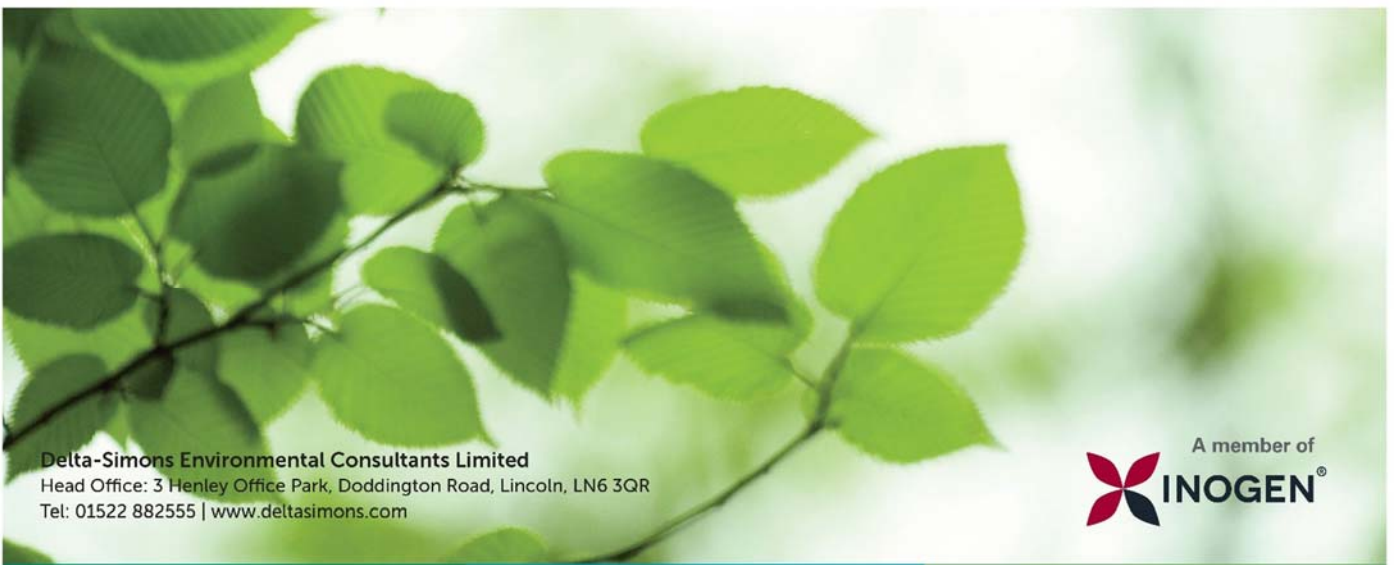


Preliminary Risk Assessment

**Land at Londoneast-uk Business & Technical Park
Presented to NTT Communications Corporation**

Issued: January 2018

Delta-Simons Project No. 17-1150.01






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Report Details

Client	NTT Communications Corporation
Report Title	Preliminary Risk Assessment
Site Address	Land at Londoneast-uk Business & Technical Park, Yewtree Avenue, Dagenham, RM10 7XS
Project No.	17-1150.01
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About us

