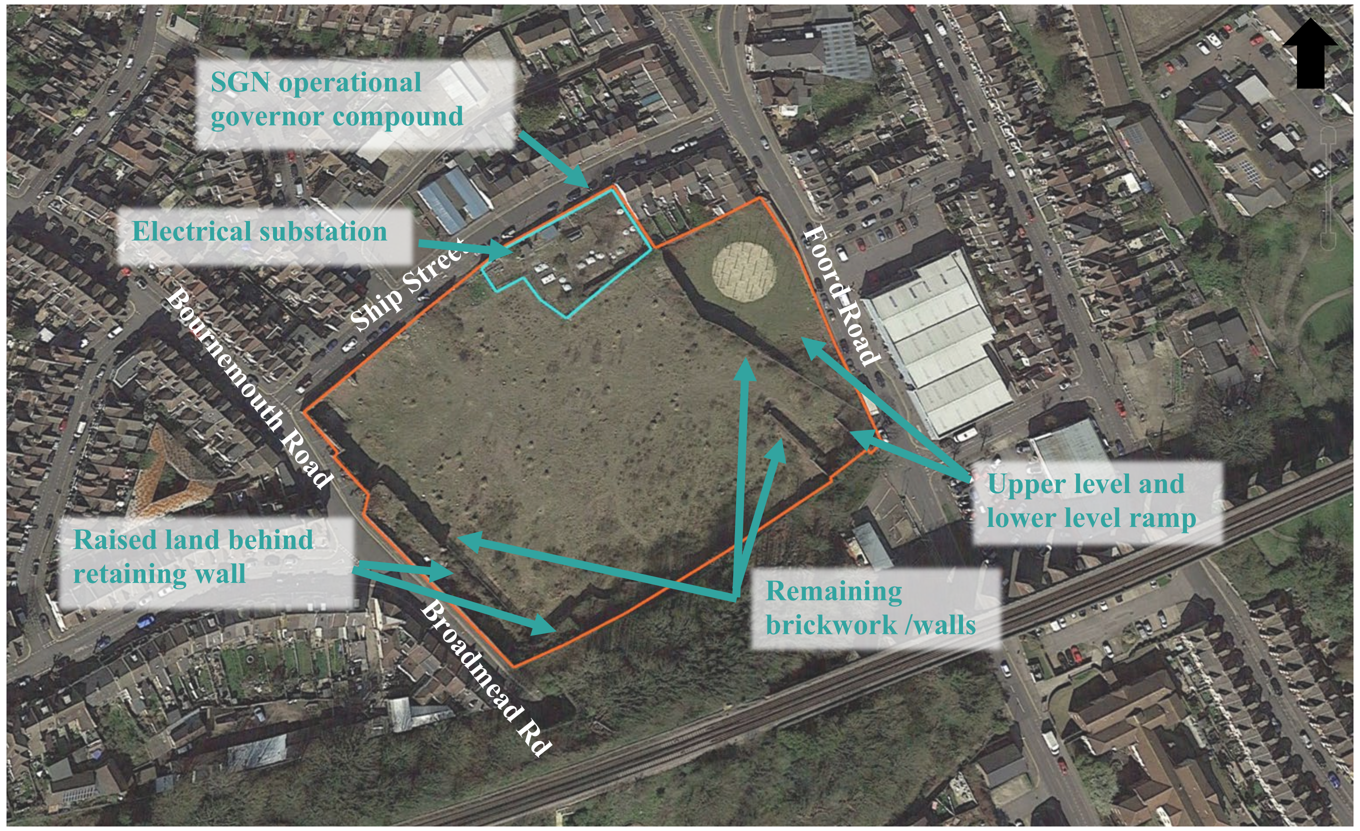



Figure 2 Site layout and surrounding area

The site is located at Ship Street, approximately 500m east of Folkestone Central Station and approximately 600m north of Folkestone town and harbour area. The site is bound by Ship Street to the north, Foord Road in the east, Bournemouth Road leading into Broadmead Road in the west and a vegetated embankment which forms part of the railway viaduct in the south. The site is positioned in a primarily residential area and residential properties directly border the site in the northeast.

## 2.2 Proposed development

The proposed development includes up to 135 new homes with car and cycle parking spaces and soft and hard landscaping. At least 5% custom-build homes are to be provided within the development under a customisable home model.

The proposed outline parameters provide flexibility for the future reserved matters applications to provide a mix of houses and apartments, of an appropriate size and tenure mix.

Parameter Plan 1 sets out the maximum heights of each block, which are as follows:

| Block | Maximum eaves level (OD) | Maximum ridge level (OD) |
|---|---|---|
| A | 41.5m | 38.5 |
| B | 41.5m | 38.5m |
| C | 32.5m | 35.5m |
| D | 33.6m | 35.6m |
| E | 33m | 36.5m |
| F | 33m | 36.5m |

Two priority access junctions are proposed on Ship Street, which link to the primary internal vehicular loop road through the site. A secondary internal route is proposed at the northern part of the site, connecting with the loop road on the western and eastern side.

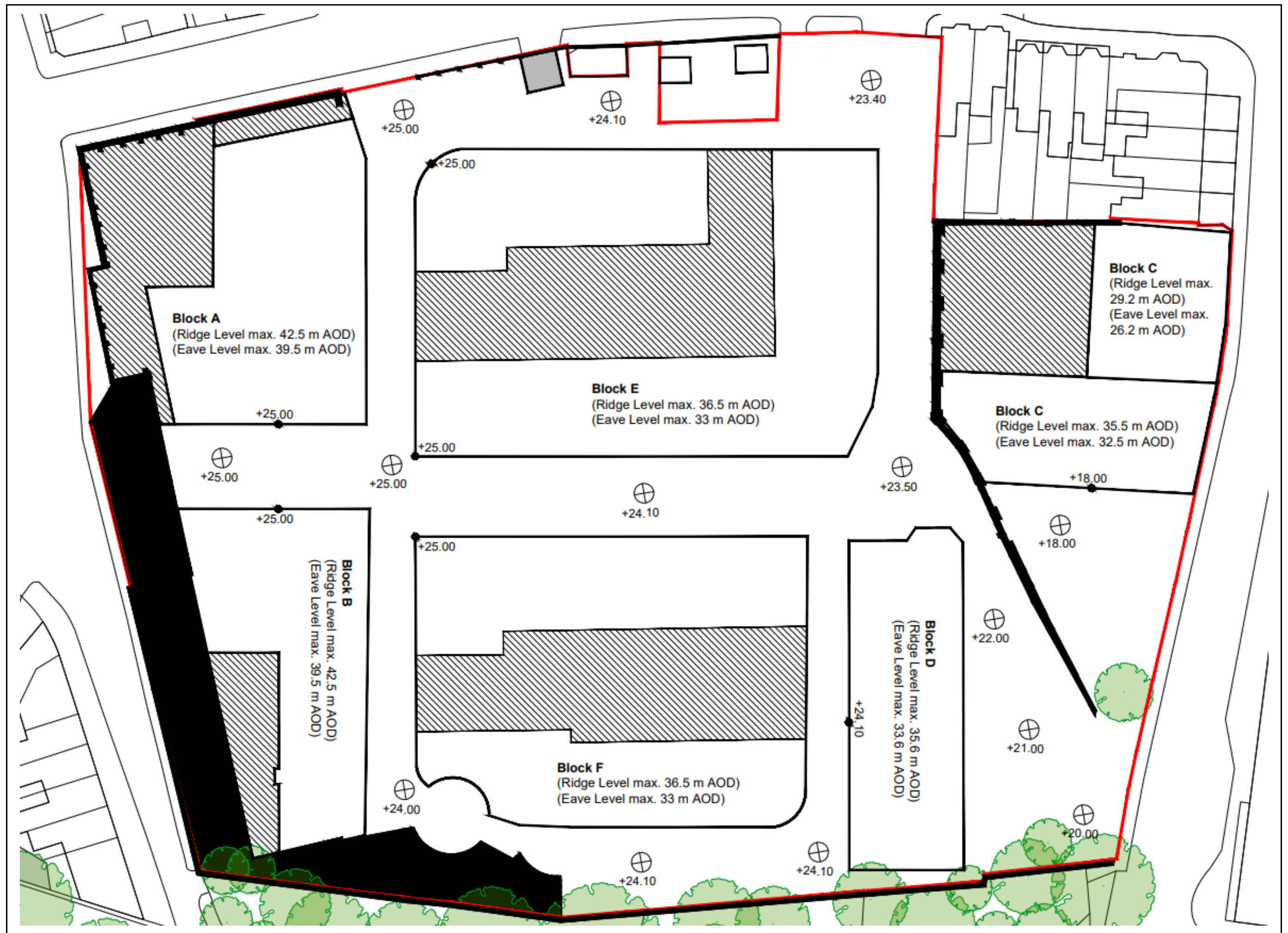
In terms of parking, a total of three car parking areas are proposed; two accessed from the loop road and one accessed from Foord Road.

For pedestrians, a new Green Link is proposed to run roughly through the centre of the site connecting Bournemouth Road in the west with Foord Road in the east. The Green Link aims to increase the permeability and public access of the site, while providing a new shared green amenity for the new neighbourhood. Secondary pedestrian access points are proposed from Ship Street along footways adjacent to the loop road.

Cycle access is proposed via the site access points on Ship Street, along the loop road on site.

The proposals include the demolition of some existing boundary walls and small ancillary structures, as shown on the demolition plan (ref. 1788-FPA-ZZ-00-DR-A-10001).

In addition, the scheme includes the retention of the historic perimeter brick walls on the corner of Bournemouth Road and Ship Street, the vaulted retaining walls on the western boundary of the site and to the east of the site. It is also proposed to open up the arches of the former perimeter brick walls on the corner of Bournemouth Road and Ship Street that were bricked up in the past.




Extract from drawing number 1788-FPA-ZZ-00-DR-A-05002-P01

**Figure 3 Proposed masterplan**

The development includes a mix of apartments and terraced housing with private gardens and will be split on two levels. The foundations are likely to include shallow pad or strip foundations for the terraced housing and pile foundations for the apartment blocks. The proposed development does not include any buildings with basements.


The current elevation varies across the site and the previous remediation (discussed in Section 3.6) resulted in the site being left at 0.6m below the original ground level. To create a level development platform suitable for the proposed development, earthworks will be required.

# 3. Site background

## 3.1 Information sources

The following sources of information have been reviewed and assessed within this report:

- client supplied information including eight reports on previous ground investigations, assessments and summary statements including the RSK 2022 Phase 1 and Phase 2 report [1] which includes a commercial environmental search report in Appendix D;
- information from the National Gas Archives (included in Appendix A); and,
- readily available online sources including Groundsure.io [2], Layers of London [3], Folkestone and Hythe planning portal [4], Historic England aerial photo explorer [5] and British Geological Survey (BGS) GeoIndex Onshore [6].

A summary of reviewed documents and information sources is presented in Section 3.3 (site history), Section 3.5 (environmental setting) and Section 3.6 (contamination status).

### 3.1.1 Previous reports

Previous information on the site has been sourced from the planning portal and provided by the client. The reports reviewed to inform this report are outlined below.

- Mouchel Parkman (2008) Environmental Improvement Strategy [7]. A partial copy of the report underpinning the remediation works.
- Mouchel (2010) Factual Verification Report on Environmental Soil Improvement Works [8]. This report details the first phase of remediation completed in 2009 comprising below ground structure removal, source removal and material treatment.
- WSP (2012) Residual NAPL Recovery Validation Report (Redacted) [9]. This redacted report provides the factual summary of the WSP NAPL remediation.
- Idom Merebrook (2015) Letter regarding Ship Street, Folkestone, Site appraisal [10]. A letter from Idom Merebrook to the Local Authority Environmental Health officer providing an assessment of the ground conditions ahead of the acquisition of the site by Shepway District Council.
- Knapp Hicks and Partners Ltd (2015) Letter regarding pre-purchase engineering assessment, former gasworks site, Ship Street, Folkestone [11]. This letter was prepared to provide an assessment of the site including an assessment of the retaining walls, obstructions and a summary of the further investigations/ assessments required.
- Worley Parsons (2015) Letter regarding Ship Street, Folkestone, Groundwater and NAPL monitoring (Redacted) [12]. This letter from Worley Parsons to National Grid, outlines the groundwater monitoring completed between November 2014 and January 2015. The letter is heavily redacted.
- Advisian (2017) Factual Groundwater Monitoring Report (Redacted) [13]. A factual report detailing the findings of the 2016 groundwater monitoring.
- Advisian (2020) Factual Land Condition Summary Statement NGPH Site, Ship Street, Folkestone [14]. A short summary of the groundwater monitoring completed by Advisian.
- RSK Geosciences (2022) Former Gasworks Site. Phase 1 and Phase 2 Geoenvironmental Factual and Interpretive Report [1]. The most recent ground investigation data for the site which includes an assessment of the ground conditions, NAPL, groundwater and ground gas.
- Ecologia (2022) Preliminary Outline Remediation Cost Assessment. Former Gasworks Site, Shop Street (typo), Folkestone, CT19 5BE. Ref EES 22.092.1 [15]. An outline cost assessment provided to Folkestone and Hythe District Council.

## 3.2 Regulator engagement

#### Local Authority

A meeting with the Local Authority was held on the 14th September 2023. Arup presented slides that provided background information relevant to the site's contamination status, outlined the proposed development and discussed the embedded and potential remediation measures which will be required. The requirement for further investigation was discussed including further investigation of vapour risk and additional ground investigation within the unremediated areas including the SGN operational compound.

#### Environment Agency

A meeting with the Environment Agency was held on 10th October 2023. The Environment Agency provided a written response to the meeting in November 2024, included in Appendix B. The scope of works outlined in the meeting was accepted in principle by the Environment Agency. The Agency agreed further ground investigation and conceptual modelling of the site would be required. They also highlighted:

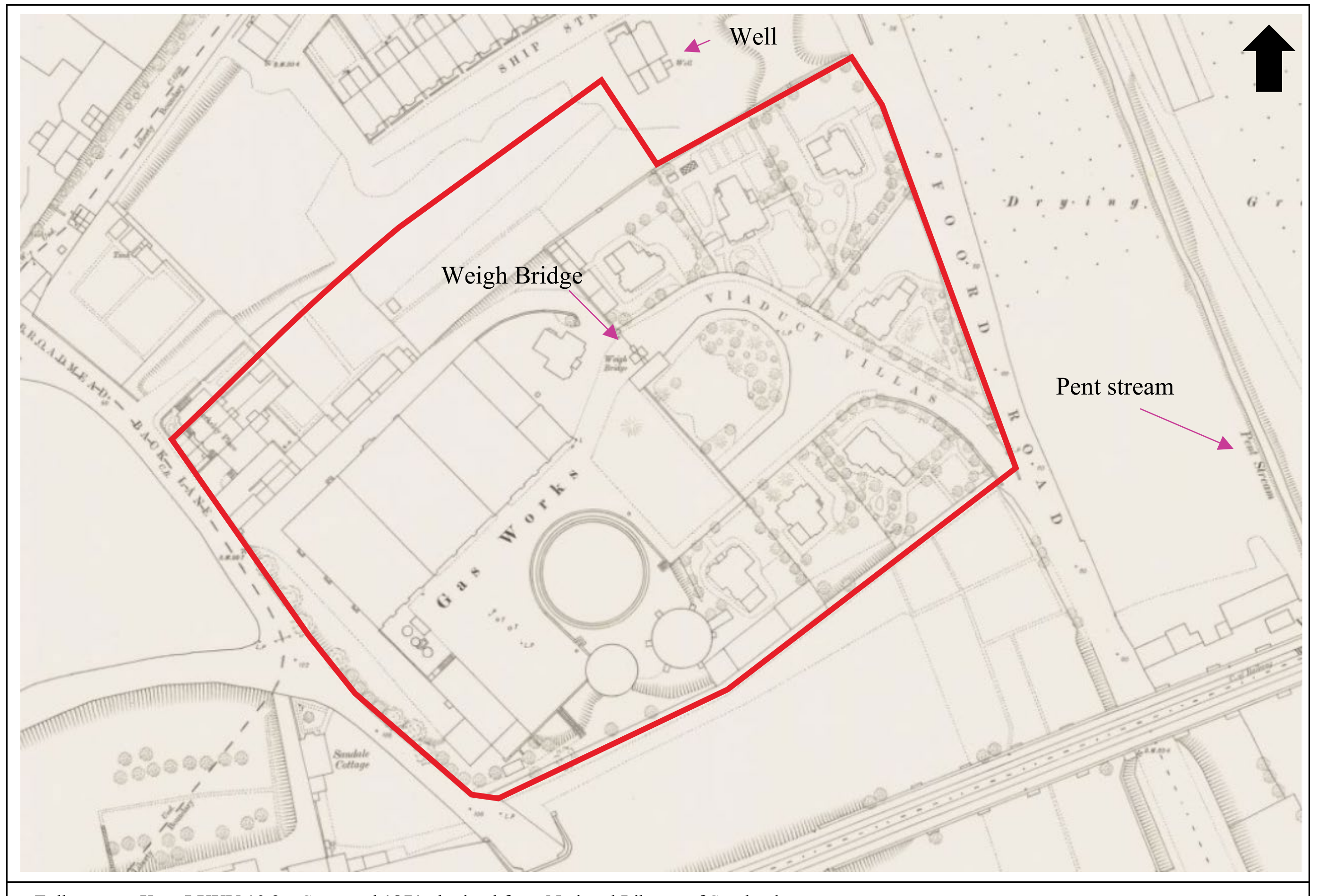
- the Pent Stream should be considered as a receptor to the site and additional sampling upstream and downstream maybe required.
- If monitored natural attenuation (MNA) is selected as a remedial method in the future a sufficient data set and detailed risk assessment would be required to support the use of this method.
- A piling risk assessment would be required.

During the initial consultation with the Environment Agency, they also noted that although the Folkestone formation, which is a principal aquifer, is not currently a well exploited groundwater resource, this could change in the future. Although the groundwater body is listed as 'poor' they have a duty to reverse it to good, therefore the poor status would not result in a position to reduce the end point. This principle should be considered in appropriate risk assessments of new data and remediation options appraisal.

## 3.3 Site history

The Folkestone Gas & Coke Company was established in 1842 with the first site located at Beach Gasworks in Folkestone [16]. The Foord Road site was acquired in 1866 and gas production commenced within the year [16]. Coal was brought onto site by lorry from Shorncliffee station due to the lack of railway sidings on the site. [16](Appendix B). The first available historic mapping surveyed in 1871 presented in Figure 4 shows that the gasworks and associated infrastructure occupied the south, centre and west of the site including a gasholder and two large tanks in the south and two smaller tanks and a pump in the centre of the site.

Several large and small residential premises occupied peripheral areas of the site and a weighbridge off 'Viaduct Villas' was present at the gas works entrance. Pent Stream was shown approximately 50m east of Foord Road transecting a 'Drying Ground'. A well was located approximately 30m north of the site associated with a residential property. The railway and viaduct ran east to west approximately 50m south of the site boundary.




Folkestone - Kent LXXV.10.3 – Surveyed 1871 obtained from National Library of Scotland.