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Executive Summary

<p>Context and Purpose</p>	<p>The purpose of this Assessment is to support the proposed Data Centre redevelopment of the Site which is has undergone remediation undertaken by EC Harris (formerly ARCADIS) overseeing specialist remediation contractors at the instruction of Sanofi (the former occupier). In addition, the Report will also serve as a document for funding partners, tenants or in the event that the Site is sold at a later date.</p> <p>The application site to which this scheme relates currently benefits from a combination of an outline and partially discharged reserved matters and conditions for three warehouses, a medical centre and a training centre for the London Fire Brigade with ancillary parking, roads and landscaping. These elements will not now be implemented and instead this eastern extremity of the wider former Sanofi site is proposed to deliver two data centre buildings with ancillary infrastructure. This report therefore links the previously authorised remediation works with this free-standing planning application for alternative uses and alternative buildings on this part of the wider pharmaceutical site.</p>
<p>Current Site Use</p>	<p>The Site area comprises an area formerly occupied by chemical manufacture facilities (agrochemical and pharmaceutical) and a landfill (D44). Now non-operational, with all buildings demolished having undergone remediation and groundwater monitoring under the supervision of ARCADIS. A Permeable Reactive Barrier (PRB) is present along the southern boundary adjacent to the railway line, installed by Sanofi to prevent possible off-Site migration of contaminants towards sensitive receptors.</p>
<p>Geology</p>	<p>The Made Ground encountered across the majority of the Site was typically in the range of 1 m to 3 m thick with greater thicknesses encountered in the area of the D44 Landfill. River Terrace deposits were encountered below the Made Ground in the majority of locations and are typically 3 m to 5 m in thickness. A greater thickness of River Terrace Deposits was encountered in the vicinity of the D44 Landfill to a maximum depth of 14.8 m bgl generally comprising very clayey sand. This is considered to be a potential scour hollow which was further investigated and reported in the Scour Hollow Investigation report November 2009 which concluded that the London Clay had not been breached and inferred that there was still up to 10 m of London Clay beneath the scour hollow and above the underlying Lambeth Group and deeper Chalk aquifer.</p>
<p>Environmental Setting</p>	<p>The Site lies within a predominantly commercial/industrial area. The superficial deposits beneath the Site are River Terrace Deposits (Secondary A Aquifer) underlain by the London Clay Formation (Unproductive Strata). The nearest surface water feature is a pond, located approximately 5 m east. The Beam Valley Country Park is located approximately 30 m to the south. The overall environmental sensitivity of the Site's setting is considered to be moderate.</p>
<p>Flood Risk</p>	<p>The Site is not located within an area considered by the Environment Agency (EA) to be at risk from fluvial or tidal flooding.</p>
<p>Historical Review</p>	<p>From a review of the historical maps, potential sources of contamination have been identified on-Site principally associated with the former Sanofi works. Potential historical off-Site sources of contamination located within close proximity to the Site include: railway, sewage works and a factory.</p>
<p>GroundSure Report Summary</p>	<p>From regulatory information listed in the GroundSure Report, no relevant issues have been identified associated with the Site. Located within 250 m of the Site are a mixture of active entries which include: a fuel station, former landfills, former factories, works and an electricity sub-station.</p>

<p>Conceptual Site Model</p>	<p>It is considered that following the completion of soil and groundwater remediation and PRB decommissioning (which is the responsibility of Sanofi/ ARCADIS), and implementation of mitigation measures during development comprising importation of a topsoil capping layer, gas protection measures, and upgraded water supply pipes, that no plausible pollutant linkages would remain with respect to Human Health.</p> <p>It is, therefore, considered that the Site represents a Low risk to Human Health and controlled water in the context of the proposed commercial development assuming normal brownfield development protocols are recognised and observed.</p>
<p>Recommendations for Development</p>	<p>A geotextile membrane and minimum 600 mm of certified suitable for use top soil and subsoil overlying a geotextile marker membrane and capillary break layer will be incorporated into all new landscaped areas.</p> <p>As from the results of the ground gas assessment, ground gas protection measures, in accordance with BS8485:2015, are required for any new buildings proposed at the Site (upgraded to include a hydrocarbon/ VOC resistant membrane).</p> <p>The local water authority will require upgraded potable water pipes and/or dedicated isolated clean sewer runs due to the potential for hydrocarbon contamination of shallow soils, which may infiltrate water supply pipework.</p> <p>A 'Hotspot' protocol will be in place for groundworkers and sub-surface maintenance workers to act upon should areas of suspected significant contamination be identified during the groundworks.</p> <p>Any ground/ construction workers who are required to undertake sub-surface work at the Site will be made aware of the possibility of encountering localised contamination (specifically residual asbestos within D44 Landfill area) and safe working practices and use of appropriate PPE should be implemented to mitigate the risks.</p> <p>It is understood that earthworks will be required in order to form developable platforms, and to enable obstruction removal works to facilitate piling. A piling risk assessment and Materials Management Plan will be designed, giving consideration to the waste hierarchy, in order to reduce the amount of material requiring off-Site disposal. If considered necessary, a waste classification exercise could be completed in order to determine the likely disposal costs of soils requiring off-Site disposal.</p>
<p>This is intended as a summary only. Further detail and limitations of the assessment is provided within the main body of the Report.</p>	