Figure 4 1871 Kent map showing the site and surrounding area.

Historical mapping from 1898 shows the gasworks had expanded to cover the site. Two additional gasholders had been constructed in the centre and northeast of the site and a large, unmarked building occupied the northwestern corner of the site as shown in Figure 5.

Various small buildings, tanks and structures were present around the site. Historic records shown in Appendix B show the gasworks included retort houses, coal stores, boilers, condensers, benzole plant, carburetted water gas (CWG) plant, tar and liquor pumps, a blacksmiths forge, gas oil tanks and a livesey washer, a rotary washer in addition to the three gasholders and two large tar tanks.

Significant residential development occurred in the surrounding area during the latter part of the 19th Century. Pent Stream was culverted during this period, only small stretches to the north of the site and south of the viaduct are visible on the 1898 map, the rest of the stream having been buried under residential development.

Figure 6 on the next page shows the gasworks, photographed from the air in 1949; the layout appears to be same as in 1898. The site remained in this configuration with minor additions of buildings, tanks and small-scale structures until 1956. In 1949, the site company was dissolved, and vested in South Eastern Gas Board under the Gas Act 1948 [18]. The South Eastern Gas Board was nationalised and became part of the Dover Group of the Kent County Division of SEGB. The gasworks was closed in 1959 and replaced by a site in Coombe Valley Road, Dover [17].

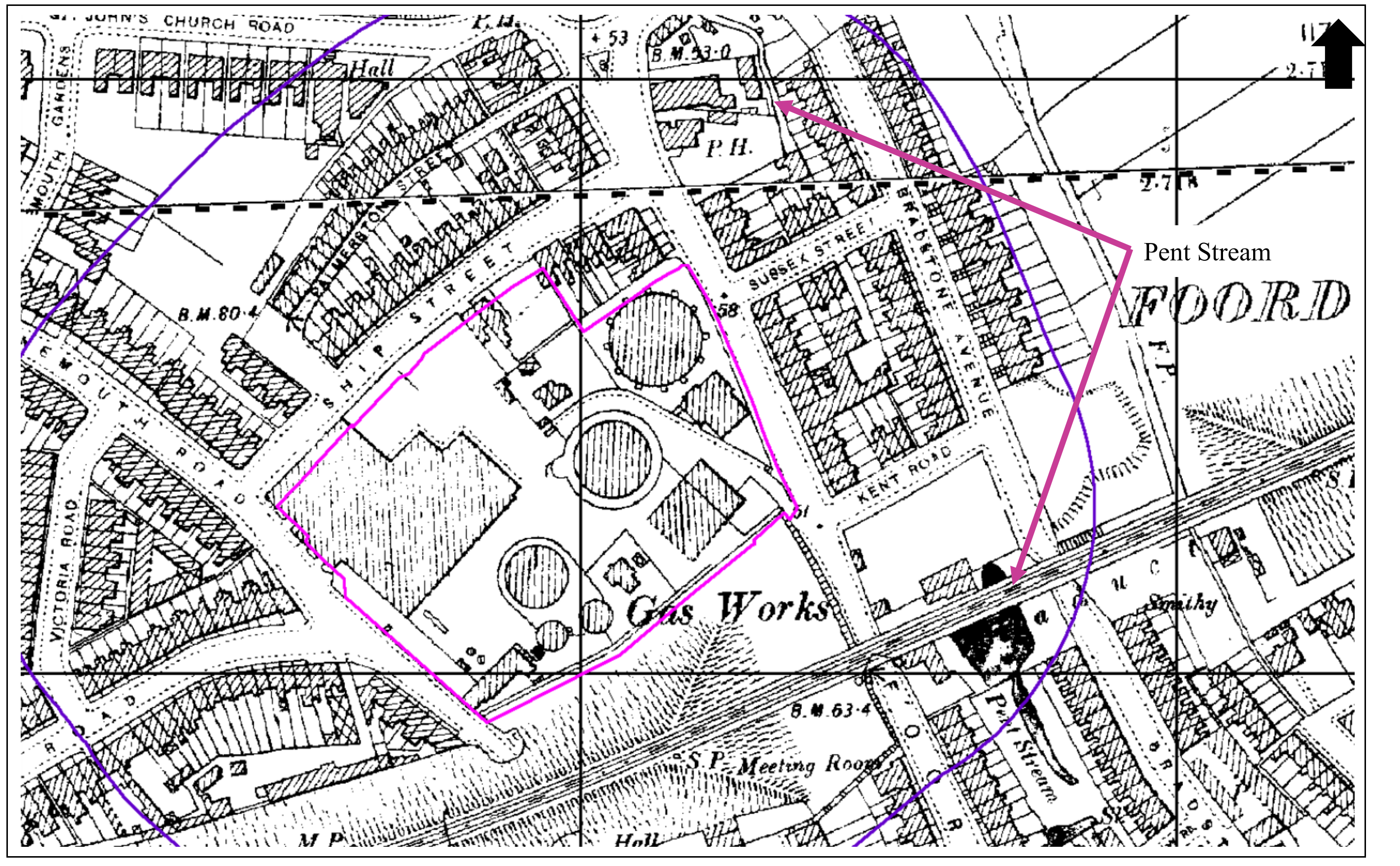



Figure 5 Extract from RSK Landmark report. 1898 1:2500 scale map

A large proportion of the site was demolished between 1960 and 1964, with the gasholders remaining for storage purposes until 2001 when gasholders No.3 and No. 2, which had below ground tanks, were dismantled and backfilled. Based on the information provided in the 2007 Environmental Improvement Strategy [7] the bases of Gasholder No. 2 and No.3 were approximately 7m below the original ground level and remain in situ. Gasholder No.1 was also dismantled in 2001 but comprised an above ground structure with a concrete slab at ground level [19]. The internal retaining walls, part of a tank structure and red brick perimeter walls are the only remaining structures from the gasworks onsite.

In the early late 1960's an electricity substation shown on site along the northern boundary in part of the site now referred to as the SGN operational governor. A plan from 1967 (included in Appendix A) shows the boosters (electric and diesel), pipework, valves and an anti-freeze tank. The SGN operational governor area was further developed in the late 1980's and currently contains a gas pressure reducing station and associated infrastructure including a large bunded tank with unknown contents and electrical substation.

In 1973 an area in the southwest of the site, was sold to Acrow Engineers for use as a storage depot and refuelling facility, later this part of the site was then sold to Rentokil who used the site as a storage area [1]. National Grid Property holdings then bought this part of the site in 2005. Remediation of the site was undertaken in several phases between 2009 and 2011 (discussed further in Section 3.6.1 below).

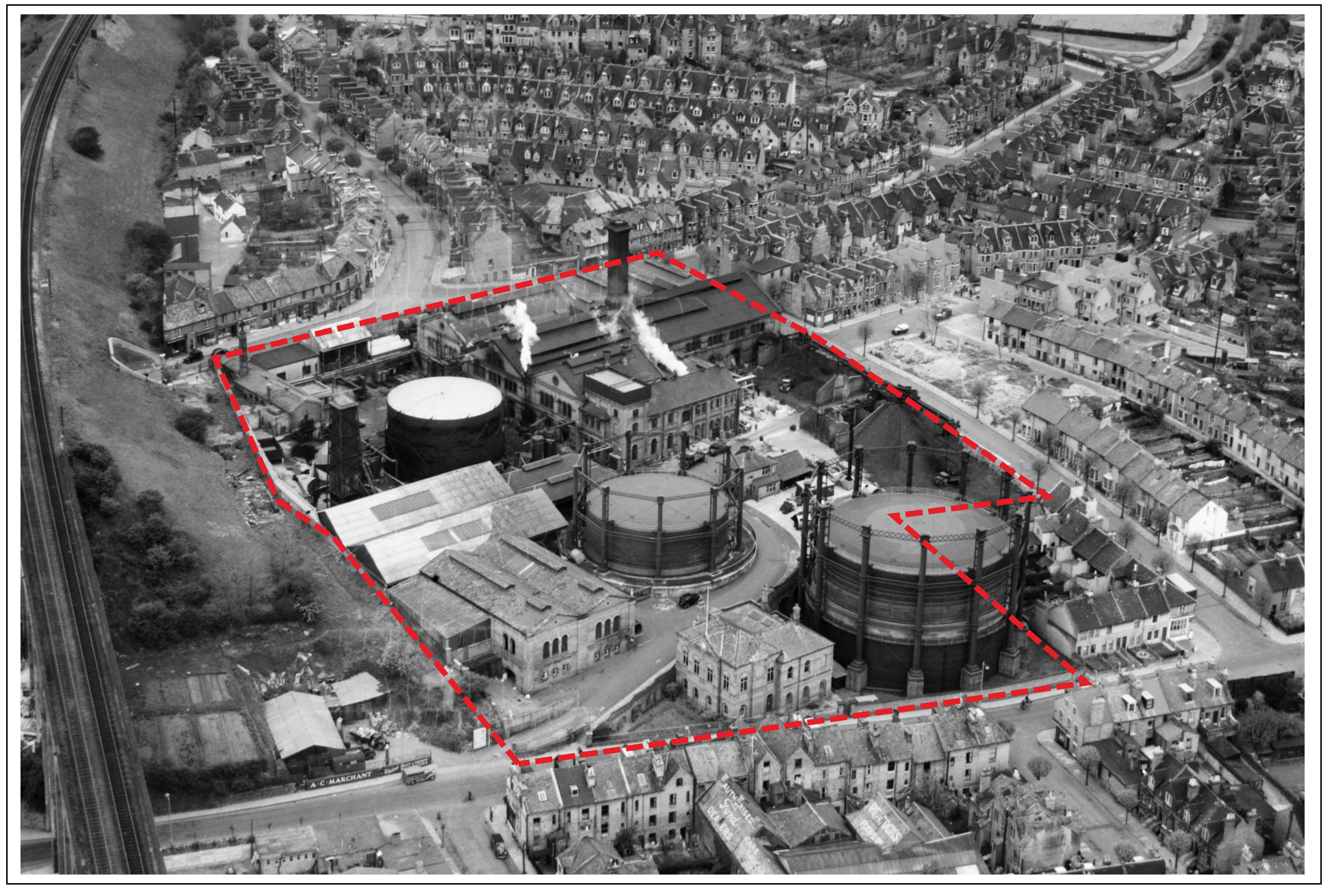


Figure 6  1949 aerial imagery EAW023048 © Historic England Archive

Figure 7 is an aerial photograph from 1960 which shows the partial demolition of the site.

Figure 7  Extract from Google Earth 1960 aerial photography

In 2014, in the northeast of the site within the previous Gasholder No.3, an art installation including a series of lights was installed; it is still present. The site was bought by Folkestone and Hythe District Council in 2021.

## 3.4 Environmental database search and Local Authority records

Further information on potential contaminative uses, environmental permits, landfill records, and environmental incidents, discharge consents and incidents is provided in the RSK 2022 report [1]. A summary is provided below.

- There are no active or historic landfills within 500m of the site boundary.
- The site was registered on the contaminated land register. The register notes remediation was completed in 2010. The local authority search confirmed the site has not been identified as Part 2A.
- There is only one Integrated Pollution Prevention and Control record within 250m of the site relating to Invicta Motors located 22m east of the site.
- An environmental information request was completed by RSK for the site in April 2022. The response confirmed there are no current tanks onsite, and there was no monitoring taking place at the site at the time of writing.

## 3.5 Environmental setting

### 3.5.1 Geology

The stratigraphy of the site is based on published records such as BGS and previous ground investigation records. The stratigraphy sequence comprises Made Ground over the Lower Greensand beds which comprises Folkestone Formation, overlying Sandgate Beds as shown in Figure 8.

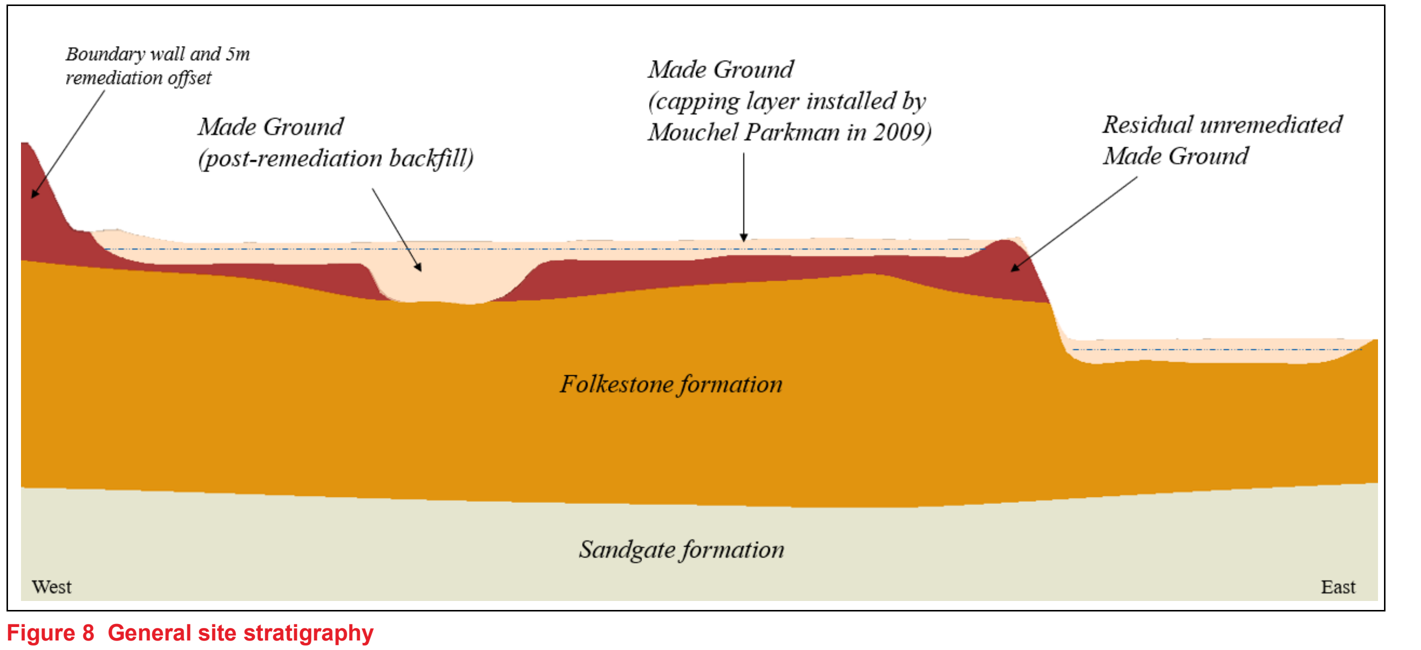



Figure 8  General site stratigraphy

Remediation was undertaken across the site in 2009 [8], discussed further in Section 3.6.1. Historical structures such as tanks, foundations, pipework, concrete slabs and part of the gasholder structures were removed as part of the first phase of remediation. The remediation also included excavation of significantly contaminated soils and gross contamination across the site and around historical structures. The material was segregated and stockpiled onsite and screened against site specific remediation target values, discussed in Section 3.6.1 below. Material that met these criteria was used as backfill across the site. The excavation areas were then capped with 600mm of site won crushed concrete. The site was left at 600mm below the previous ground level.

Table 1  Summary of stratigraphy based on RSK 2022 investigation data

| Stratum | Elevation of top of stratum (mOD) | Thickness (m) |
|---|---|---|
| Made Ground | +25.5 to +18.0 | 0.2 to 5.6 |
| Folkestone Formation | +23.6 to +18.1 | 9.9 to 15.45 |
| Sandgate Formation | +10.7 to +6.7 | Not proven |

### 3.5.2 Hydrogeology and hydrology

The Environment Agency designates the Folkestone Formation as a principal aquifer and the underlying Sandgate Formation as secondary A aquifer. The site is not located within 1km of a source protection zone (SPZ) and the closest permitted water abstraction point is from Pent Stream approximately 440m northwest of the site.

The closest surface water receptor is the Pent Stream located approximately 50m northeast of the site boundary. The stream has been culverted as it passes the site, since the late 19th century. The aerial imagery and historical maps indicate a short section of the stream an open culvert near the junction of Foord Road and Blackbull Road behind the social club and under the building but is otherwise a covered culvert until it discharges into Folkestone Harbour.

DNAPL and LNAPL has been recorded during previous investigations and monitoring by Worley Parsons (who became Advisian) [12] [13] and RSK [1]. During the RSK 2022 investigation[1], groundwater levels recorded in boreholes that were not impacted by NAPL were recorded between 16.93m OD and 18.13m OD in the Folkestone Formation.

The groundwater levels indicate a groundwater flow direction to the east and southeast. Due to the proximity of the site to the sea, there is the potential for tidal variation at the site. We have not seen continuous groundwater level monitoring to establish this.

Perched water was recorded in the Made Ground in two locations during the RSK 2022 investigation [1]. Both locations were positioned on the lower level in the east of the site in an area which is anecdotally prone to flooding.

### 3.5.3 Ecological designations

There are no ecologically designated sites within 250m of the site boundary [1].

## 3.6 Contamination status

The following section is based on information provided in the seven reports or letters outlined in Section 3.1. Various phases of ground investigation were undertaken between 1998 and 2006 prior to the remediation being completed. These are discussed further in the Mouchel Parkman factual verification report [8] and are not discussed further in this report. This report has focused on the completed remediation and ground investigation information obtained since the remediation, to support understanding of the current ground conditions.

### 3.6.1 Previous remediation

Previous remediation was undertaken in two phases between 2009 and 2011 in line with the 2007 Mouchel Parkman Environmental Improvement Strategy [7] which was agreed with the regulators prior to commencement. The aim of the improvement strategy was to deliver a site '*generally suitable for a residential development comprising flats with managed landscaping in contained beds, no gardens, with the possible inclusion of light commercial properties (shops)'* [8]. This strategy would have been based on standards and agreed methods appropriate at that time, some of which have evolved significantly over the last 15 to 20 years

Phase one, completed in 2009 by Mouchel Parkman included excavation of the Made Ground across the site to approximately 2m bgl for processing. Processing included screening, crushing oversized materials and separation of contaminated material. The excavations were then backfilled with a combination of acceptable site won materials which included suitable demolition rubble and imported material to a level between 0.6m and 0.8m below the original ground level (bogl). Verification sampling was completed, and chemical results were assessed against remedial target values (RTV) which had been agreed as part of the Environmental Improvement strategy.

During the excavations, residual foundations and substructures were encountered and removed where possible. Due to restrictions the following three areas, shown on Drawing 1 and Figure 9 in blue, were not remediated;

- The operational SGN governor station in the north.
- Within 5m of all retaining walls structures including in the south of the site around a historic tar tank.
- In the northeast of the site, along a common boundary wall.