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1.0 Introduction

1.1 Appointment

Delta-Simons Environmental Consultants Limited ('Delta-Simons') was instructed by NTT Communications Corporation (the 'Client') to carry out a Preliminary Risk Assessment, including a review of previously completed investigation, remediation and verification completed by others, of a plot of land forming part of the former Sanofi Works in Dagenham, East London which is proposed for redevelopment as a Data Centre (hereafter referred to as the 'Site'). A Site location map is presented as Figure 1.

1.2 Context & Purpose

The purpose of this Assessment is to support the proposed commercial redevelopment of the Site which has undergone remediation undertaken by EC Harris (formerly ARCADIS) overseeing specialist remediation contractors at the instruction of Sanofi (the former occupier). In addition, the Report will also serve as a document for funding partners, tenants or in the event that the Site is sold at a later date.

The site benefits from a number of outline and reserved matter permissions. Outline planning permission (11/01044/OUT) on the wider site was granted by the London Borough of Barking & Dagenham in March 2012 for:

'Permission for Mixed use redevelopment comprising erection of up to 30,000m² of buildings (Use classes B1(c), B2, B8, D1), retention and re-use of 41,637 m² of buildings (Use classes B1, B2, B8, D1) including up to 3,500 m² healthcare building (Use class D1), erection of 9,816 m² training centre (Use class D1), 9,276 m² supermarket including petrol station, 80 bed hotel and restaurant (Use class C1) and 2 floodlit synthetic turf football pitches with associated landscaping and parking.'

In February 2015, a replacement planning permission was issued as a result of a s73 planning application to vary Conditions 5 (Approved Parameter Plans) and 24 (Car Parking) (14/00959/OUT) which relocated the position of the hotel element and increased the total number of car parking spaces accessible from Rainham Road South from 700 spaces to 763. A further adjustment to the consent (Conditions 5 and 24) was made in July 2015 which updated the Parameter Plans to reflect an amended site layout, size of buildings and to increase the allowable building heights on Areas 3, 4a & 4b from 12 m to 15 m. Condition 24 was amended to increase the amount of car parking spaces in areas 3, 4a and 4b from 120 to 147.

An application for the Approval of Reserved Matters (Appearance, Scale, Layout, Access & Landscaping) for the Erection of Units A, B, C, D1, D2, D3 & the Medical Centre within Areas 4a & 4b was approved on 10 October 2016. The approval of the relevant outline conditions was submitted to and approved by the Council on 22 November 2016. The approved development was partially implemented on 10 April 2017 with Units A & C constructed to shell level, with the platform for Unit B completed. Development has paused on these buildings pending discussions with the Council regarding the potential re-purposing of these buildings for film studio use.

Elsewhere on the former Sanofi site further planning permissions have been granted for a public house (constructed), a hotel (under construction), a supermarket (now lapsed), the delivery of the ELUTEC school (constructed) and the delivery of a costa coffee house (pending).

In this context the application site to which this scheme relates currently benefits from a combination of an outline and partially discharged reserved matters and conditions for three warehouses, a medical centre and a training centre for the London Fire Brigade with ancillary parking, roads and landscaping. These elements will not now be implemented and instead this eastern extremity of the wider former Sanofi site is proposed to deliver two data centre buildings with ancillary infrastructure.

To assist the reader, in addition this report refers to remediation works already completed by Sanofi / Arcadis as part of the discharge of site wide conditions under planning reference 12/00917/CDN.