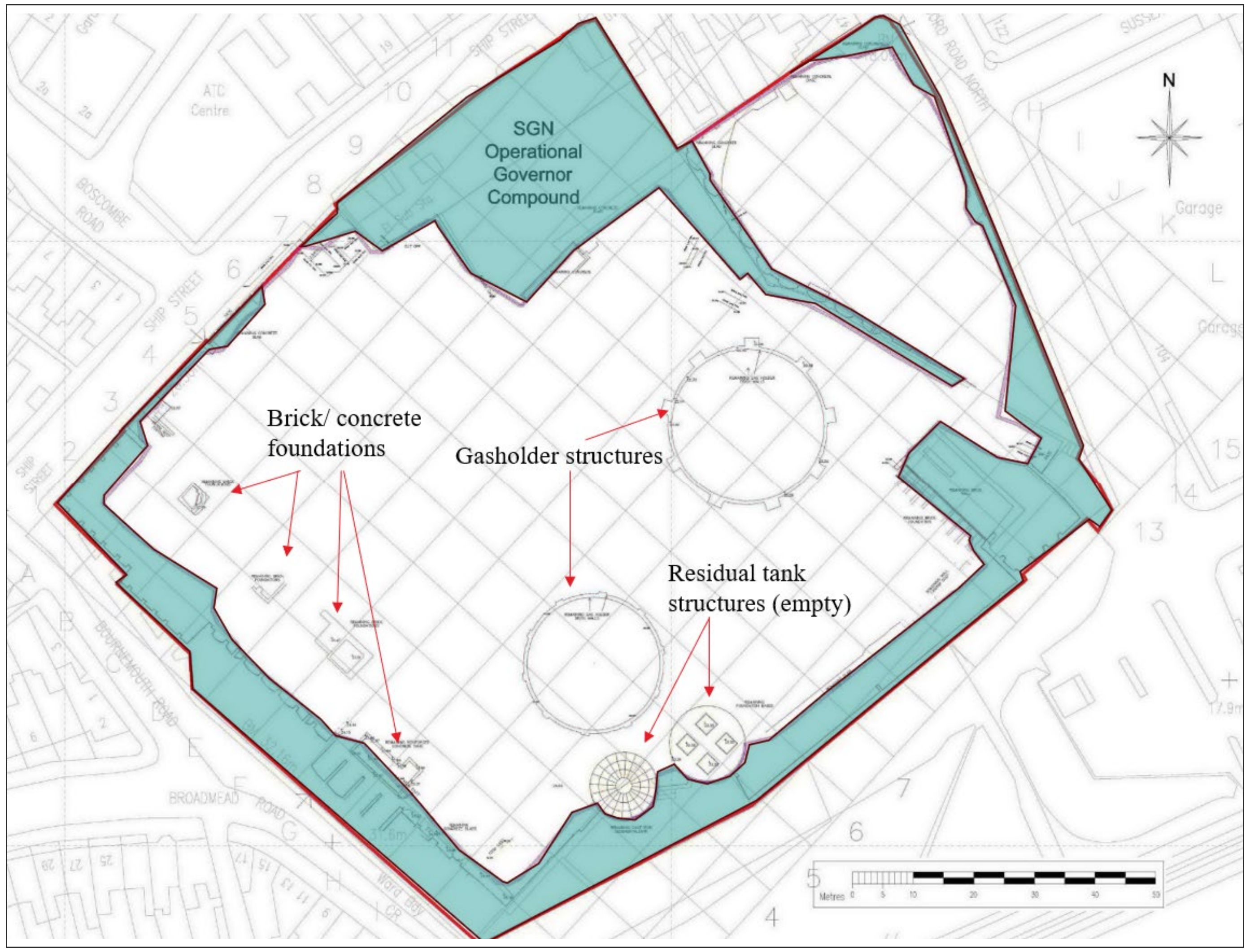



Figure 9 Remaining obstructions and un-remediated areas (shown in blue)

The second phase of remediation completed in 2011 by WSP targeted free phase contamination in the aquifer. The objectives of this phase were to (1) prevent free phase migration offsite and (2) to treat free phase hydrocarbons, both 'as far as reasonably practicable' as defined at that time.

Ground gas and vapour monitoring was completed in 2003 prior to the remediation works. The quantitative risk assessment completed by Mouchel Parkman [8] suggests methane, carbon dioxide and volatiles were not significant based on their methods. Additional monitoring and assessment are required for further development of the site to current standards.

#### 2009 Mouchel Parkman remediation

The Mouchel Parkman remediation was completed between February and October 2009. This first phase of remediation included the excavation of 25,000m$^3$ material; 18,000m$^3$ of soft material and 7,000m$^3$ hard material (crushed concrete). Where possible material was processed and treated onsite and used to backfill the excavation. Unsuitable material was removed from site and disposed of appropriately. This resulted in 8,000 tonnes of material disposed of as hazardous waste.

The excavation depth was on average 1.5m bogl. Excavation extended locally where visual or olfactory evidence of contamination was noted and up to 6m bogl in the areas surrounding historic tanks. The site was backfilled to 0.6m bogl with site won material. This was approximately 21,000m$^3$ comprising 14,000m$^3$ of soft material and 7,000m$^3$ crushed concrete and 100 tonnes of type 1 natural sand quarry material which was used within the former compound area to increase levels. The site was capped with 0.6m of geotechnically classified site won material.

A narrow trench was dug in the northeast of the site, around the gasholder base to investigate the presence of NAPL as shown on Drawing 1. The trench was to approximately 1.6m bgl with two sections reaching a maximum depth of

2.1m bogl. An oily sheen was noted on the surface of perched groundwater which accumulated within the pit; the trench did not extend deep enough to encounter groundwater of the Folkestone Formation principal aquifer.

Validation sampling was completed on a 20m grid from the base and wall of the excavation areas and stockpile testing of site won material was completed on every 500m$^3$ of stockpiled material. Chemical results were screened against RTV which were derived as part of the quantitative risk assessment report which underpinned the Environment Improvement Strategy. The RTV are based on human health risks and did not consider the risk to controlled waters.

The results from the stockpiles of material used for backfilling were all below the RTVs, with most over an order of magnitude below the RTV. The results from the samples collected at the walls and base of the excavations were below the RTVs for metals, total petroleum hydrocarbons (TPH), phenol, and cyanide. A few results were above the RTV's for pH and benzo(a)pyrene. The mean results for both these determinands were below the RTV.

In some areas, excavation could not be completed without compromising stability of the remnant walls such as within the 5m offset zone of the retaining walls, and between large structures such as the tanks in the southeast of the site, and between the retaining wall and the railway embankment in the south. Within these areas, validation pits were completed, and samples collected and compared against the RTVs. The results from the pits collected between the tanks and within the standoff zone next to the entrance of the site were confirmed as compliant with the RTVs.

In August 2009, 14 samples were collected from 16 trial pits located at various points across the site within the backfilled material. These results were compared against the pre-2009 remediation investigation results, 29 samples collected from stockpiles during the works and the RTVs. Overall, the samples recorded concentrations lower than both datasets and the RTVs showing an improvement in material quality.

During the excavations, residual foundations and substructures were encountered and removed where possible. The two underground gasholder structures were broken down to 2m below the original ground level (now at 1.4m bgl current ground level) with the remaining 5m of wall structure left insitu as shown in Figure 10.


**Figure 10 Partial demolition of gasholder walls (extracted from Mouchel Parkman factual report [8])**

Other tanks that were identified during the works were emptied and, if possible, excavated along with any contaminated surrounding materials as shown in Figure 11. The Mouchel verification report [8], identifies the residual structures that were left in insitu and a summary is provided on Drawing 1. This includes a reinforced concrete tank, brickwork, concrete slabs and foundations and a cast iron segmental tank (believed to be part of the retaining structure in the south). Pipe work and tanks found contaminated with tars were disposed of to a suitable licenced facility.


**Figure 11 Excavation of contaminated material from a tank during the remediation (extracted from Mouchel Parkman factual report [8])**

Baseline monitoring was completed at the start of the Mouchel remediation with samples collected from 28 boreholes to establish baseline conditions. Monitoring and sampling was completed monthly from ten retained boreholes throughout the works. The other 18 boreholes were decommissioned as works progressed. The verification report states that except for a temporary increase in metal concentrations in July 2009, there was no evidence of any significant changes to the groundwater conditions during the works. Samples were collected from the Pent Stream at the beginning of the works (March 2009) and end of the works (October 2009). The results were compared against drinking water standards (DWS) and environmental quality standards (EQS). The validation report states water quality results from the sample collected at the end of the works, were not significantly different from at the start.

The validation report states that the remediation was completed in line with the agreed strategy. Following completion of the works the regulatory authorities, including the Environment Agency, confirmed that the works were undertaken in accordance with the agreed remediation strategy and planning conditions were discharged.

### 2011 WSP remediation

The WSP validation report [9] has large sections of the report that have been redacted. Prior to the remediation being completed, NAPL monitoring was completed over an eight-month period between November 2009 and June 2010. This information was used to design a NAPL remediation strategy. The remediation was undertaken in two phases over a six-month period, involving an initial NAPL skimming phase followed by total fluid abstraction. The NAPL recovery system included 15 100mm boreholes which were installed to a maximum depth of 15m below ground level (bgl) in the Folkestone Formation between 21st March and 6th May 2011.

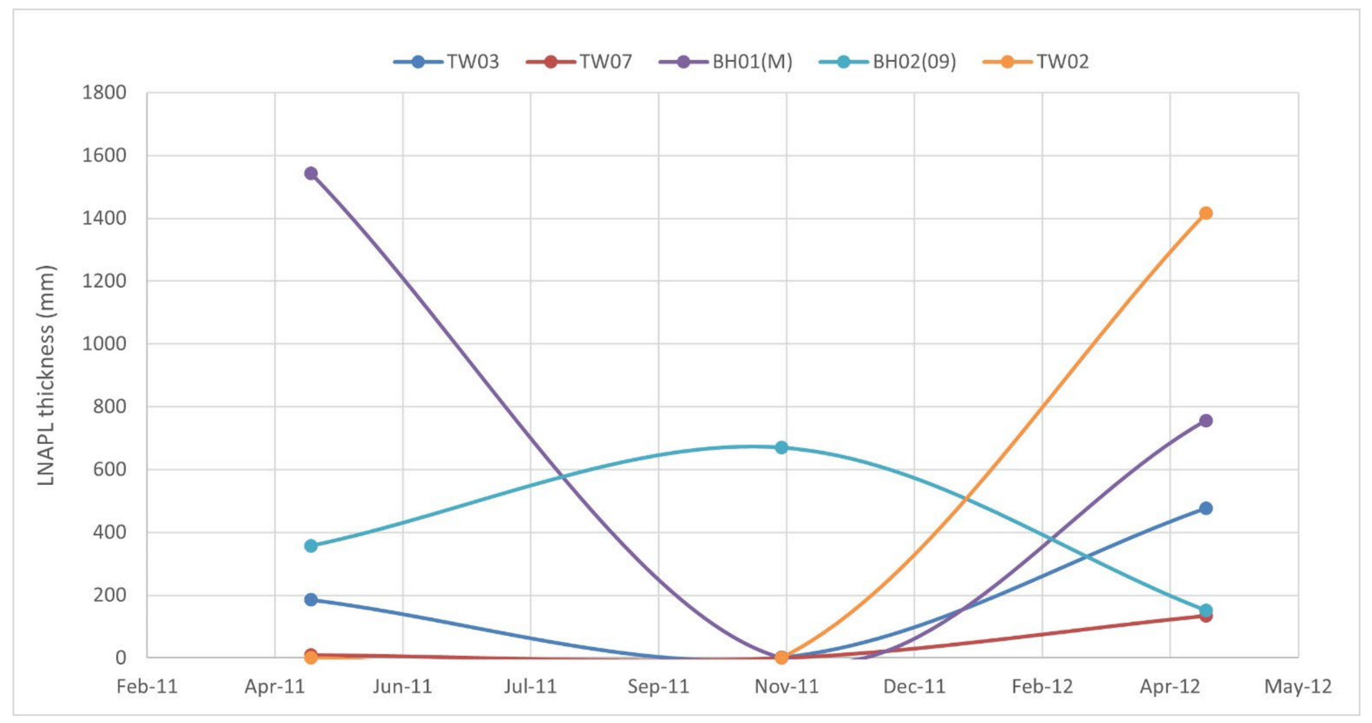
Site wide monitoring was undertaken in the new and accessible existing wells to establish the baseline NAPL presence and its distribution across the site. DNAPL was not recorded in any of the locations at a measurable thickness during the baseline monitoring.

NAPL skimming was completed between 11th May and 12th July in seven wells as shown on Drawing 2. The WSP report states that three locations were selected for NAPL skimming due to a measurable thickness of LNAPL recorded during the baseline monitoring (TW03 (23mm), BH01 (10mm) and BH11 (3mm)) and a further four locations were selected which recorded a sheen and NAPL globules (TW01, TW06, TW07 and TW012). These thicknesses are different to an earlier section of the report which identifies a measurable thickness of NAPL having been recorded in 14 of the 31 wells dipped prior to NAPL recovery, not just the three above. Due to the redacted text in the report, it is unclear where this additional data has come from and why these specific locations were selected for NAPL recovery over others.

In summary,

- Between the seven locations, 44 litres of LNAPL was recovered during the two months of skimming.
- DNAPL was not recorded during any of the wells during the skimming phase.
- Total fluid recovery was undertaken within TW01, TW02, TW03, TW05, TW06, BH01 and BH11 between 12th July and 11th November 2011.
- In all seven of these locations, groundwater and LNAPL was extracted from a combined point and fed into treatment plants at the surface where it was separated back into the two phases. Once separated, the NAPL was stored for further disposal and groundwater treated via a water treatment system and discharged to foul sewer under a consent.
- During the four-month extraction period, 131 litres of LNAPL and 3,070m$^3$ of contaminated groundwater was abstracted.
- DNAPL was recorded within TW02 and TW03 in August 2011. Thicknesses of 1.27m and 2.2m were present on 16th August 2011 in TW02 and TW03 respectively.
- During a second monitoring round on the 31st August, the thickness had decreased to 0.28m and 1.24m. A draw down test was conducted in September 2011 and 25L of DNAPL was removed from these two locations.

A final round of monitoring was completed by WSP in April 2012 in all accessible locations. The results are included in Table C 1. The WSP factual data shows the LNAPL distribution fluctuated after monitoring. In locations in the south of the site the thickness of LNAPL increased after monitoring, whereas locations in the north showed a general decrease as shown in Figure 12. DNAPL was not recorded at a measurable thickness in any of the monitoring wells during the April 2012 monitoring round.




Locations in the north include BH01(M) and BH02 (09) and locations in the south include TW02, TW03, TW07.

**Figure 12 WPS LNAPL monitoring from selected locations pre and post NAPL remediation**

### 3.6.2 Residual contamination

Two phases of groundwater and NAPL monitoring, and one ground investigation have been completed after the initial site remediation. Groundwater and NAPL monitoring was completed by Advisian in 2014, 2015 and 2016 and a ground investigation was completed in 2022 by RSK. The Advisian sampling was completed at all known accessible monitoring and NAPL recovery wells onsite which comprised 25 locations. The intrusive phase of the RSK investigation comprised only five boreholes, nine window samples and 20 trial pits as shown on Drawing 2. Only one round of groundwater sampling and six rounds of ground gas monitoring were completed following the intrusive investigation. Groundwater levels and NAPL were monitored during the six rounds of ground gas monitoring.

#### Soils

Visual and olfactory evidence of contamination was noted throughout the Made Ground and Folkestone Formation during the RSK investigation. Olfactory evidence of contamination was only noted in one location (BH4) in the Sandgate Formation between 12.75m bgl to 18.50m bgl. Potential ACM was noted within the Made Ground between 0.3m bgl and 0.8m bgl within the capping layer in BH3.

RSK tested 54 soil samples for a range of determinands including 44 soils from the Made Ground of which 15 were taken from the capping layer between ground level and 0.6m bgl, 12 from the Folkestone Formation and one from the Sandgate Formation. Their soil assessment was split into five datasets; Made Ground with or without visual or olfactory evidence of contamination, Made Ground without visual or olfactory evidence of contamination but noted as containing asphalt, Folkestone Formation samples with visual or olfactory evidence of contamination and natural soils without evidence of contamination. A summary is provided below.

*Capping layer*

15 samples were from between ground level and 0.6m bgl. This material is expected to be the capping layer placed by Mouchel Parkman in 2009.

In general, concentrations of metals were low, with most below current residential with home grown produce (here after referred to as residential) generic screening criteria (GAC). Only two samples recorded concentrations slightly exceeding the GAC of 200mg/kg for lead but these are below other criteria for instance for landscaped areas and parks near residential buildings.

- Concentrations of cyanide in the capping layer range between less than the method detection limit (MDL) and 133mg/kg with 70% of the samples above the GAC of 1.4mg/kg.
- Concentrations of phenol were all below the MDL.
- Concentrations of ammoniacal nitrogen were all below 1.5mg/kg which is low (soil GAC are not available for this analyte).
- Asbestos was recorded in five of the 14 samples tested from the capping (36%). Asbestos was recorded as loose fibres and loose insulation material up to a fibre count of 0.021%w/w. This is relatively significant for capping layers in potential residential settings.
- TPH concentrations were generally low, with all but one result recording TPH concentrations below 1,000mg/kg. One sample recorded a TPH concentration of 1,890mg/kg at 0.3m bgl (TP16). This sample primarily comprised heavy end aromatics (C16 to C35 at 1,811mg/kg).
- Concentrations of some polyaromatic hydrocarbons (PAH), dibenz(ah)anthracene, benzo(a)anthracene, benzo(a)pyrene and benzo(b)fluoranthene, were consistently recorded above the residential GAC. The highest concentrations were recorded in the sample from TP16 at 0.3m bgl where dibenz(ah)anthracene was 6.97mg/kg, benzo(a)anthracene was 60.5mg/kg and benzo(a)pyrene was 35.7mg/kg. Although concentrations in the other capping samples were not as high, they were consistently recorded above criteria for public open space making this material unsuitable for use in landscaped areas and parks near residential buildings.
- Benzene, toluene, ethyl benzene and xylene (BTEX) and volatile organic compounds (VOC) and semi volatile organic compounds (SVOC) concentrations were all low and mostly below the MDL. Its not clear what sampling methodology was used and that can result in the loss of a substantial proportion of volatiles.

In summary the material in the top 0.6m bgl is not suitable for use within cover layers within residential gardens, landscaped areas or parks near residential buildings, due to the due to potential human health risks associated with PAH concentrations and asbestos. Human health risks could be adequately mitigated if this material could be placed at depth under a clean capping layer.

*General Made Ground*

In general concentrations of metals, ammoniacal nitrogen, phenol, BTEX, VOC and SVOC (other than PAH) were low and below the GAC within the Made Ground.

Concentrations of cyanide were recorded above the GAC of 1.4mg/kg in 70% of the Made Ground samples. TPH concentrations were generally low, with 65% of samples recording concentrations below 1,000mg/kg. Eight samples recorded concentrations above 1,000mg/kg with the highest concentrations recorded in WS4 at 1.2m bgl (6,170mg/kg), WS2 at 1.4m bgl (4,470mg/kg) and TP9 at 1.8m bgl (2,600mg/kg). The TPH profile in all three of these samples included a high proportion of heavy end aromatic hydrocarbons, predominantly C21 to C35, with some aromatic C10 to C12 corresponding with high concentrations of naphthalene. All other TPH results were below 2,000mg/kg.