The principal aims of a Phase I Environmental Assessment, as stated in British Standard BS10175:2011, are to obtain information in order to:

- ▲ Evaluate the environmental setting of the Site and to identify sensitive receptors;
- ▲ Provide information from which possible contaminant-pathway-receptor relationships can be identified; and
- ▲ Formulate a Conceptual Site Model (CSM) to consider the significance of the contaminant-pathway-receptor relationships and identify whether further investigation is required.

Delta-Simons has completed a Ground Gas Monitoring Assessment Report (reference 15-0273.02 dated November 2016), outlining the requirements for ground gas protection measures for the proposed development.

The following third party documentation relating to the Site has been reviewed by Delta-Simons, which have been used to inform relevant sections of this Report:

- ▲ Abstraction Well Decommissioning, Dagenham, Sanofi-Aventis by BAE Systems Environmental dated November 2008;
- ▲ Historical Data Review, Dagenham Facility by ARCADIS Geraghty & Miller International Ltd dated December 2008;
- ▲ Baseline Groundwater Monitoring Report, Dagenham Facility by ARCADIS Geraghty & Miller International Ltd dated May 2009;
- ▲ Site-Wide Investigation Report, Dagenham Facility by ARCADIS Geraghty & Miller International Ltd dated November 2009;
- ▲ Scour Hollow Investigation Report, Dagenham Facility by ARCADIS Geraghty & Miller International Ltd dated November 2009;
- ▲ Annual Report on the Monitoring and Assessment of the PRB, Dagenham Facility by ARCADIS (UK) Ltd dated January 2010;
- ▲ Updated Site-Wide Detailed Quantitative Risk Assessment, Dagenham Facility by ARCADIS (UK) Ltd dated July 2011;
- ▲ Sediment and Surface Water sampling of Boyers Pond, Dagenham Facility by ARCADIS (UK) Ltd dated November 2011;
- ▲ Remediation Priority Areas Validation Plan, Dagenham Facility by ARCADIS (UK) Ltd dated November 2011;
- ▲ Quantitative Risk Assessment for Boyers Pond, South of Dagenham Facility by ARCADIS (UK) Ltd dated March 2012;
- ▲ Site Wide Remediation Areas Validation Plan, Dagenham Facility by ARCADIS (UK) Ltd dated May 2012;
- ▲ D44 Landfill Remediation Validation Report (Landfilled Material), Dagenham Facility by ARCADIS (UK) Ltd dated September 2012;
- ▲ Former D44 Landfill Groundwater Remediation Implementation Plan, Dagenham Facility by ARCADIS dated June 2013;
- ▲ PRB Groundwater Monitoring Report - August 2013, Dagenham Facility by ARCADIS dated September 2013;
- ▲ Biannual Site-Wide Groundwater Report – August 2013, Dagenham Facility by ARCADIS dated September 2013;
- ▲ Regulatory Correspondence provided by ARCADIS;
- ▲ PRB Biannual Performance Monitoring Report – March 2014, Dagenham Facility by ARCADIS dated May 2014;
- ▲ Biannual Site-Wide Groundwater Report – March 2014, Dagenham Facility by ARCADIS dated June 2014;
- ▲ PRB Biannual Performance Monitoring Report – October 2014, Dagenham Facility by ARCADIS dated December 2014;
- ▲ Biannual Site-Wide Groundwater Report – October 2014, Dagenham Facility by ARCADIS dated January 2015;

- ▲ Conditional Sale and Purchase Agreement;
- ▲ Environmental Liability Deed (dated June 2015);
- ▲ Back Plot A, Dagenham Facility – Validation Report by ARCADIS (reference 2712710702_01) dated March 2016;
- ▲ Back Plot B, Dagenham Facility – Validation Report by ARCADIS (reference 2712710702_01) dated April 2016; and
- ▲ Site Wide Groundwater Monitoring Report – May 2016 by ARCADIS (reference 2572312803_01) dated August 2016.

In addition, reference has been made to a GroundSure report EnviroInsight, GeoInsight and historical mapping, presented as Appendix B.