PAH concentrations in the deeper Made Ground ranged between 0.16mg/kg to 1,130mg/kg total PAH. The highest total PAH concentration was recorded in WS2 at 1.4m bgl. This sample also recorded high TPH concentration (4,470mg/kg) and was also one of the only samples to record concentrations of BTEX and VOC above the MDL with concentrations of 343mg/kg 1,2,4-trimethylbenzene, 8mg/kg benzene, 56mg/kg ethylene benzene and 189mg/kg xylene all exceeding the residential GAC. Observations of black staining and a hydrocarbon odour were noted in the Made Ground at this location.

Naphthalene concentrations exceeded the GAC of 2.33mg/kg in 19% of the Made Ground samples. Concentrations ranged between 0.04mg/kg and 427mg/kg; the maximum naphthalene concentration was recorded in WS4 at 1.2m bgl. Benzo(a)pyrene concentrations ranged between 0.06mg/kg and 56mg/kg; the maximum concentration recorded in WS2 at 1.4m bgl exceeds the GAC of 2.3mg/kg by an order of magnitude.

Asbestos was detected in samples throughout the Made Ground. Of the 26 samples tested, 42% detected asbestos. Where identified, asbestos was recorded as loose fibres, with one record of loose insulation material. Asbestos concentrations were between <0.001%w/w (four samples) and 0.193%w/w (chrysotile recorded at 1.5mbgl in TP13). The asbestos type was recorded as chrysotile in nine samples, amosite in one and a mix of chrysotile, amosite and crocidolite in TP9 at 2.7m bgl. The fibre count in this sample was 0.055%w/w.

*Samples from Folkestone Formation / Sandgate Formation*

Of the 13 samples collected from natural strata, only one was from the Sandgate Formation. This sample collected from 17.4m bgl, recorded low concentrations of c metals, cyanide, ammoniacal nitrogen, phenol, VOC and SVOC (other than PAH). TPH, BTEX and some PAH were detected confirming some contamination has migrated through the Folkestone Formation into the Sandgate Formation. TPH comprised predominantly aromatic's and the highest concentrations were within the C10 to C12 band range (326mg/kg from a total of 863mg/kg). A benzene concentration of 1mg/kg and total PAH concentration of 21.8mg/kg was also recorded in this sample.

Generally, concentrations of contaminants in the Folkestone Formation were low including concentrations of metals and phenols mostly below the MDL. Cyanide concentrations were recorded above the MDL in four samples, including a maximum concentration of 259mg/kg in TP19 at 2.2m bgl. Ammoniacal nitrogen was recorded above the MDL in 58% of samples; in four samples concentrations exceeded 50mg/kg and a maximum concentration of 740mg/kg was recorded in BH4 at 5.6m bgl.

TPH concentrations in the Folkestone Formation were generally low with only two samples recording concentrations above 200mg/kg. One sample from TP19 at 2.2m bgl recorded a TPH concentration of 8,650mg/kg and one from BH2 at 5.2m bgl recorded a TPH concentration of 49,500mg/kg. These results indicate that isolated pockets of hydrocarbon product are likely to remain in the Folkestone Formation with the potential to migrate and / or to cause continued impact to water quality through gradual dissolution, breakdown and release hydrocarbons into the groundwater.

A strong hydrocarbon odour was noted at BH2, however, there were no visual observations of contamination at this depth noted on the log. BH2 is located in the southwest of the site in the vicinity of a large tank which was excavated during the 2009 Mouchel Parkman remediation. The validation report stated the tank and its contents were removed and an excavation to 5m bgl was completed, removing any contaminated material around the sides and at the base of the excavation. The walls and sides were then validated before the pit was backfilled. It is very likely contamination migrated laterally and vertically from the tank before it was removed and residual contamination is still present within this part of the site at depth. Only a thin thickness of NAPL was noted in BH2 during the RSK monitoring (discussed below), however, these results in conjunction with the high concentrations recorded in soil at 5.2mbgl confirm residual product is present.

The log for TP19 noted black staining and an oily odour at the depth of the sample and high TPH concentrations (>6,000mg/kg) were recorded at nearby WS04 at 1.2m bgl. It is likely there is still residual contamination within the centre of the site which requires further investigation.

Speciated TPH analysis of the sample from BH2 identified that most of the hydrocarbon mass was aromatic C10 to C16 (30,700mg/kg) whereas the results from TP19 identified a slightly heavier material, mainly aromatics C12 to C21. These results suggest either two different sources of contamination or different levels of degradation.

### Obstructions

As noted in Section 3.6.1 several deep structures were left insitu during the 2009 remediation. This included reinforced concrete tank, brickwork, concrete slabs and foundations and a cast iron segmental tank which are shown on Drawing 1. The RSK investigation included six locations targeting retaining structures or the edge of the boundary walls and three which targeted concrete/ brick obstructions left in the ground following the Mouchel remediation. The foundations were located in all three pits (TP3, TP4 and TP8).

### Non-aqueous phase liquids (NAPL)

Since the WSP NAPL remediation and monitoring in 2011/2012, two more recent phases of NAPL monitoring have been undertaken at the site; four rounds of NAPL monitoring were completed between November 2014 and September 2016 by Worley Parsons/ Advisian and six rounds of monitoring were completed by RSK between May and June 2022. A summary of the NAPL monitoring results from WSP and Advisian/ Worley Parsons monitoring is provided in Table C 1. Data from the RSK investigation is provided in Appendix K of the 2022 report [1].

Figure 13 below summarises the results of NAPL monitoring recorded in a number of key locations over a period that spans the 2011/2012 NAPL remediation and monitoring by Advisian in 2014 to 2016. In some locations such as

BH11(9) located in the northeast of the site near the SGN compound the thickness of product remained fairly stable throughout this period. Within other locations (most notably BH01(M) in the centre of the site) a significant rebound appears to have taken place in the years following the NAPL extraction causing thicknesses to return to pre NAPL extraction levels in January 2015 before declining again by September 2016. In a small number of locations (e.g. TW13 also located in the northeast near the SGN compound), LNAPL thicknesses increased from a sheen/ observations of NAPL on the interface probe to a measurable thickness in September 2016.

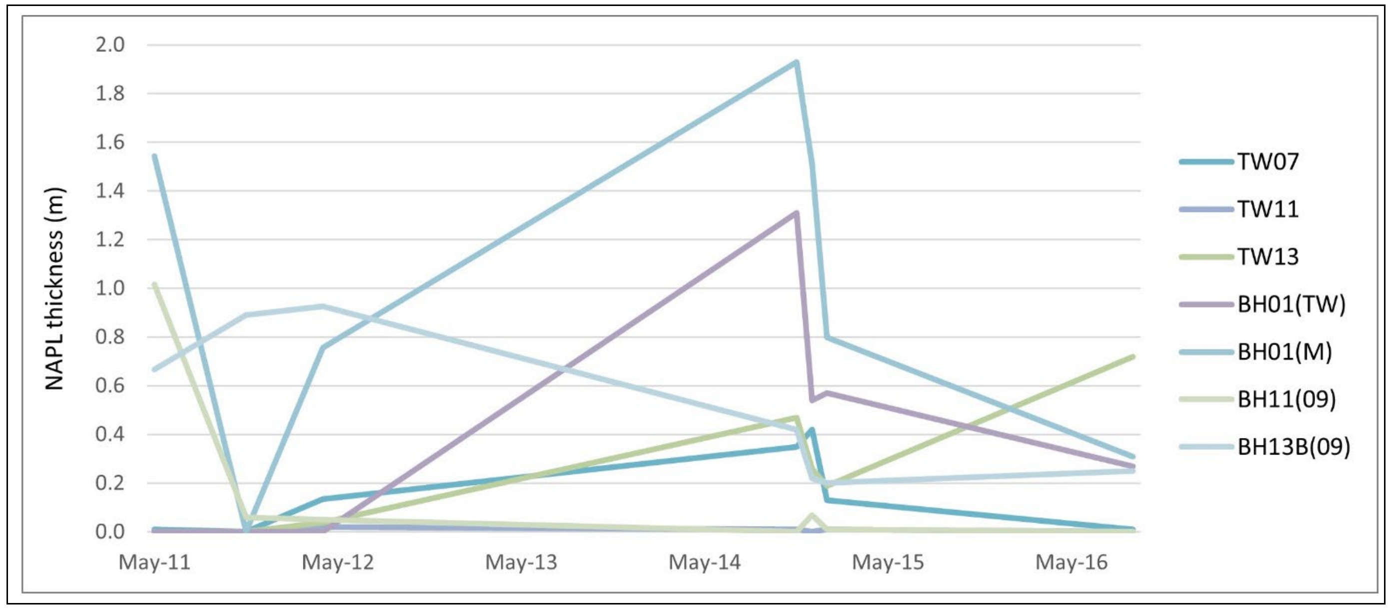



**Figure 13 NAPL thickness between 2011 pre NAPL remediation and 2016 post remediation**

In 2022 six rounds of NAPL monitoring was completed over a period of five weeks by RSK. A maximum thickness of 2.63m of product was measured in BH3 located in the centre of the site. LNAPL was consistently recorded at this location over the five-week monitoring period, at varying thicknesses. In general, measurable product was recorded in the centre and northeast of the site; high TPH concentrations measured in groundwater samples suggest that product is also likely to be present in the east of the site (discussed further below). Observations of NAPL such as oil present on the interface probe, oil noted in bailers and black product at the base of wells indicate a NAPL is present over a greater number of locations, however, this was not detected by the interface probe. Further information can be found in the RSK report [1].

The RSK investigation did not include any new installations around TW3 and TW2 where DNAPL was previously extracted and some of the greatest NAPL thicknesses were previously recorded. It should also be noted, the RSK boreholes were installed with 50mm standpipes which will likely result in higher NAPL thicknesses than wider diameter wells.

In summary NAPL monitoring demonstrates NAPL is still present onsite in measurable thicknesses. The distribution of the residual product onsite is variable, with the highest quantities have been recorded in the centre and northeast of the site but some migration / seasonal variation is likely. Additionally, NAPL may be present in other parts of the site outside the centre and northeast which hasn't previously been detected.

Two NAPL samples were obtained and tested by the laboratory during the RSK investigation. The laboratory results indicate the product has a profile of a weathered diesel and PAH.

## Groundwater

Groundwater samples were obtained during the Worley Parsons, Advisian and RSK investigations from locations which were free from measurable NAPL as outlined below.

- Six wells during the 2014/2015 Worley Parsons monitoring (TW8, TW9, TW14, TW15, BHRS02 and BHRS03).
- Two wells (TW08 and TW09) during the Advisian 2016 groundwater monitoring.
- Three wells during the RSK investigation (BH1, BH2 and BH4).

The groundwater results from the Worley Parsons and Advisian sampling rounds are discussed in the Worley Parsons 2015 letter [12] and Advisian 2017 [13] report. The full results from the RSK groundwater samples are provided in the RSK report [1] and a summary is provided below.

Groundwater samples were obtained from three boreholes during a single round of groundwater monitoring by RSK in 2022. The samples were collected from locations where no NAPL was recorded or it was recorded below a measurable thickness. However, petroleum hydrocarbon results from BH2 and BH4 were both elevated and above solubility limits for C10 to C16 indicating that residual product, potentially suspended colloids, is present at these two locations. The highest petroleum hydrocarbon concentrations were consistently recorded in BH4, where 44.5mg/l aromatic C10 to C12, 7.7mg/l benzene and 2.2mg/l xylene was recorded. These values are all several orders of magnitude above the water quality standards (WQS).

Phenol was recorded above the WQS of 0.0077mg/l in both BH2 (0.53mg/l) and BH4 (0.12mg/l) and PAH were significantly elevated. Naphthalene was recorded above the WQS of 0.002mg/l in all three wells; BH1 0.003mg/l, BH2 4.29mg/l, and BH4 10.5mg/l.

Ammoniacal nitrogen, also a common contaminant on gas works, was recorded in both BH2 (126mg/l) and BH4 (168mg/l) at levels between two to three orders of magnitude higher than the EQS of 0.3mg/l. The results from the cyanide testing, show the groundwater has been impacted by cyanide across the site (all three locations). The highest concentration of 1.17mg/l recorded in BH4 is four orders of magnitude above the EQS for free cyanide of 0.001mg/l. The proportion of free cyanide (the most toxic and mobile form) from these samples is unknown, however, speciated cyanide testing from the 2014/2016 monitoring recorded concentrations of free cyanide consistently higher than the EQS.

In general, concentrations of metals were low and within an order of magnitude of the relevant WQS. Exceedances of the WQS were recorded for arsenic, copper and nickel. Testing for chloride which can be used as an indicator of saline intrusion is limited and was only completed on one round during the 2016 monitoring. The results from these two samples were below 30mg/l which does not indicate groundwater has been impacted by saline water.

## Ground gas and vapour

Ground gas monitoring was completed by RSK between 5$^{th}$ May and 14$^{th}$ June 2022 over six rounds. Sampling was completed during a range of atmospheric pressures. Twelve installations were installed within the Made Ground/ top of the Folkestone Formation. RSK also monitored the five deeper installations screening the Folkestone Formation and Sandgate Formation. Although these wells were not fully saturated, they were installed for the purpose of groundwater monitoring and screen a relatively small portion of the unsaturated zone.

Within the twelve shallow installations:

- a maximum methane concentration of 2.8% v/v was recorded in BH3 in the centre of the site;
- a maximum carbon dioxide concentration of 8.9% v/v was recorded in WS2 located in the west; and,
- a maximum flow rate of 0.5l/hr was recorded in each of BH5, WS1 and WS6.

Based on the worst-case ground gas concentration and maximum flow rate identified at each location, a maximum methane gas screening value (GSV) of 0.01l/h and carbon dioxide GSV of 0.03l/hr has be derived. These results equate to a characteristic situation (CS) as outlined in BS8485 [21] of 1. Due to the sensitivity of the proposed development and high risk source, additional ground gas monitoring is required. In addition, as outlined in BS8485, threshold concentrations of 1%v/v methane and 5%v/v carbon dioxide should be considered as part of the assessment and if exceeded consideration should be given to increasing the CS to CS2. Concentrations above these thresholds do not necessarily mean the CS should be increased, rather that further consideration should be given to potential risk based on aspects such as the robustness of the data set and other aspects of the conceptual model.

Vapour monitoring using a PID was not undertaken as part of the ground gas monitoring. However, a PID was used during the groundwater monitoring in each groundwater installation. PID readings above detection were recorded in all new RSK installations including a maximum of 160ppm in BH3. This installation is specifically targeting the groundwater and does not necessarily reflect conditions in the unsaturated zone; additional vapour monitoring of the unsaturated zone should be undertaken in this part of the site.

### 3.6.3 Data gaps and constraints

Although remedial measures have been taken across the site and recent ground investigation has been completed, there are several data gaps and uncertainties that require review, additional investigation or assessment including:

#### Structures and earthworks

- The exact location and remaining vertical extent of the gasholder structures is unknown. These structures were backfilled in 2001 with crushed concrete, however, the composition of the material is unknown. There are no available records of the backfilling detailing how the base was left so it is unknown if the base has been punctured or remains in place. Additionally, these structures may be acting as a secondary source of NAPL.
- Verification testing behind the retaining walls and tank structures in the southwest of the site were limited to three shallow trial pits behind the tanks. Additional investigation is required behind the tank structures and the retaining wall on the western boundary.
- Similarly there has been no investigation completed within the SGN compound. Investigation is required within this part of the site.
- During the 2009 investigation a trench was excavated in the northeast of the site around the former above ground gasholder to investigate the presence of NAPL. The report states no NAPL was encountered, however, the trench only extended to around 2m bgl and therefore didn't reach the top of the groundwater. Investigation completed by RSK in this area included a trial pit and window sample. Additional investigation is required in this area to characterise the groundwater.
- The 2009 remediation included capping the site with 0.6m of crushed concrete and site won material. The 2022 RSK investigation identified asbestos within this material, however, testing of the capping material was limited. Additional testing of the capping material should be completed to understand the extent of asbestos impacted material across the site.

#### Groundwater/ NAPL

- Recent groundwater data from the site is limited to three samples. Additional groundwater sampling is required to inform detailed risk assessment and remedial strategy development, provide additional information on the aquifer such as if the aquifer has been impacted by saline intrusion and identify any tidal influence on the aquifer.
- Groundwater sampling has historically been completed in locations free from a measurable thickness of NAPL. A comprehensive sampling strategy should be undertaken across the site to identify any secondary plumes that are potentially impacting the aquifer.
- There has been no detailed quantitative risk assessment of groundwater since the 2006 assessment which informed the remediation. After additional ground investigation has been completed, detailed assessment will be required including fate and transport modelling of contaminants in the principal aquifer.
- There has been limited investigation of the Sandgate Formation. Deeper boreholes should be installed to assess if, and to what extent, contamination has migrated into the Sandgate Formation.
- To date groundwater level monitoring has been limited. Additional groundwater level monitoring and hydrological assessment is required to provide a comprehensive understanding of the principal aquifer.
- NAPL monitoring completed since the 2011 NAPL recovery has been sporadic and from a mix of 100mm and 50mm wells meaning the results are not directly comparable and leave uncertainty as to the extent of NAPL across the site. In addition, recent NAPL monitoring identified NAPL within bailers and equipment that was not detectable by the interface probes. Additional monitoring is required to understand the NAPL mobility and extent across the site.

#### Vapour and ground gas

- Vapour monitoring of the unsaturated zone has not been completed to date. Specific vapour monitoring should be completed in conjunction with a detailed vapour risk assessment to evaluate the potential for significant volatilisation and vapour intrusion into future buildings.
- The amount of gas monitoring and vapour monitoring is not sufficient for a high sensitivity development on a potentially contaminated site. Additional monitoring is required.

### 3.6.4 Summary

Ground investigation and monitoring completed following the previous remediation indicates that residual contamination remains within the Made Ground and natural strata. The highest levels of contamination (e.g. residual NAPL) are likely to occur in localised pockets rather than site wide, however, some other issues such as secondary plumes of dissolved phase contamination may be more widespread. Asbestos also appears to occur frequently within the capping layer and Made Ground and as a result an additional clean capping layer is likely to be required as part of the proposed development.

Residual obstructions remain within the ground and groundwater and NAPL monitoring completed over an eight-year period has identified residual product within the aquifer. Figure 14 shows a cross section of the site stratigraphy post remediation.