1.3 Background

The Site forms part of a former chemical works operated by Sanofi. The plot under consideration, the “Phase II” development area, referred to here as the ‘Site’, is an approximate 6 ha area of the wider former Sanofi owned area of former works, proposed for commercial development.

Sanofi has appointed ARCADIS to carry out a programme of Site investigation and remediation works covering the whole area occupied by the Sanofi ownership, in order to achieve ‘significant betterment’, in particular with regard to groundwater quality. The active remediation works were predominately completed in 2014, with ongoing remediation in the Permeable Reactive Barrier (PRB) Wayleave (a small area within Remediation Priority Area (RPA) 1) and validation monitoring still ongoing for RPA 3 and Defined Remediation Area (DRA) 14, in the Science and Technology Park (adjacent to the western Site boundary). The remediation was followed by validation monitoring of groundwater. Additional monitoring with respect to the proposed decommissioning of the Permeable Reactive Barrier (PRB) will be required as per the conditions of the Local Planning Authority.

As part of their assessment ARCADIS divided the Sanofi facility into three principal areas based upon historic, current and proposed future use which are summarised in Table below.

Area	Historical Use	Current Use	Intended Use
Retained Land	Chemical manufacture (agrochemical and pharmaceutical)	Pharmaceutical manufacture until June 2013, now Science and Technology Park.	Science and Technology Park.
Surplus Land	Chemical manufacture (agrochemical and pharmaceutical) and landfill (D44)	Non-operational. Buildings demolished, undergoing remediation/ commercial development.	Commercial redevelopment.
Green Belt	Gravel extraction, landfill and allotments	Recreational ground and car parking.	Recreational ground and car parking.

The “Phase II” development Site area under consideration with respect to this Report includes a significant proportion of the ‘Surplus Land’ which was further sub-divided into 9 Zones by ARCADIS. The subject Site comprises Zones 5 to 7 and approximately half of Zone 8. The Environmental Executive Summary issued by Sanofi (April 2014) shows the Site under consideration by the Client as an area labelled “Back Plot B” and in part “Back Plot A”, with Site access to the north through the “Green Belt” land. The validation monitoring and validation reports completed by ARCADIS have been divided into these two areas.

A Site layout plan is presented as Figure 2.

1.4 Limitations

The standard limitations associated with this assessment are presented in Appendix A.

2.0 Site Description, History and Environmental Setting

2.1 Site Details

National Grid Reference (NGR)	The approximate NGR for the centre of the Site is 550830, 185310. A Site location map is presented as Figure 1.
General Site Location	The Site is part of the wider former Sanofi facility located on Rainham Road South, Dagenham, Essex. A Site layout plan is presented as Figure 2.
General Site Description	The Site area comprises an area formerly occupied by chemical manufacture facilities (agrochemical and pharmaceutical) and a landfill (D44). Now non-operational, with all buildings demolished having undergone remediation and groundwater monitoring under the supervision of ARCADIS. A Permeable Reactive Barrier (PRB) is present along the southern boundary adjacent to the railway line, installed by Sanofi to prevent possible off-Site migration of contaminants towards sensitive receptors. There a numerous monitoring wells across the Site, a selection of which form a network of validation monitoring wells.
Surrounding Area	The Site itself is bound to the west by former pharmaceutical manufacturing buildings (which ceased operations in June 2013 to become a Science and Technology Park) and Green Belt land to the north, and pond, D68 Landfill and Green Belt land to the east, railway lines and Beam Valley Country Park (including ponds) to the south, beyond which are residential properties, and surplus land proposed for retail/ commercial development to the west. The River Beam is located to the south-east and the culverted Wantz Brook to the south-west.

2.2 Site Geology

The published geology for the area indicates that the majority of the Site is underlain by River Terrace Deposits (gravels) which in turn are underlain by the London Clay followed by the Lambeth Group (predominantly clays and sands) and the Thanet Sand Formation. The Upper Cretaceous Chalk underlies the Thanet Sand Formation.

The BAE Abstraction Well Decommissioning Report indicates that one of the four former abstraction wells was situated in close proximity to the Site where there was approximately 5 m of Made Ground, 20 m of London Clay and 35 m of Lambeth Group deposits with Chalk encountered at approximately 60 m depth below ground level (bgl). The other three wells had similar stratigraphic profiles. These wells were decommissioned by BAE in line with Environment Agency (EA) guidance. It is understood that Sanofi no longer make any payments for the abstraction of groundwater and there is no record of an abstraction licence Geolinsight data report.

The Made Ground encountered across the majority of the Site was typically in the range of 1 m to 3 m thick with greater thicknesses encountered in the area of the D44 Landfill.

River Terrace deposits were encountered below the Made Ground in the majority of locations and are typically 3 m to 5 m in thickness. A greater thickness of River Terrace Deposits was encountered in the vicinity of the D44 Landfill to a maximum depth of 14.8 m bgl generally comprising very clayey sand. This is considered to be a potential scour hollow which was further investigated and reported in the Scour Hollow Investigation report November 2009 which concluded that the London Clay had not been breached and inferred that there was still up to 10 m of London Clay beneath the scour hollow and above the underlying Lambeth Group and deeper Chalk aquifer.

The base of the London Clay was not proven as part of the ARCADIS investigations.

An indicative geological cross section is presented as Figure 3.

The Site is not located within an area, which may be affected by coal mining issues.

No radon protective measures are necessary in the construction of new buildings within the area of the Site.

2.3 Site Hydrogeology/Hydrology

The depth to groundwater at the Site is typically between 1.0 m and 2.5 m bgl within the River Terrace Deposits which is classified as a Secondary A Aquifer.

Groundwater flow within the River Terrace deposits is generally towards the south with south-easterly and south-westerly components towards the River Beam and Wantz Brook respectively. It is therefore, considered that the shallow groundwater in the River Terrace Deposits is in hydraulic continuity with the ponds to the south of the Site in the Beam Valley Country Park and the River Beam and potentially also the Wantz Brook (although this is culverted in the area closest to the Site).

The deeper chalk aquifer is classified as a Principal Aquifer but is considered to be afforded protection from contamination in the River Terrace Deposits by the presence of the London Clay.

Groundwater contours and inferred flow direction are shown on Figure 4.

From information provided within the GroundSure Report, and as mentioned in the previous section, there are no longer any active groundwater abstractions on-Site.

According to the GroundSure Report, there are 14 surface water features within 250 m of the Site, the closest of which is an unnamed tertiary river, located approximately 3 m north of the Site.

From information provided within the GroundSure Report, there are no surface water abstractions located within 2 km of the Site.

2.4 Flooding

According to the GroundSure Report, the Site is not located in an area at risk of flooding from rivers and seas.

2.5 Ecological Receptors

According to the Groundsure Report, there are 13 Local Nature Reserves (LNR) within 2 km of the Site, which relate to four different named areas, Beam Valley (located directly to the south of the Site), The Chase, East Brookend Country Park, and Dagenham Village Churchyard.

2.6 Environmental Sensitivity

Based upon the available information, the Site setting is considered to be of a moderate environmental sensitivity.

2.7 Historical Use of the Site & Surrounding Area

On-Site Features	Location
Stockdale Farm, consisting of several small buildings is present in the west of the Site from the earliest mapping of 1862.	West
Several buildings across the Site are marked as present in 1969 mapping. Further redevelopment of existing works buildings, and the addition of tanks are shown circa 2002.	Across the Site
Between 2002 and 2010 the majority of the buildings on Site have been demolished, leaving the Site largely vacant and considered representative of its current form	Across the Site

On-Site Features	Direction	Approximate Distance from the Site (m)
A railway track from circa 1895 until present.	South	10
Dagenham train station from circa 1895 until present.	South-West	350
A Sewage works appears from circa 1895 and by circa 1955 is expanded into a larger works, which is no longer present by 1973 map edition.	South-East	450
A man made pond (later named Beam Valley Country Park), from circa 1955 to present.	South-West	30
Works buildings associated with those on-Site from circa 1969. Some of the buildings are no longer present by 2010 mapping, with the remaining buildings still present until at least 2014.	West/ North-West	20
A Scrap Yard appears between 2002 and 2012 map editions, and is still present until at least 2014.	South-East	500
A works, believed to be associated with a landfill is present only on the 1975 map edition.	East	100

2.8 Environmental Database Review

The full GroundSure Report provides a database of environmental information, and the most relevant information is summarised below.