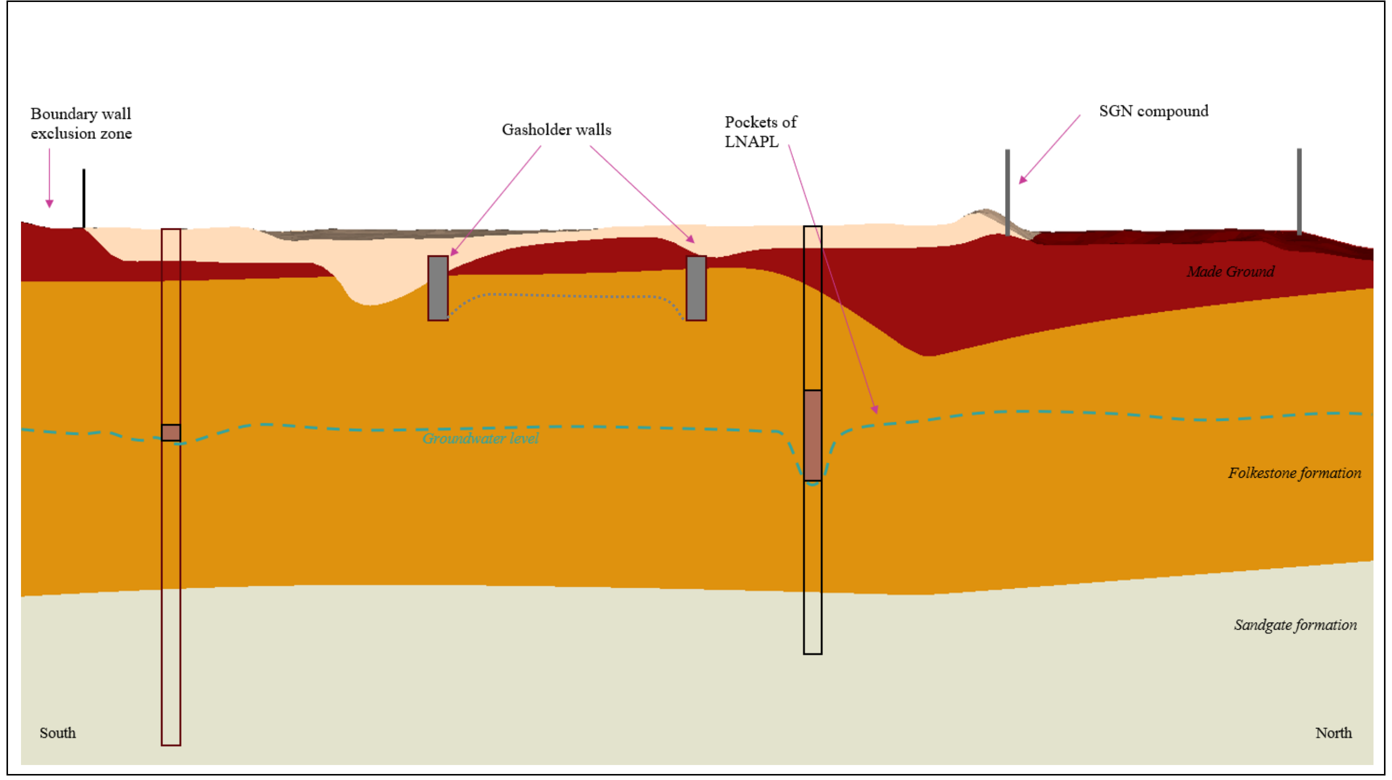



**Figure 14 Summary of site condition**

Data gaps have been identified including a requirement for vapour assessment, groundwater sampling and an assessment of the hydrogeological conditions.

# 4. Conceptual model

## 4.1 Introduction

A significant amount of remediation has been undertaken at the site which will have improved the contamination status of the site for both soil and groundwater, compared to the condition after the gasworks closed and before those works were undertaken. Those remediation works had specific objectives, relevant at that time but did not deal with all potential issues at the site to current standards. Some areas were constrained, and works could not be completed. This section outlines the potential residual sources of contamination and a brief conceptual model informing further works, including a summary of the RSK linkage evaluation presented in the RSK (2022) report[1]. It details the enhanced protection measures which will be incorporated in the scheme design and the potential areas where residual risk may require further consideration, investigation, options appraisal and active remediation.

## 4.2 Residual sources

### 4.2.1 NAPL

The 2009 remediation by Mouchel Parkman cleaned and removed most of the below ground structures. Several structures remain in the ground as discussed in Section 3.6.2 and presented in Figure 15. The 2011 NAPL recovery removed 175 litres of LNAPL from the site over a six-month period. Monitoring completed between 2014 and 2022 has recorded NAPL across the site at thicknesses similar to pre-remediation levels. The RSK investigation highlighted several gaps in the exploratory location network including to the south of the gasholder structures. It is possible these structures are acting as secondary sources of NAPL. Additional investigation around the residual structures and detailed monitoring of the NAPL across the site is required.

The areas shown in blue in Figure 15 were not remediated due to various constraints. This was either due to access (SGN operational governor compound) or restrictions due to the retaining walls. Ground investigation is required within the SGN compound to characterise this part of the site. The history suggests the SGN compound was used primarily for coal storage with one or two tanks present on the northeastern boundary. Several below ground structures are currently onsite associated with the SGN governor and a bunded above ground tank is located on the northern boundary alongside the electrical substation. In addition to the previous and current uses within this part of the site, groundwater and NAPL monitoring indicates there is the potential for NAPL to have migrated into this part of the site. The Made Ground within the SGN compound may be a source of contamination and the below ground structures may be a secondary source of NAPL. NAPL within the Folkestone Formation has the potential to migrate into the previously remediated parts of the site or offsite.

### 4.2.2 Unremediated areas at site periphery

Although remediation could not be completed near the retaining walls, verification sampling was done around the edge of the site. The verification samples confirmed the contaminant concentrations in this material were below the RTV. However, testing was limited and the RTV were protective of human health (at that time) and not controlled waters. The residual Made Ground in these areas has a potential residual source of contamination. Several condition surveys of the retaining walls have been completed; the most recent survey was undertaken in 2022 by BSF Consulting Engineers Limited [20]. The survey concluded significant work would be required if the boundary walls are retained as part of the development. The walls are up to 4m in some areas and are not structurally sound, ground investigation within 5m of the retaining walls may be limited to specific methods that do not disturb the ground.

Development in the unremediated areas in the west and south may include significant amounts of raising levels and fill which should mitigate many of the contaminant linkages between residual soils and human receptors and may limit the need for some remediation in these areas.

### 4.2.3 Remediated backfill and capping

The capping layer and remediated backfill was compliant with the original RTV. The RTV were protective of residential development without private gardens at that time, there have been updates to guidance since they were used, and the RTV did not consider the risk to controlled waters. The proposed development has changed to include private gardens which are more sensitive, and the site is on a principal aquifer, new remediation targets may be required for some areas. It will be efficient if there are different targets for different parts of the site such as gardens, landscaped areas, and hard standings or below buildings. This reduces unnecessary remediation.

These new targets will be risk based and may result in lower concentrations for determinands than the previous values in some areas and higher in others. In addition, asbestos has been recorded within the capping layer. The top 800mm to 1000mm of private gardens or 600mm to 800mm of soft landscaping areas should be formed of uncontaminated suitable soils which are free from asbestos and meet the new RTV. It is likely some of the material that is currently insitu would not be suitable for use within these cover layers. Some examples of cover layers are provided later in this section.

The site will require cut and fill to achieve the proposed formation levels and therefore some of the existing capping may be excavated for various reasons and potentially reused below new capping layers in other areas of the site.

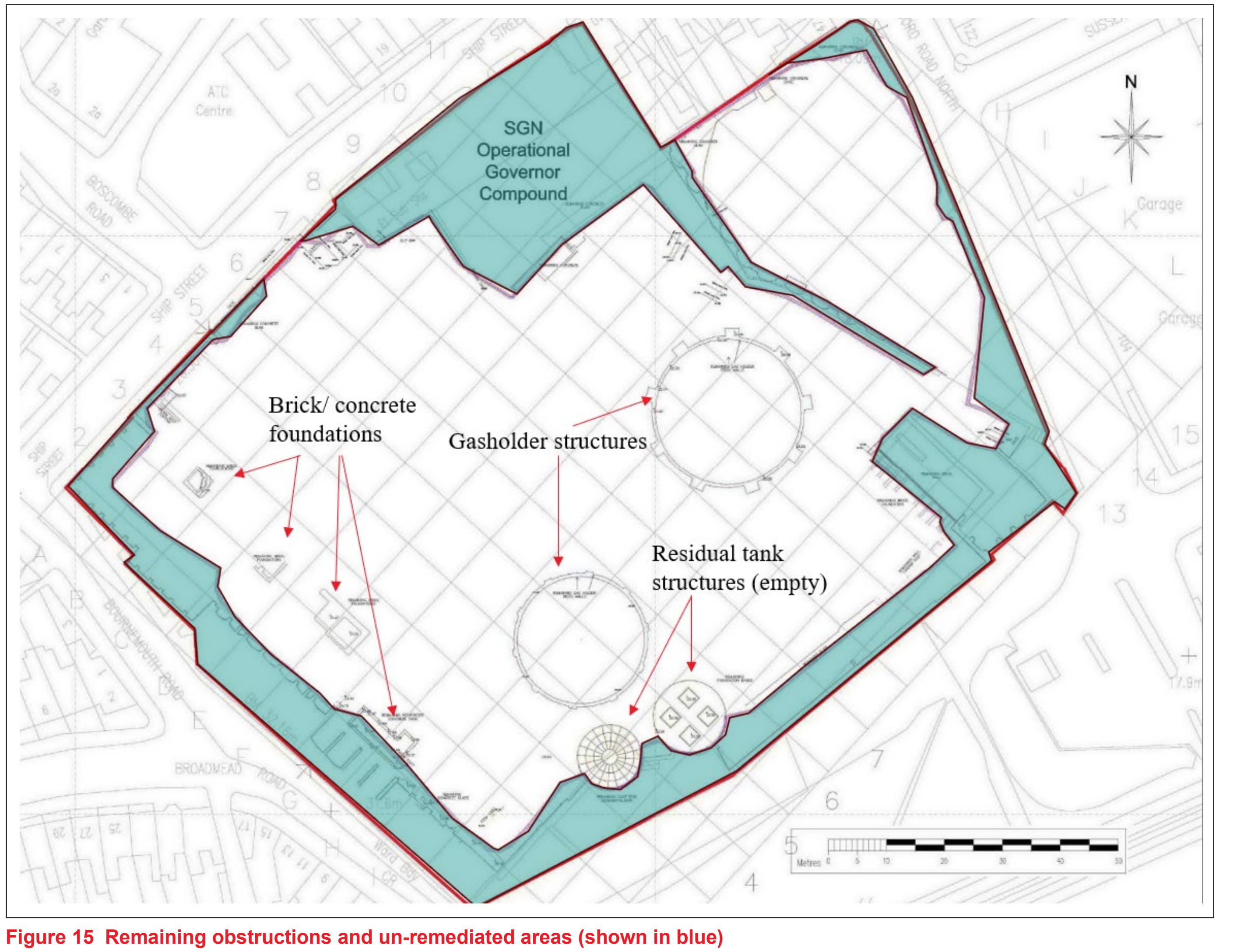



**Figure 15 Remaining obstructions and un-remediated areas (shown in blue)**

### 4.2.4 Dissolved phase groundwater contamination

Although recent groundwater sampling has been limited, the three samples from the RSK investigation identified high concentrations of dissolved phase contaminants including cyanide, naphthalene, ammonia and aromatic hydrocarbons.

A detailed risk assessment of these dissolved phase contaminants is required to enable agreement with the Environment Agency and to set an appropriate level of remediation that is protective of groundwater and surface water. Additional groundwater sampling and monitoring will be necessary. The scope should be agreed with the Environment Agency and baseline monitoring may be required over several months or longer. The monitoring will be required to ascertain the hydrogeological conditions including continuous monitoring of groundwater levels within the principal aquifer to assess the potential for tidal influence. The detailed risk assessment should include fate and transport modelling of dissolved phase contaminants to assess the potential for lateral migration of groundwater contamination within the Folkestone Formation. The assessment will consider the risk of potential impacts to sensitive offsite receptors including the Pent Stream as well as significant lateral migration within the aquifer. If practicable sampling from the Pent Stream and groundwater down gradient of the site will allow a more effective evaluation of the potential for offsite contaminant migration.

The detailed risk assessment will inform the requirement for dissolved phase remediation. The options for remediation if required will be outlined in a remediation options appraisal which will determine the appropriate risk management approach.

## 4.3 Linkage evaluation

A summary of potential contaminant linkages is outlined in Table 2 below. The linkages are broadly consistent with those presented in the RSK report but with modifications. The assessment and proposed risk management measures have been updated to reflect our own review of the data. In the risk management section, we have included likely measures to facilitate redevelopment. These linkages will also require further assessment following the completion of additional investigation works.

**Table 2 Summary of linkage evaluation**

| Linkage | Assessment | Risk management |
|---|---|---|
| Human health and phytotoxic linkages: | | |
| Oral, dermal and inhalation exposure with impacted soil, soil vapour and dust by future residents | The 2009 Mouchel cover system included soil remediated to achieve human health RTV overlain by a capping layer of crushed concrete. The RTV did not consider all potential exposure pathways and may not conform with current guidance. Further investigation is required to provide a characterisation of soil followed by updated assessment of human health risk based on the cut fill model required for development. | Enhanced protection can be achieved through construction of improved cover systems and vapour protection for buildings if required; this is discussed further in Section 4.4. This can used suitable site won soils or include various treatment methods or imported soils for gardens for instance. |
| Inhalation exposure of future residents and neighbours to asbestos fibres | Asbestos was detected in 40% of the samples. The maximum asbestos by weight was 0.193% at 1.5m bgl at TP13. Asbestos was detected within the crushed concrete capping layer. Current rules on asbestos in soils are more detailed than those available in 2009. | Enhanced protection achieved through construction of improved cover systems. This is discussed in Section 4.4. Risks during construction can be managed through health and safety measures including damping down, appropriate controls, PPE and monitoring. |
| Concentrations of ground gas and vapour accumulating in enclosed spaces or small rooms which could affect future site users. | The RSK assessment characterises the site as CS1, noting that ground gas protective measures are not necessary. | Further monitoring is required including vapour monitoring. There was insufficient monitoring for a residential development on a source such as this. |
| Uptake of contaminants by plants potentially causing contamination of homegrown produce (human health) or impacting plant growth (phytotoxicity) | Private gardens are proposed. Concentrations above criteria protective of homegrown produce consumption and with the potential to inhibit plant growth have been recorded across the site. Assessment should be based on upper soils based on cut and fill. | Appropriate design of cover systems including specification of appropriate re-use criteria for cover soil, imported topsoil, and tree pits depending on landscaping design. |
| Organic contaminants permeating potable water supply pipes | Ground investigation results have been compared against GAC provided in UKWIR Report [22] indicate a linkage exists. | Remediation of gross contamination and installation of verified clean service corridors and barrier pipes for pipe materials discussed in Section 4.4.4 |
| Inhalation exposure of future residents and current offsite users to vapour from groundwater and NAPL | Groundwater sampling by RSK in 2022 was limited to just three samples. Initial results indicate a potential vapour risk from groundwater. | Additional investigation including vapour sampling and risk assessment will confirm level of risk. If required, vapour protection can be installed in future buildings to prevent vapour intrusion. |
| Controlled waters related linkages | | |
| Leaching of soil contaminants and vertical migration of product causing impacts to underlying principal/ secondary aquifers | The RTV for remediated soil did not consider risks to controlled waters and residual contamination remains in remediated and unremediated ground. NAPL may remain. Leaching of dissolved phase contamination is possible through infiltration. Downward migration o could occur if contained by, and then released from, sub-surface structures. | Investigation and risk assessment is required to assess the impact to groundwater from residual contamination. Based on the data and consultation with the regulators as part of the previous remediation, infiltration across the site will be limited and potentially prevented. This is discussed further in Section 4.4.1 |
| Migration of dissolved phase contaminants to wider principal and secondary aquifers | The groundwater results identify contamination in the aquifer. Migration of dissolved phase contaminations into the wider aquifer is possible through advective groundwater flow. | Further investigation to characterise groundwater sources and hydrogeological characteristics of the site. Risk assessment will be undertaken to evaluate the potential for lateral migration of key contaminants. Remedial options appraisal to determine the most appropriate risk management approach. Depending on the assessment results and the review of potential remedial options, risk management could range from monitoring to an active remedial solution such as insitu or exsitu treatment. |
| Migration of dissolved phase contaminants to surface waters (Pent Stream) and downstream Folkestone Harbour (via flow within the Pent Stream) | The Pent stream is situated approximately 50m northeast of the site. It is lined; however, short stretches may be in connectivity with the groundwater. Uncertainty remains regarding groundwater flow, and this may also be complicated by tidal influence. | |
| Migration of NAPL to wider principal and secondary aquifers | LNAPL was recorded at several locations by RSK in 2022. DNAPL was potentially recorded in one location in the Made Ground. Potential migration of residual NAPL is possible but likely limited, unless new releases associated residual structures occur | Investigation to provide greater coverage particularly around residual obstructions which may be a potential secondary source of NAPL. Additional longer-term monitoring is required to understand the NAPL across the site. |

## 4.4 Enhanced protection in scheme

The following sections outline the enhanced protection measures that will be employed by the scheme as part of the development. These measures will be embedded within the scheme to address the plausible pollutant linkages outlined above.

### 4.4.1 Limited infiltration

The previous assessment and consultation with the regulators, considered a residential scheme with no public gardens, and limited soft landscaping. The scheme included almost complete cover across the site by buildings and hardstanding, minimising infiltration. Based on these assumptions soil remedial targets for the 2009 remediation were driven by risk to human health receptors and did not include assessment of risk to controlled waters.

In 2015 Idom Merebrook [10] undertook an assessment of the site. As part of this they undertook informal consultation with the Environment Agency. The report states the Environment Agency *'would not support a proposed development that does not incorporate measures to restrict infiltration or incorporate further assessment and remediation.'*. The proposed development now includes private gardens and areas of soft landscaping. Approximately 50% of the site will be covered with hard landscaping or buildings. The surface water management plan includes an active drainage system with attenuation tanks to capture surface water before discharge to sewer and will therefore limit infiltration. Within private gardens and soft landscaped areas, infiltration may be prevented by several solutions.

One solution could be a bentomat layer installed at the base of the capping material (discussed further below and shown in Figure 17) with an overlying granular layer, a membrane and 600mm of clean capping material. This will be appropriately designed and incorporated into the earthworks model for the site. The bentomat layer will require contouring across the site with additional discharge points into the proposed drainage system to prevent waterlogging and surface water flooding in soft landscaped areas.

Another solution would be to install an impermeable membrane at the base of the granular layer. This would reduce the potential build up to formation level, however, there is the potential this could be damaged by follow-on development post earthworks such as piling or during the installation of services. It would also require a drainage system around the site to capture infiltrated rainwater and discharge it to sewer.

A third option would be to create an in situ impermeable layer through stabilisation and solidification. This would reduce the potential build up to formation level and prevent leaching of potential contaminants within the existing Made Ground. If this technique was employed, a capping layer would still be required above the stabilised soils comprising a suitable planting medium and a drainage system would be required to capture rainwater and discharge to sewer.

If infiltration is not prevented in the soft landscaping areas and private gardens, additional risk assessment will be required to evaluate leaching of contamination from the unsaturated zone. Additional investigation and characterisation of unsaturated zone sources would also be required, followed by remediation in areas where residual contamination exceeded RTV.

### 4.4.2 Capping layers and cover systems

Cover systems are required across the site. The specific requirements including the buildup will be incorporated into the remediation strategy and will reflect the proposed design and risk assessment findings. Soils used in the redevelopment of the site will be both existing site-won soils and imported materials. Materials will be suitable for reuse if they meet the risk-based criteria which will be defined in the remediation strategy. This will include new remedial targets which will be protective of both controlled waters and human health. The targets will be derived for different material types considering human health and controlled waters risk including general fill, upper capping, and topsoil.

#### Hard standing and under buildings

Within areas of hard landscaping including paving and roads, the road or paving engineered construction will be underlain by a geotextile marker layer as shown in Figure 16. This will be underlain by at least 600mm of general fill. The general fill SQC will consider vapour risk. Under buildings a vapour membrane or other gas protection system may be required.

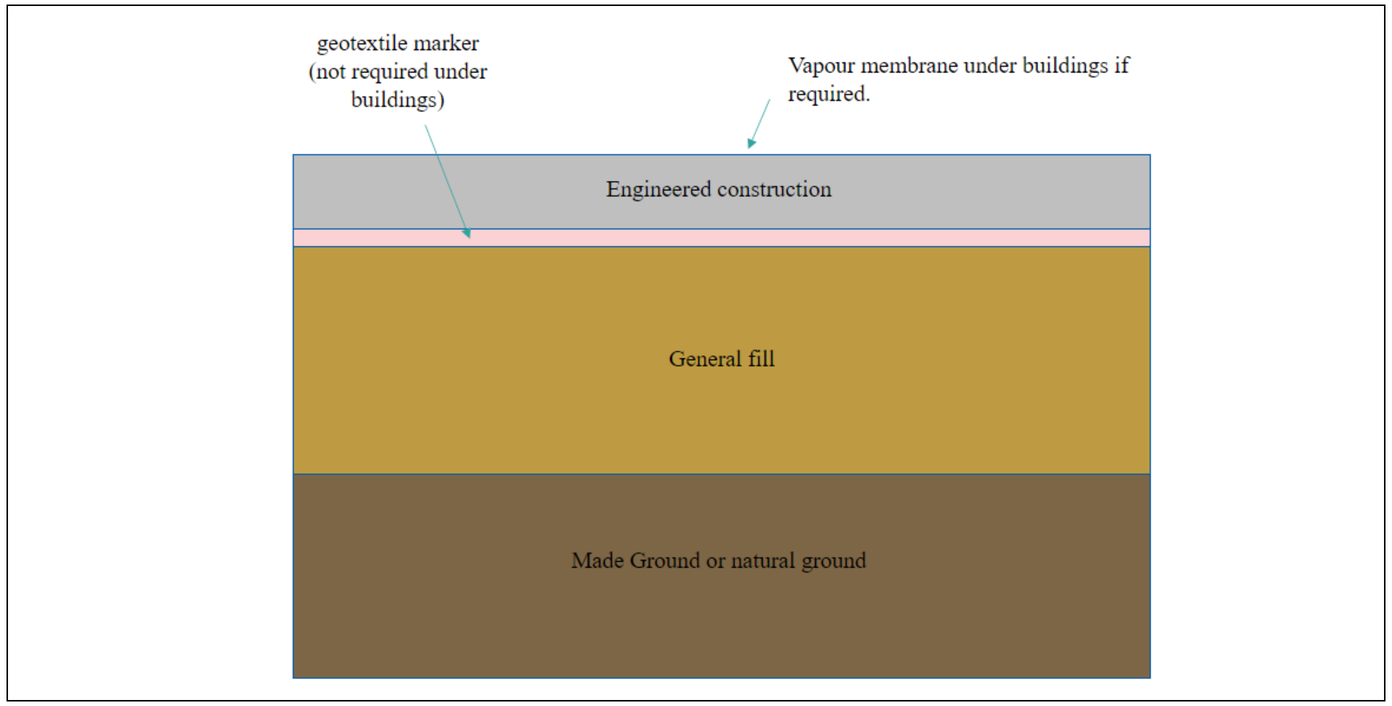



**Figure 16 Example of cover system in areas of hard standing or under buildings**

#### Soft landscaped areas and private gardens

Infiltration will be minimised within areas of soft landscaping and private gardens. This can be achieved in several ways as described below and illustrated in Figure 17.

1. The Made Ground/ natural ground will be overlain by an impermeable geotextile or geosynthetic clay liner, which is overlain by a drainage layer and permeable geotextile marker layer, capped with landscape material. The impermeable geotextile or geosynthetic clay liner would require protection during earthworks (if required).
2. The impermeable geotextile or geosynthetic clay liner may be replaced with a compacted clay barrier or stabilised/ solidified layer with a thickness greater than 0.5m.

Within the proposed private gardens the landscaping material would increase to 800mm to 1m and within areas where tree pits are proposed this may increase to between 1m to 1.2m.

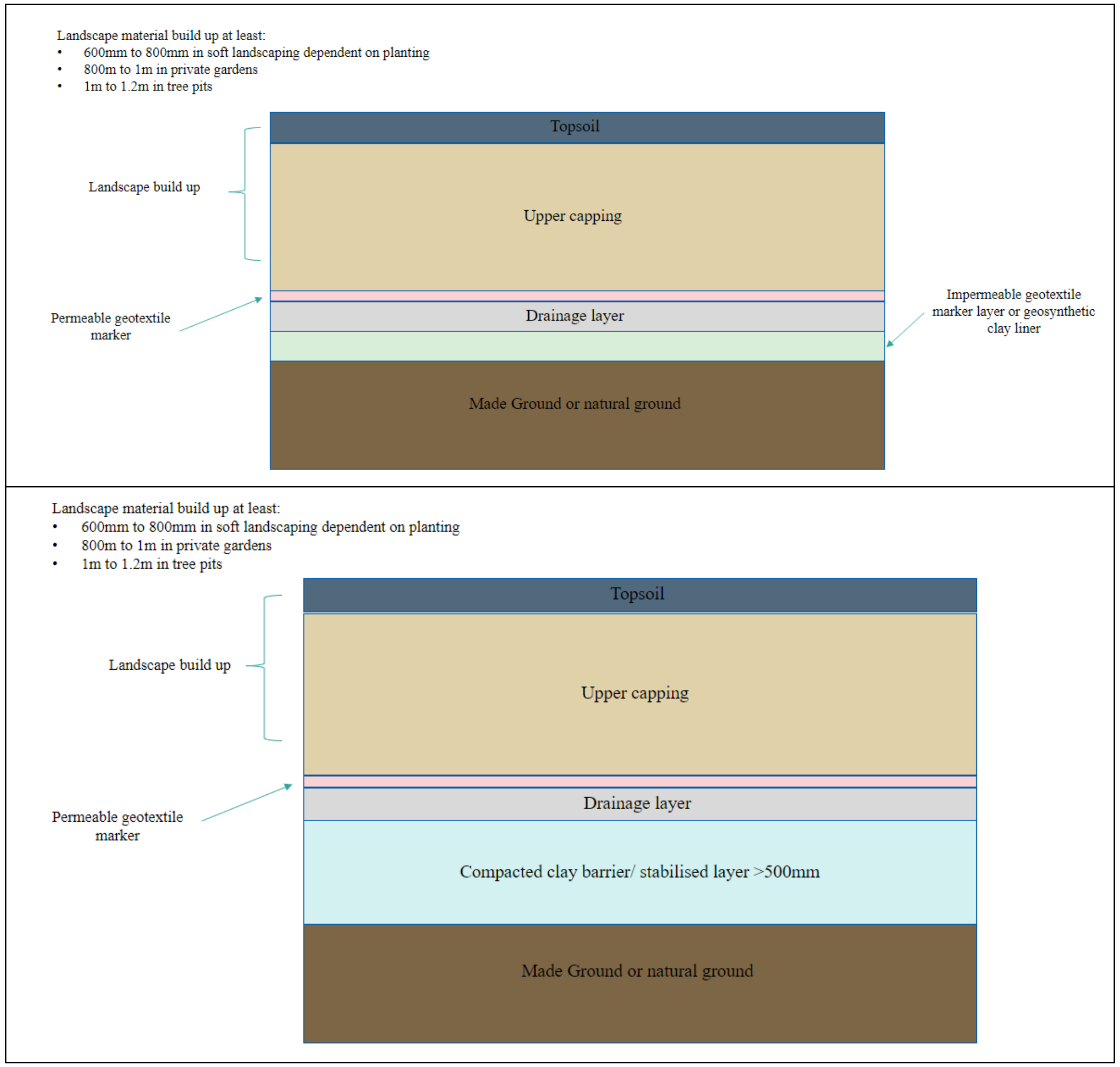



**Figure 17 Example of cover system in areas of soft landscaping or public gardens**

### 4.4.3 Vapour and gas protection measures

Additional assessment is required to consider the vapour risk based on the current ground conditions.

RTVs will be derived that consider the potential risk from vapour for the general fill and landscaping material. Vapour membranes may or other gas protection may be required. These must be properly verified to be effective. Appropriate measures will be outlined in the remediation strategy.

### 4.4.4 Installation of services

To mitigate risks to future site maintenance workers and to avoid the possibility of chemical attack on buried services, clean service runs will be created by excavation of placed or in situ soils and replacing with suitable imported backfill underlain by a marker layer.

The UK Water Industry Research Ltd (UKWIR) guidance should be consulted regarding the use of barrier pipe and pipe material specification. The risk assessment and proposed pipeline materials will be agreed with the local water company.

### 4.4.5 Foundation works or piling risk assessment

Foundation works or piling risk assessment will likely be required as part of the planning conditions and has been requested during consultation with the Environment Agency. This will identify an approach to piling that avoids creation of unacceptable pathways and requires regulatory approval. Groundwater monitoring, a risk assessment and mitigation plan will be completed before any piling works are undertaken onsite. The foundation solution will be designed considering the Environment Agency piling into contaminated land guidance [24].

Based on the ground conditions, obstructions and contamination risk and considering sustainable design, the preferred option will likely be a mix of piled foundations for the larger buildings and shallow foundations (pads or strips) for smaller residential properties. Specialist rotary displacement or helical piles may be considered as they are less likely to create a preferential pathway and reduce the quantity of contaminated soil that is generated compared to CFA piles.

As contaminated materials will arise from foundation works and other excavations below the proposed capping layer (which may include metals, asbestos, hydrocarbons and other contaminants) then additional environmental controls, health and safety procedures, boundary monitoring, and possibly odour suppression will be required in the development phase.

Soils and groundwater may be aggressive to various construction materials due to sulphate concentrations, hydrocarbons, and other contaminants such as ammonia. The design of any in ground materials will be required as part of the foundations risk assessment. The potential risk posed to buried concrete should be managed by designing all concrete in contact with the ground in accordance with BRE SD1 [23].

### 4.4.6 Earthworks

Earthworks will be required to create a level platform for development and to allow suitable thicknesses of capping layers as defined by the remediation strategy within areas of soft landscaping. Reusing site won material is the preferred and sustainable option where possible and the earthworks will be designed to maximise the reuse of materials on site.

A key aim for the development will be to maximise the reuse of excavated soils as a non-waste and minimise the amount of material classed as a waste and sent offsite for disposal. Only if excavated material is not required, is unsuitable for use, cannot be treated to make it suitable for use, or cannot be recovered in the construction of the scheme, should it be considered for offsite reuse, offsite treatment, or disposal.

Materials will be managed using the CL:AIRE Definition of Waste Code of Practice (DoWCoP). This voluntary code of practice describes an approach, whereby specific construction activities are described, with supporting information, in a materials management plan (MMP). The MMP is prepared once the assessment is complete, quantities are defined, and those undertaking the work and how it will be carried out are known. The MMP is reviewed by an independent 'Qualified Person' registered with CL:AIRE who, if satisfied, submits a declaration. Once the declaration is submitted the work can commence. Following the completion of the reuse works a MMP verification report is required in accordance with the requirements set out by the MMP and the verification report must be submitted to CL:AIRE.

Treatment of soils necessary to achieve the reuse criteria by exsitu methods will be carried out under appropriate environmental permits, most likely a mobile plant permit. Environmental management and monitoring to ensure protection of receptors during soil treatment (such as runoff containment by use of low permeability membrane and bunding) will be undertaken and detailed in the mobile plant permit submissions.

Topsoil, subsoil and engineered fill imported for use at the site (or generated from site-won soils) would be certified as chemically suitable for purpose. Samples of imported topsoil and secondary aggregates would be taken in-situ and scheduled for laboratory testing to verify certification. All supplier and verification chemical results would be collated by the contractor for inclusion in the remediation verification report.

## 4.5 Areas requiring additional consideration

### 4.5.1 Obstructions

Several inground structures remain across the site including brick and concrete foundations and the two below ground gasholder structures. Depending on location, depth, size etc and construction requirements these subsurface structures could obstruct future redevelopment and in some cases may require removal. This should consider the potential that sub-surface structures could be associated with residual contamination including NAPL. Prior investigation of these structures will be required before removal to characterise the contamination risks and to identify mitigation strategies.

Some obstructions such as the gasholder bases may be left insitu although may form an obstruction to piling. In this instance, investigation of these structures will be completed to ensure potential contamination associated with these structures does not present an ongoing risk or secondary source of contamination. The foundation design will consider these remnant obstructions.

### 4.5.2 Constraints

In addition to the below ground gasholder bases, there are several constraints associated with the site including the retaining walls and size of the site. The 1.5ha site is spilt on two levels with entrances in the north and southeast. The constrained nature of the site restricts vehicle movements, storage onsite and the ability to undertake large scale excavations. The site is bound by retaining walls which require remediation and have an exclusion zone, limiting remediation and earthworks in these areas.

The site is also surrounded by residential development, particularly in the northeast of the site where several residential properties are located on the boundary wall. Enhanced measures such as odour and dust suppression will be required during the works.

### 4.5.3 Soil sources

Previous remediation across the site included the removal of shallow sources such as tanks and treatment of contaminated soils, however, it is likely shallow sources remain within the Made Ground. Additional ground investigation and detailed risk assessment will be undertaken to assess the risk to receptors from these soil sources. If required, localised treatment or soil removal may be required. A watching brief will be in place throughout the works and gross contamination will be removed if encountered.

### 4.5.4 NAPL remediation

The techniques for dealing with the LNAPL depend on the extent, thickness, content, ground conditions and constancy or connectivity of the NAPL plume. Examples include:

- removal using a system such as the NET extraction system;
- sequential LNAPL skimming, vacuum-enhanced skimming and total fluid recovery;
- augmented recovery using enhanced chemical desorption (or bioremediation) in-situ, with recovery by physical treatment systems.
- multiphase vacuum extraction (MPVE) and volatilisation technologies including soil vapour extraction (SVE);
- localised excavation and manual removal if the contamination is localised, shallow and in discrete areas (unlikely on this due to previous remediation and known ground conditions); and,
- in-situ or ex-situ bioremediation, or chemical treatment followed by monitored natural attenuation.

To date monitoring has recorded limited DNAPL across the site. DNAPL was recorded in two locations during the 2011 remediation works. This was removed at the time and DNAPL hasn't been recorded since, apart from potential DNAPL in the Made Ground in the northeast of the site during the RSK investigation. If DNAPL is identified, then the following techniques may be required:

- in-situ chemical oxidation in groundwater using simple permanganate or Fenton's reagent;
- soil vapour extraction (SVE) for shallow sources and unsaturated zones;
- dual phase vacuum extraction (DPVE);
- monitored natural attenuation may be suitable, either on its own in areas of lower concentrations, or following some form of chemical, physical or thermal treatment.

There are other techniques such as insitu resistance treatment which is a high energy thermal technique, and excavation with low temperature thermal desorption etc. The most suitable technique will be assessed based on the additional ground investigation data and selected considering the sustainability of the technique.

#### 4.5.5 Groundwater remediation

The most significant contamination issue affecting groundwater is likely to be the presence of NAPL and for most organic contaminants the key focus of remediation is likely to be the removal of product. A detailed risk assessment will be completed to evaluate the potential for impacts to groundwater from dissolved phase contamination. Depending on the dissolved phase contamination identified, a long list of available remediation options will be defined using Land Contamination: Risk Management (LCRM) remediation options applicability matrix discussed further in Section 5 below. The long list will be reviewed to identify potentially technically feasible options for each source.

# 5. Additional assessment and risk management

## 5.1 Planning conditions

A planning application for residential development will be submitted for the site in quarter (Q)3 2025. If permission is granted various conditions related to contaminated land are likely to be inserted that define the assessment and risk management steps that will need to be followed and approved by the regulators prior to and during redevelopment of the site. Typically these accord with the LCRM guidance which involves a tiered assessment and risk management approach as detailed below.

- Submission of a preliminary risk assessment (PRA) and proposed site investigation scheme (SIS).
- Contamination risk assessment based on the findings of the approved SIS.
- Development of a remedial strategy based on the findings of the investigation and risk assessment.
- Submission of a verification report demonstrating compliance with and completion of the approved remedial strategy.

Each of the above conditions is likely to require submission of reports and other documentation for regulatory review and approval before moving onto the next stage. Further details of the likely requirements of each stage is described below.

Other possible and related planning conditions may include but not necessarily be limited to:

- A foundation works risk assessment.
- A long term monitoring plan.
- A construction environmental management plan (CEMP)

### 5.1.1 PRA and SIS

The RSK 2022 report [1] provides a PRA, describes a phase of site investigation, the results of the investigation and a generic risk assessment for the site.

An updated PRA will be submitted to discharge the relevant planning condition that reflects the current site redevelopment plans and considers and evaluates the residual contamination risks. A site investigation scheme will need to be presented for regulatory approval that aims to address key data gaps, provides refinement of key risks and informs the development of remedial options. Further details of the investigation requirements are described below.

### 5.1.2 Additional investigation

Several phases of ground investigation have been completed across the site. These investigations were undertaken prior to the current proposed design being finalised.

Further investigation is required to understand/ characterise the following:

- the residual structures including understanding if they are acting as a secondary source of NAPL. Investigations around the gasholder structures may include ground penetrating radar surveys to accurately delineate the structure;
- the residual NAPL including the quantity, extent, composition. To allow for NAPL characterisation and remediation if required at a later stage, 100mm boreholes should be installed which can facilitate remediation systems such as the NET system;
- the extent and magnitude of dissolved phase contamination in the Folkestone Formation;
- the hydrogeological conditions onsite including groundwater flow direction and tidal influence if applicable;
- the presence of asbestos within the capping layer;
- the presence of potentially volatile contamination and risk of vapour release and migration; and
- to characterise ground conditions in previously un-investigated areas including around the retaining walls where practicable to do so and within the gas governor compound.

An interpretative ground investigation report will need to be submitted to the regulators to describe the ground conditions and potential pollutant linkages based on the redevelopment plans. This will include a generic contamination assessment based on comparison of site testing results with environmental and human health-based standards. The interpretive report will identify where further and more detailed quantitative assessment is required to allow development of a proportionate remedial solution.

### 5.1.3 Detailed risk assessment

Detailed assessment of risks to controlled water and / or human health is expected to be required to support the development of a robust remediation strategy.

Fate and transport modelling of dissolved phase contamination in the Folkestone Formation is likely to be required to determine the potential for significant lateral migration of priority contaminants within the principal aquifer which in turn will help confirm groundwater remediation or risk management requirements. Detailed assessment of human health risk may also be required including vapour exposure modelling to assess risks to future site users based on recorded levels of volatile organics in soil, groundwater and vapour samples.