Information Type	0 – 250 m	251 – 500 m	501 m – 1 km	Details/Comments
Historic IPC Authorisations	0	0	19	All of these relate to either Aventis Pharma Ltd or Rhone Poulenc Rorer Ltd, located circa 550 m west of the Site, at various dates from 1994 to 2000.
Discharge Consents	0	1	-	The entry is located approximately 370 m south of the Site and relates to Site drainage, registered to Rhone Poulenc Rorer Ltd, issued 1992 and revoked in 2009.
IPPC Part A (2) and Part B	4	1	-	The two closest are located approximately 150 m west of the Site and relate to Chemical process, and formulation and finishing of Pharmaceutical Products by Aventis Pharma.
Records of Category 3 or 4 Radioactive Substances Authorisations	0	0	6	The closest entry is approximately 500 m west of the Site, relating to the accumulation of radioactive waste, approved in 2000 for Argenta Discovery Ltd and has since been revoked. The other five entries are all located approximately 510 m west of the Site, registered to Aventis Pharma Ltd or Rhone Poulenc Rorer Ltd, with one for the keeping and use of radioactive materials, and the rest for the disposal of radioactive waste.
National Incidents Recording System, List 2	3	4	-	Two of the entries are located off Site circa 150m to the west, both occurring in 2002, relating to minor air impact by atmospheric pollutants. Another entry is located 50 m east of the Site for minor water impact by microbiological pollutants, also in 2002. Two entries for significant water impact by microbiological pollutant occurred in 2003, approximately 260 m north of the Site.
EA Registered Landfill Sites	0	0	1	The entry is for a landfill taking non-biodegradable wastes, located approximately 990 m south of the Site.
EA Historical Landfills	3	0	5	The three closest entries are all within 100 m to the east/north-east of the Site relating to commercial or inert waste. One of these, located approximately 40 m north-east of the Site, has been identified as contaminated land under section 78R of the Environmental Protection Act 1990.
BGS/DoE non-operational landfill sites	1	0	1	The closest entry is located approximately 100 m east of the Site and is reported as being no risk to aquifer.
Local Authority Landfill Sites	0	0	2	Both entries relate to a Refuse Tip located approximately 970 m east of the Site and identified on 1962 and 1963 mapping.
Waste Treatment, Transfer or Disposal Sites	0	2	0	Both entries relate to a Scrap Yard approximately 400 m south of the Site, dated 1990.
EA licensed waste sites	0	0	2	The closest entry is located approximately 660 m north-west of the Site, relating to a metal recycling site, issued in 2012 and appears to be currently active.
Current Industrial Data	12	0	-	There are four entries on-Site that include gas features, generic tanks, and unspecified works or factories. The other eight entries are off-Site within 250 m of the Site and include an underground network station, electrical features, unspecified works or factories, and generic tanks.
Fuel Station Entries	0	1	-	The entry is located approximately 490 m south-west of the Site, for a BP fuel station, which is still active.

3.0 Contamination and Remediation Review

ARCADIS has carried out a staged assessment of contaminated land in accordance with the principles set out in CLR11. The staged assessment comprises desk-top study, site investigation (Phase II), and quantitative risk assessment in line with the source-pathway-receptor principle, development of remediation strategy and implementation and validation of remediation. The Sections below set out a summary of the key findings of the investigations, and the principles of the remediation programme.

Relevant correspondence with the EA confirming their acceptance of the approach undertaken by ARCADIS at various stages in the process are included as Appendix C and are referenced in the Sections below.