The risk assessment will be used to develop the key objectives for remediation and risk management and if required to aid the development of specific remedial target criteria.

### 5.1.4 Remediation strategy

Remedial requirements and objectives will be dependent on the findings of the detail risk assessment and will be presented in the remediation strategy and options appraisal. Remedial options should be selected that overall are considered most suitable based on the appraisal of options and adhering to the principles of sustainable remediation. The UK Sustainable Remediation Forum (SuRF-UK) has published a framework for assessing sustainable remediation [26]; describing how it links with the relevant regulatory guidance and the factors to be considered. It describes sustainability appraisal tools to evaluate the wider benefits and impacts of remediation. In addition, ISO has published ISO 18504:2017 which provides procedures on sustainable remediation[27]. It provides:

- a standard methodology, terminology and information about the key components and aspects of sustainable remediation assessment; and
- informative advice on the assessment of the relative sustainability of alternative remediation strategies.

These approaches will be considered during the options appraisal to ensure that the selection of specific techniques is optimised. It is inherent in some of the key decisions being made such as; reuse of soils, minimising disposal but balancing the requirement for treatment (and creating suitable soils) against the environmental impacts of that treatment.

The findings of the RSK investigation and previous phases of NAPL recovery and monitoring suggests that residual NAPL is likely to remain in groundwater (and potentially soil and structures). Based on the sensitivity of the site setting it is likely that the risk assessment will identify this a potentially significant source due to the potential for ongoing dissolution and wider impacts to the aquifer. Therefore, depending on the findings of further investigation and assessment, a key element of the remediation strategy is likely to be a review of available techniques and options for the treatment of residual NAPL. Potential options for NAPL recovery and treatment were described previously in Section 4.5.4.

Other remedial requirements at the site may include the treatment of soils and water in-situ (i.e. in the ground with minimum disturbance) or ex-situ (i.e. following excavation). Remediation may sometimes involve the long-term monitoring of ground conditions, often water quality, to demonstrate that the development has had a beneficial effect, and conditions are stable or improving over time. In some cases, this can be done instead of specific treatment with agreement from the regulator. Some remediation activities will typically be carried out before development, whereas others are better undertaken during main development works to achieve a cost effective and sustainable solution. Pathway interruption embedded in the design (for example by barriers and cover layers or gas membranes) and enhanced health and safety and site control measures (protecting construction workers and neighbours) will also be fundamental components of the scheme.

The remediation strategy will be cognisant of the form of development. Actions such as raising levels and providing hardstanding for instance, will limit the extent of remediation required to demonstrate the site is "suitable for use". At the same time, some development activities, such as excavations and piled foundations, could themselves result in additional contamination or the migration of contamination to groundwater and will need appropriate management and controls.

### 5.1.5 Verification strategy

A verification report will be required following completion of remediation and/or development works. Typically, a verification report may include the following items:

- details of works carried out and contamination encountered;
- details and justification of any changes from the original remediation strategy;
- lines of evidence to demonstrate the success of specific remediation;
- demonstration of compliance and description of validation methods;
- laboratory and in-situ results;
- monitoring results for groundwater and gases;
- summary data plots and tables relating to clean up criteria;
- plans showing treatment areas and details of any differences from the original remediation strategy;
- photographic and other media records;
- waste management details and records;
- on-going environmental monitoring or works to be carried out;
- details of any unexpected contamination and how it was dealt with;
- details of any onward long-term monitoring methodology (where required) in accordance with the relevant planning conditions; and,
- confirmation that remediation objectives have been met; and description of final site conditions.

Any deviation from the remediation strategy, including any unexpected ground conditions, will be documented within the validation report. On completion a set of as built drawings will be produced along with all relevant information to show that the site is suitable for its intended use.

### 5.1.6 Foundation works risk assessment

As outlined in Section 4.4.5 a foundation works risk assessment will be required for the site. This will likely form part of the planning conditions attached to the planning application.

## 5.2 Regulator liaison

The regulators have been and should continue to be consulted for aspects relating to contaminated land.

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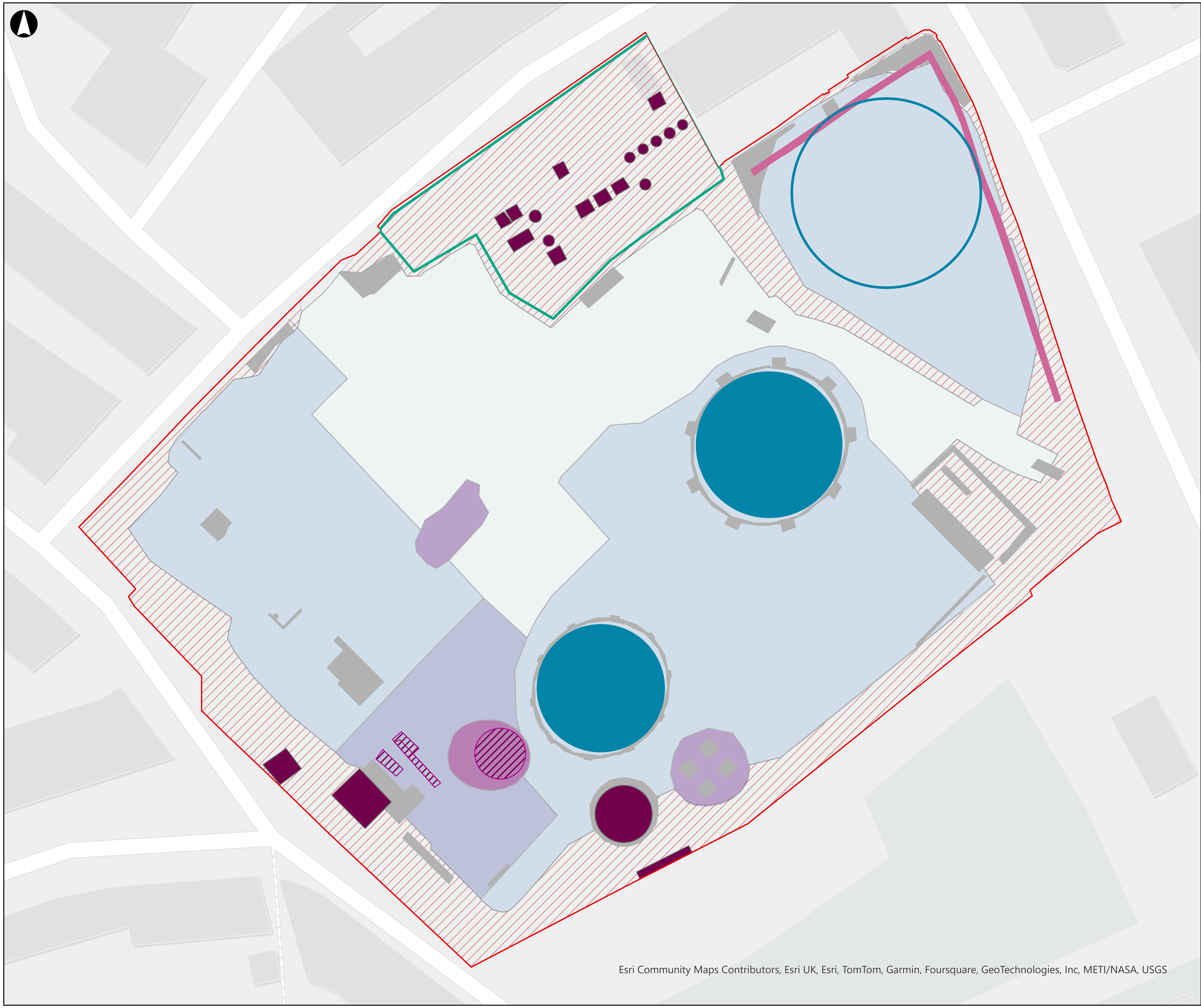
# Drawings

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**Legend**

- Red line boundary
- SGN boundary
- Gasholder - above ground
- Gasholder - below ground
- Tank structures remaining
- Removed tanks
- Trench
- Obstructions
- Unremediated areas

Remediation base of excavation (m bgl)

- 1.7
- 2
- 2.2
- 4
- 5

Coordinate System: British National Grid

Metres

0 5 10 20

| F1 | 11.03.24 | RH | NB | CB | CB |
|---|---|---|---|---|---|
| Rev | Date | By | Chkd | Appd | Authd |

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13 Fitzroy Street
London W1T 4BQ
Tel +44 20 7636 1531
www.arup.com

Client

**Folkestone and Hythe District Council**

Project Name

**Ship Street, Folkestone**

Drawing Title

**Summary of obstruction, previous remediation and unremediated areas**

Scale at A3

**1:600**

Role

--

Suitability

**For Issue**

Project Number

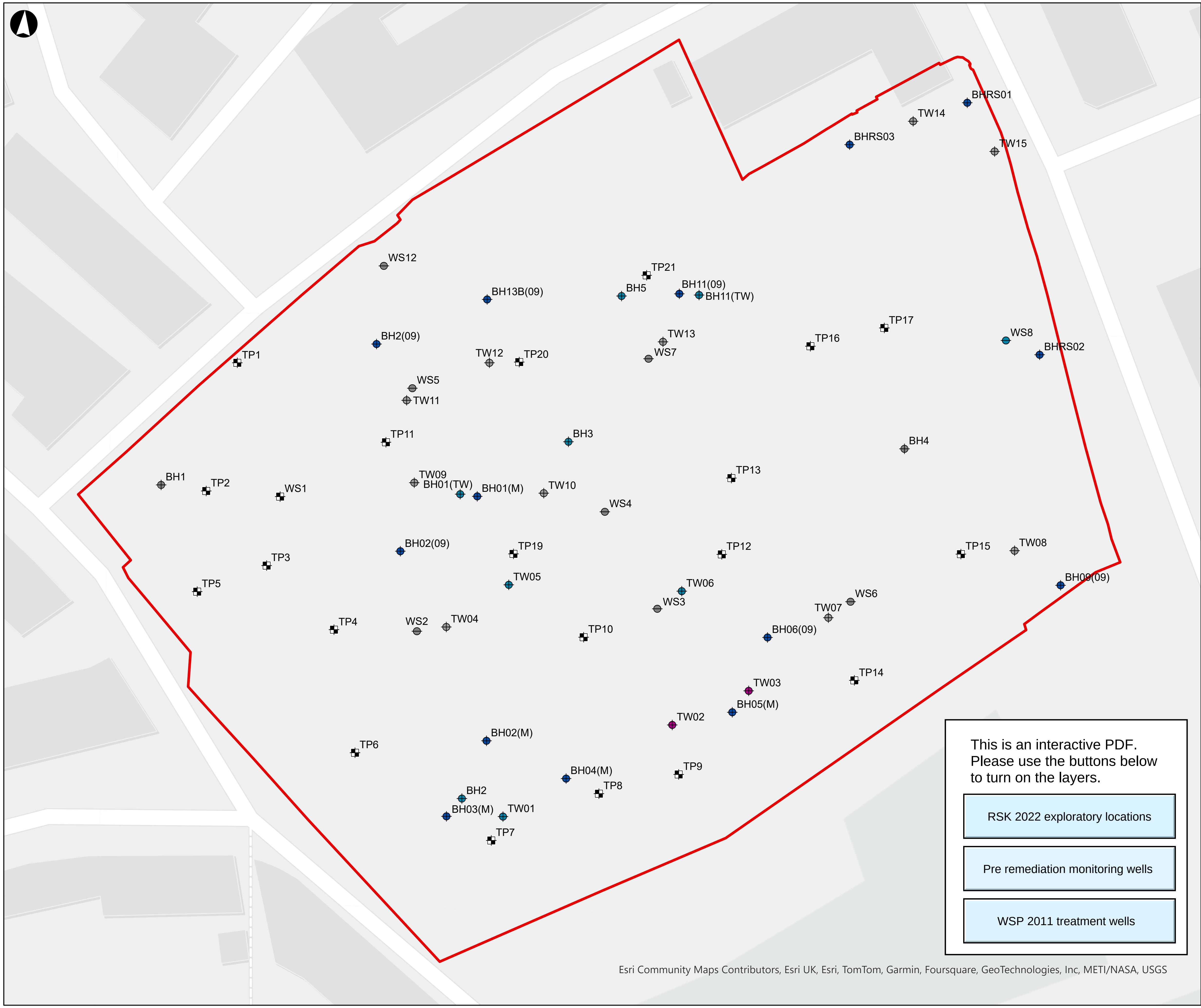
**293441**

Rev

**F1**

Drawing Number

**Drawing 1**




**Legend**

- Site boundary
- Pre remediation monitoring wells

RSK 2022 exploratory locations

- Trial pits
- Window samples - No NAPL
- Window sample - NAPL
- Boreholes - No NAPL recorded
- Boreholes - NAPL recorded

WSP 2011 treatment wells

- No treatment undertaken
- LNAPL recovery
- LNAPL and DNAPL recovery

Coordinate System: British National Grid

Metres
0 5 10 20

| F1 | 13.03.24 | RH | NB | CB | CB |
|---|---|---|---|---|---|
| Rev | Date | By | Chkd | Appd | Authd |

ARUP


13 Fitzroy Street
London W1T 4BQ
Tel +44 20 7636 1531
www.arup.com


Client
**Folkestone and Hythe District Council**

Project Name
**Ship Street, Folkestone**

Drawing Title
**NAPL recovery locations and RSK exploratory location**

Scale at A3
**1:600**

Role
**--**

Suitability
**For issue**

Project Number
**293441**

Rev
**F1**

Drawing Number
**Drawing 2**

12/03/2024 10:22

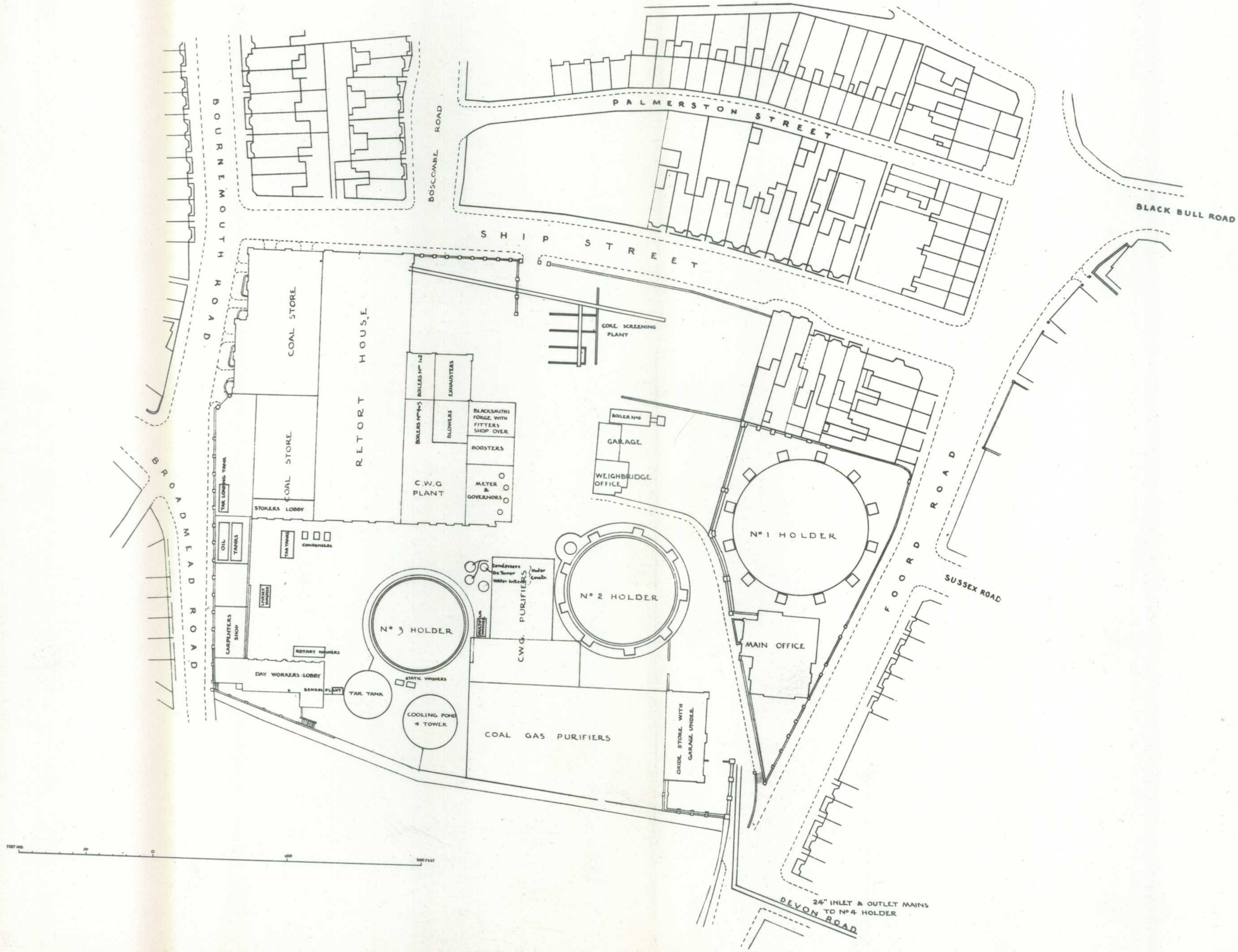
# Appendix A

## Information provided by National Gas Archives

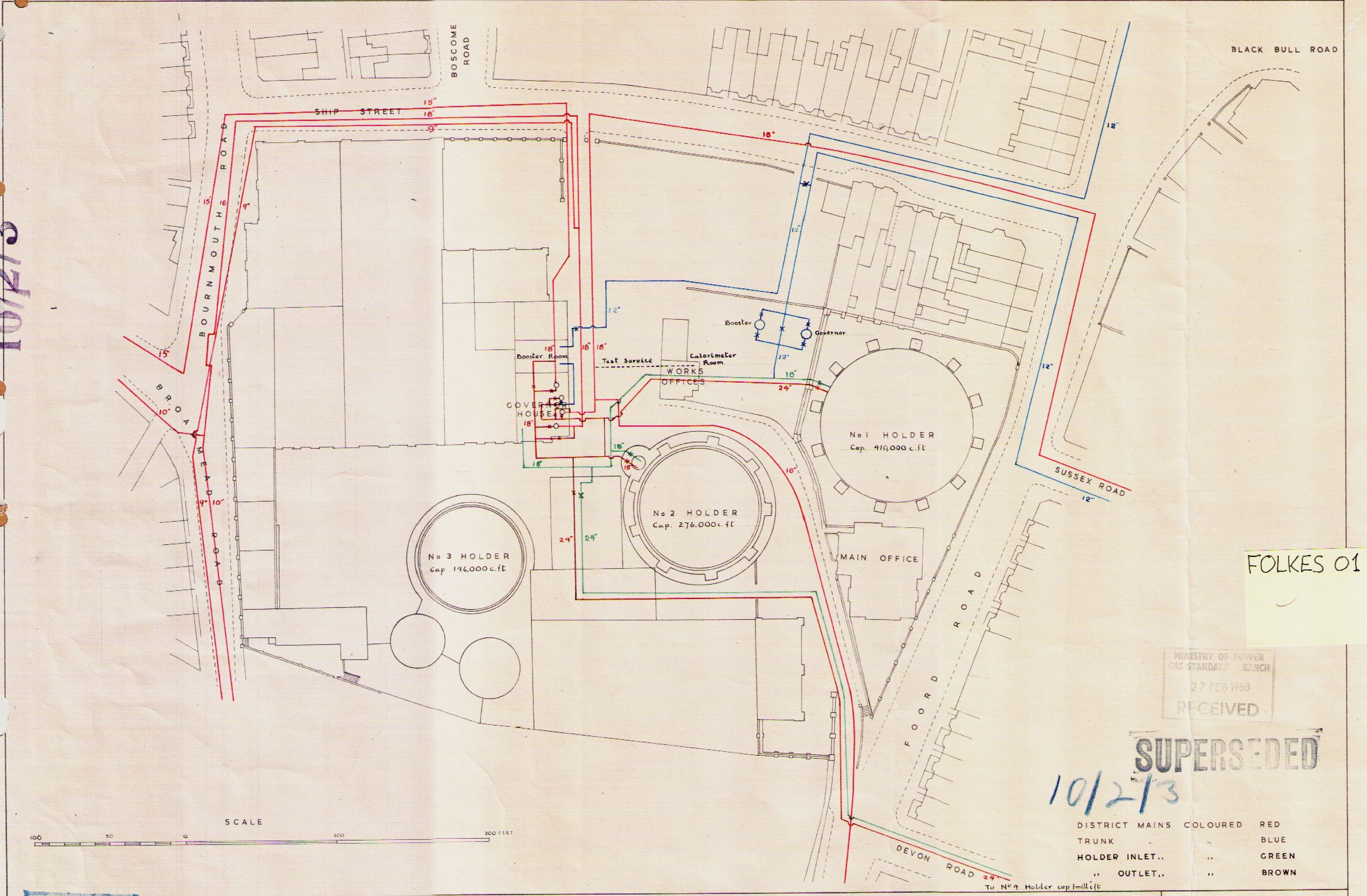
IDENTIFICATION N° 1

# THE FOLKESTONE GAS AND COKE COMPANY

## PLAN OF WORKS, SHIP STREET, FOLKESTONE.




SE/DA/E/B/3/13




DISTRICT MAINS COLOURED RED
TRUNK .. .. BLUE
HOLDER INLET.. .. GREEN
.. OUTLET.. .. BROWN



SUPERSEDED

10/2/3

FOLKES 01

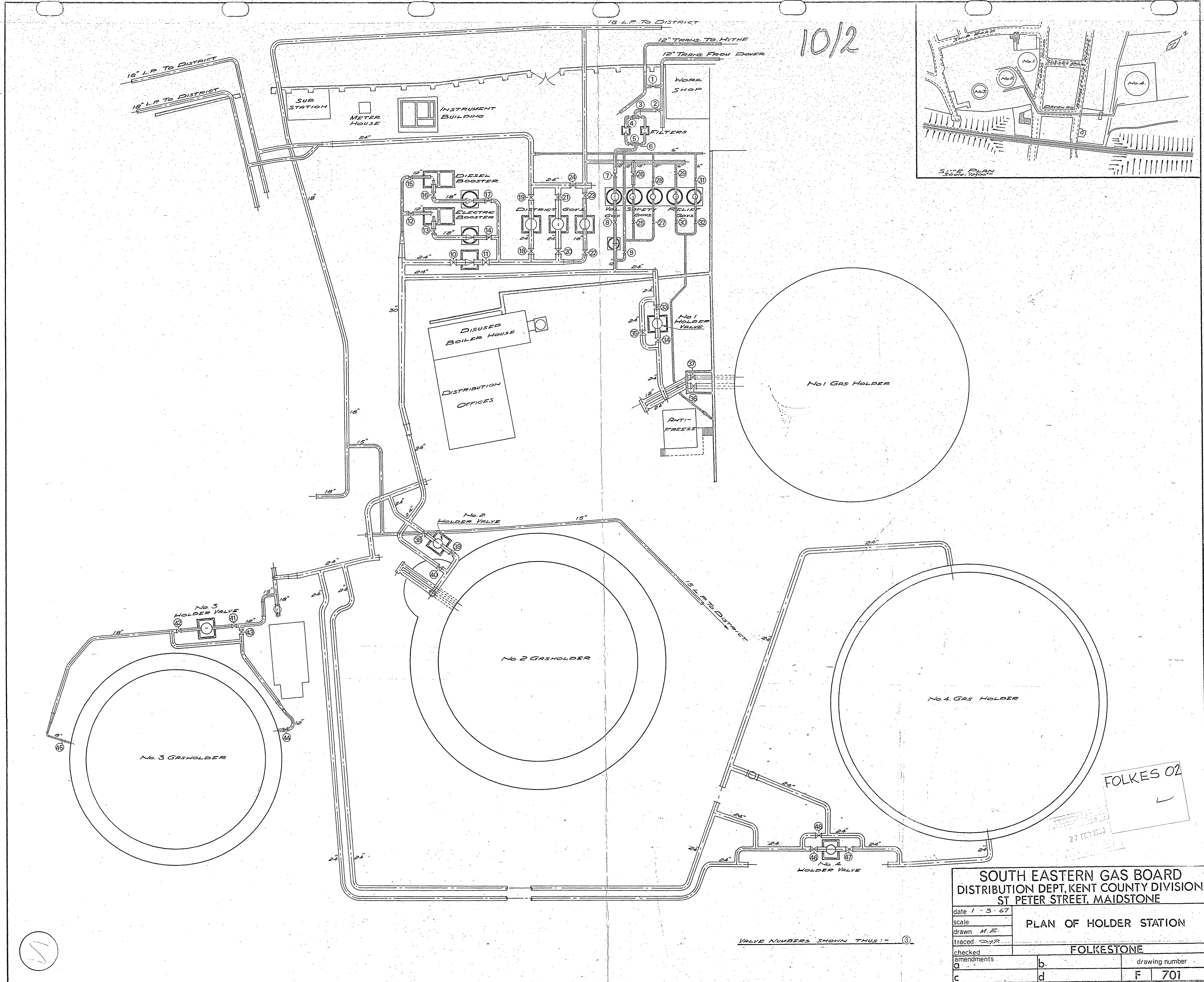


# SOUTH EASTERN GAS BOARD FOLKESTONE UNDERTAKING

## PROPOSED TRUNK MAIN AND DISTRICT CONNECTIONS AT FOLKESTONE

| | |
|---|---|
| REF No | SEGB/D/536/8 |
| DRN BY | RWW |
| DATE | 10 APRIL '51 |

10/2/3




SOUTH EASTERN GAS BOARD
DISTRIBUTION DEPT, KENT COUNTY DIVISION
ST PETER STREET, MAIDSTONE

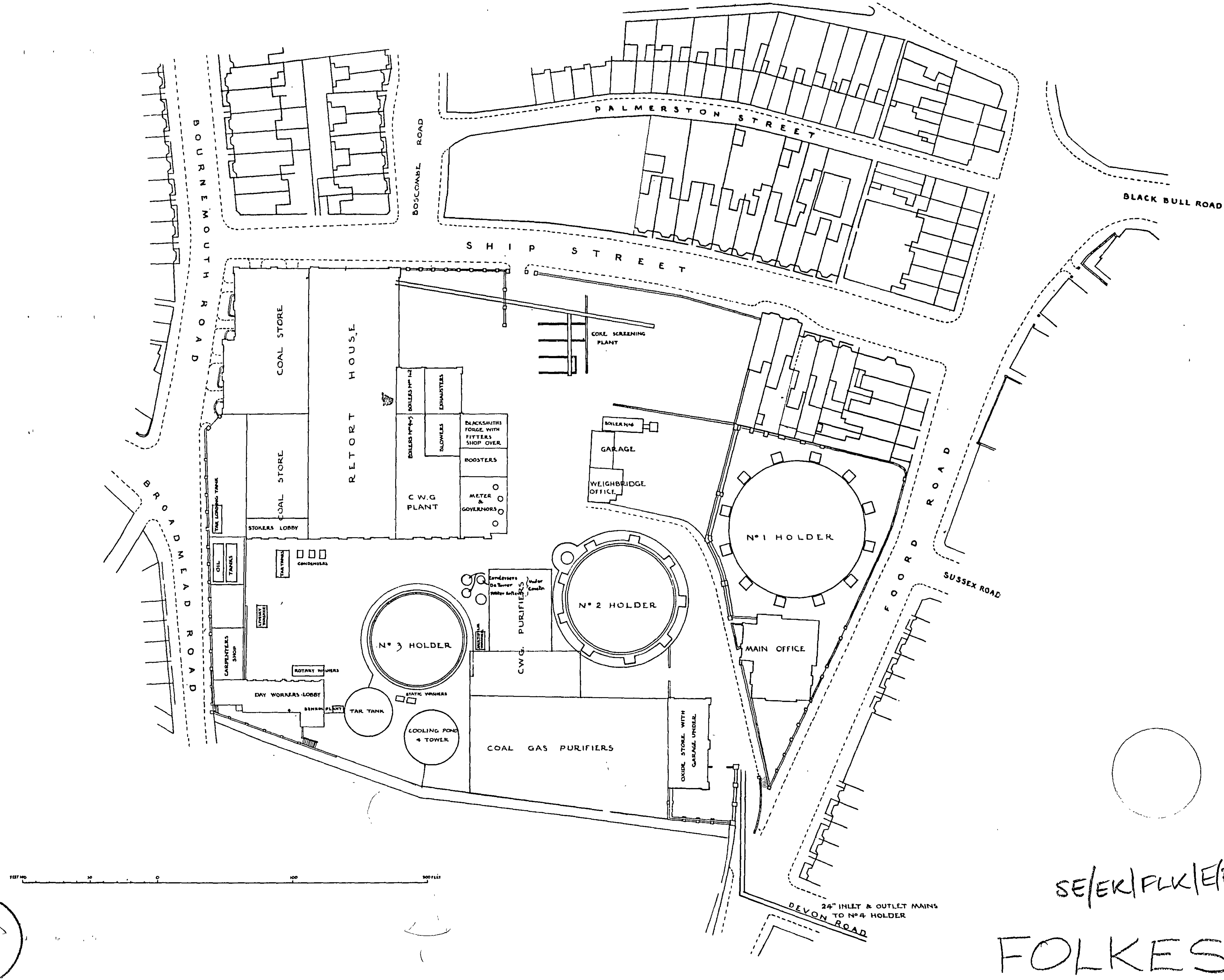
| | |
|---|---|
| date 1 - 3 - 67 | PLAN OF HOLDER STATION |
| scale | |
| drawn M.E. | |
| traced D.T.P. | |
| checked | FOLKESTONE |
| amendments a | b |
| c | d |
| drawing number | F 701 |

SE|EK|FLK|E|E/2

IDENTIFICATION N° I

# THE FOLKESTONE GAS AND COKE COMPANY

## PLAN OF WORKS, SHIP STREET, FOLKESTONE.




SE/EK/FLK/E/E13

FOLKES

## **Folkestone Gas and Coke Company (1842 - 1949)**

The original Folkstone Gas & Coke Company was established in 1842 and incorporated by special AoP in 1865.  The works were situated on Ship St and the lack of railway sidings into the site meant that coal was unloaded at Shorncliffe station and transported to the works by lorry. In 1916 the Hythe and Sandgate Gas Company was amalgamated with Folkstone and in 1933 the Folkstone GCC came under the control of the SE Gas Corporation. On nationalisation in 1949, the undertaking, along with New Romney and Lydd, became part of the Dover Group of the Kent County Division of SEGB

# Appendix B

## Environment Agency response to meeting held on 10 October 2023

Rosie Holden
Arup
8 Fitzroy Street
London
W1T 4BJ

**Our ref:** KT/2023/131050/01-L01
**Your ref:** Ship Street Development

**Date:** 24 November 2023

Dear Rosie Holden,

**Ship Street development – predominantly residential development of former gas works in Folkestone. Up to 150 houses and apartments, 1 commercial unit, public realm including green link and pocket park**

**Former Gasworks, Ship Street, Folkestone**

Thank you for seeking pre-application advice with us on the above proposal.

The scope of works at the above site (as detailed in the presentation provided and the minutes of a meeting between Arup and Environment Agency representatives dated 10th October 2023) is accepted in principle, as being in line with relevant guidance for the re-development of a contaminated site, with regard to issues of concern to the Environment Agency.

We consider Arup to have displayed a good understanding of the conceptual site model of the site and of further work required through the site meeting and presentation provided.

We have the following comments to make with regards to the above information submitted for review:

Non-Aqueous Phase Liquids (DNAPL and LNAPL) were identified in previous Site Investigation Reports undertaken by WSP and remediation works undertaken removed the LNAPL and DNAPL present. Recent monitoring on site, has identified LNAPL rebounding in previously remediated boreholes up to thicknesses greater than those previously identified and remediated.

It is expected that there is potential for a secondary source of contamination on site, which has not been sufficiently identified and delineated through previous investigations. As such, it is agreed that further Site Investigation and conceptual modelling of the site is required to better determine the sources of contamination previously identified on site.

Groundwater Modelling on site has identified a west to south westerly direction of groundwater flow, which follows the current site topography which is defined by two retaining walls, dropping in elevation from 26.67m AOD in the southwest to 22.07m AOD in the southeast. Almost all potential receptors have been identified by Arup in their presentation and previous discussions, however it is noted that the Pent Stream flows 50m to the east of the site and should be considered as a potential receptor.

The Pent Stream is culverted from a similar point at which it flows past the site to the harbour to the south and is potentially encased in concrete for this entire length. This has meant that sampling of the stream has only been conducted upstream where the site is not culverted. We have consulted within the Agency as to any elevations of pollutants within the Pent Stream that may be associated with the gas holder site and can confirm that no such pollutants of concern have been identified. However, it is also noted that the culvert has also only been sampled upstream by the Agency given the likely saltwater mixing at the harbour outlet. It is possible that manholes are present along the culvert that may allow for downstream monitoring, however the locations of these are currently unknown and would require a to visit the area to identify the presence or absence of any such manholes. We have not undertaken such action at the time of this response.

As noted within the meeting minutes provided, it is understood that monitored natural attenuation (MNA) may also be a consideration for remediation in the future, it is recommended that should this be a potential course of action that consideration be made at an early stage to ensure that a sufficient dataset and detailed risk assessment are produced to support such a proposal.

Furthermore, we note that there is potential for piled foundations to be undertaken on site. Given the sensitivity of the underlying groundwater and geology, and previous site use as a gas holder site, we would recommend the production of a Piling Risk Assessment prior to the approval of associated conditions.

Please refer to the attached Environment Agency guidance document "Piling and Penetrative Ground Improvement Methods on Land Affected By Contamination: Guidance on Pollution Prevention". NGWCL Centre Project NC/99/73. A Piling Risk Assessment (PRA) is required to demonstrate that the chosen piling method does not result in deformation of the ground that may lead to an increase in the risk of near-surface pollutants migrating to underlying aquifers. The risk assessment must investigate whether the water environment source-pathway-receptor linkages exist. Further guidance is available on the .gov web site.

Should you wish to discuss these matters further, please contact me via the email below.

Yours sincerely,

**Abbie Philpott**
**Planning Advisor**

KSLPLANNING@environment-agency.gov.uk

# Appendix C

## Advisian/ Worley Parsons NAPL monitoring data between 2011 and 2016

# C.1 Summary of LNAPL monitoring between 2011 to 2016

Table C 1 summarises the WSP, Advisian and Worley Parsons monitoring.

**Table C 1 Summary of WSP/ Advisian/ Worley Parsons LNAPL monitoring**

| Well Identity | May-11 Pre-NAPL Recovery (m) | Nov-11 Post-NAPL Recovery (m) | Apr-12 Post-NAPL Recovery (m) | Nov-14 (m) | Dec-14 (m) | Jan-15 (m) | Sep-16 (m) |
|---|---|---|---|---|---|---|---|
| TW01 | - | - | - | NM | - | - | - |
| TW02 | NM | 0.001 | 1.416 | 1.16 | 0.45 | 0.8 | - |
| TW03 | 0.185 | 0.002 | 0.476 | 0.57 | 0.29 | 0.45 | 0.21 |
| TW04 | - | - | - | 0.01 | NM | 0.01 | NM |
| TW05 | NM | 0.0100 | NM | 0.1 | 0.12 | 0.09 | 0.05 |
| TW06 | - | - | - | 0.19 | 0.2 | 0.17 | 0.20 |
| TW07 | 0.01 | NM | 0.134 | 0.35 | 0.42 | 0.13 | 0.01 |
| TW08 | - | - | - | - | - | - | - |
| TW09 | - | - | - | - | - | - | - |
| TW10 | 0.001 | NM | 0.051 | 0.13 | 0.07 | 0.02 | 0.02 |
| TW11 | NM | NM | 0.020 | 0.01 | - | 0.01 | - |
| TW12 | NM | NM | 0.130 | 0 | NM | 0.61 | 0.01 |
| TW13 | NM | NM | 0.039 | 0.47 | 0.26 | 0.19 | 0.72 |
| TW14 | - | - | - | - | - | - | - |
| TW15 | - | - | - | - | - | - | - |
| BH01(TW) | 0.001 | NM | NM | 1.31 | 0.54 | 0.57 | 0.27 |
| BH01(M) | 1.543 | NM | 0.756 | 1.93 | 1.51 | 0.8 | 0.31 |
| BH2(09) | 0.357 | NM | 0.591 | NM | 1.23 | 0.3 | 0.70 |
| BH02(09) | 0.357 | 0.67 | 0.151 | 0.05 | 0.09 | NM | 0.03 |
| BH02(M) | NM | 0.02 | 0.005 | NM | - | - | - |
| BH03(M) | - | - | - | NM | - | - | - |
| BH04(M) | 0.010 | NM | 0.19 | - | - | - | - |
| BH05(M) | 0.002 | 0.07 | 0.879 | 0.26 | 0.23 | 0.18 | 0.03 |
| BH06(09) | 0.005 | 0.31 | 0.2 | - | NM | - | - |
| BH09(09) | 0.208 | | 0.343 | 0.24 | 0.65 | 0.13 | 0.01 |
| BH11(09) | 1.015 | 0.0600 | 0.051 | NM | 0.07 | 0.01 | NM |

| Well Identity | May-11 Pre-NAPL Recovery (m) | Nov-11 Post-NAPL Recovery (m) | Apr-12 Post-NAPL Recovery (m) | Nov-14 (m) | Dec-14 (m) | Jan-15 (m) | Sep-16 (m) |
|---|---|---|---|---|---|---|---|
| BH11(TW) | - | - | - | 0.09 | 0.94 | 0.36 | 0.25 |
| BH13B(09) | 0.668 | 0.89 | 0.927 | 0.42 | 0.22 | 0.2 | 0.25 |
| BHRS01 | 0.004 | NM | 0.19 | NM | 0.51 | 0.3 | - |
| BHRS02 | - | - | - | - | - | - | - |
| BHRS03 | - | - | - | - | - | - | - |
| NM – Not measurable | | | | | | | |