3.1 Identified Contamination

The previous investigations at the Site have identified a wide range of contaminants in soil and groundwater. These have been grouped by ARCADIS as follows:

- ▲ Metals (arsenic and mercury);
- ▲ Chlorinated aliphatics;
- ▲ Chlorinated aromatics;
- ▲ Benzene, Toluene, Ethylbenzene, Xylenes (BTEX) and trimethyl-benzenes (previously referred to as hydrocarbon volatile organic compounds (VOCs) in the Historical Data Review and Baseline Groundwater Monitoring reports);
- ▲ Extractable Petroleum hydrocarbons (EPH);
- ▲ Polychlorinated biphenyls (PCBs, only in soil as insoluble);
- ▲ Tentatively identified compounds (TICs); and
- ▲ Other pharmaceutical/ industrial compounds identified by accurate mass LC-MS-MS.

The latter identified over 800 compounds during screening of soil and groundwater samples. The methodology accurately identifies compounds but provides only indicative concentrations. Compounds identified in soil (with indicative contaminant mass of 1 mg/kg) and groundwater (with indicative contaminant mass greater than 1 mg/l) were initially allocated into one of four primary classification groups:

- ▲ Pharmaceuticals;
- ▲ Pesticides (herbicides, insecticides and fungicides);
- ▲ Miscellaneous compounds; and
- ▲ Unidentified compounds.

Following this segregation, the majority of identified compounds encountered were found to be pharmaceuticals which were subsequently divided into a further five sub-groups:

- ▲ Sulphonamides;
- ▲ Barbiturates;
- ▲ Anti-psychotic compounds;
- ▲ Anti-histamine compounds; and
- ▲ Miscellaneous pharmaceuticals.

The distribution of the contaminants is described in detail in the ARCADIS/ EC Harris reports and has been the driver for the risk assessment and subsequent remediation that has been undertaken and concluded on Site. The risk assessment and remediation relevant to the Site is summarised in the sections below.

3.2 Risk Assessment

The Site Wide Detailed Quantitative Risk Assessment (DQRA) selected 55 representative contaminants of concern which was increased in the Updated Site-Wide DQRA report following the results of additional investigation works (primarily on the retained land to the north of the Site under consideration here).

In terms of potential risks to off-Site receptors the DQRA was undertaken on the assumption that the PRB was not present. This approach was supported by the EA as this was recognised as a future consideration for validation monitoring and developing future targets for the decommissioning of the PRB.

With respect to Human Health the relevant on-Site receptors considered as part of the DQRA were commercial workers and off-Site residential receptors beyond the large and small unnamed ponds to the south of the Site, approximately 150 m at their closest point.

In terms of environmental receptors considered relevant to the Site, the DQRA considered the:

- ▲ Secondary (A) Aquifer beneath the Site;
- ▲ Small unnamed pond, located approximately 80 m south of the Site;
- ▲ Large unnamed pond approximately 40 m south of the Site (referred to as Boyer's Pond in later reports);
- ▲ The Wantz stream (including culvert), located over 300 m to the south-west of the Site;
- ▲ The River Beam, located approximately 100 m south-east of the Site at its closest point; and
- ▲ The Beam Valley Local Nature Reserve.

Exceedances of Site-Specific Assessment Criteria (SSAC) relevant to the Site were identified as part of the assessment.

For future on-Site commercial workers, risks to Human Health were identified with respect to several soil contaminants in the area of the D44 Landfill and in the west of the Site due to elevated concentrations of chloroform. On-Site risks to Human Health were also identified with respect to concentrations of chloroform, trichloroethene and vinyl chloride in groundwater via the vapour inhalation pathway.

With respect to neighbouring residents, no exceedances with respect to Human Health were identified in relation to contaminant concentrations in soils (which could potentially leach into groundwater, migrate towards and beneath the residential properties and then volatilise). Potential off-Site risks to neighbouring residents were, however, identified with respect to recorded concentrations of contaminants in groundwater including chloroform, cis-1,2-dichloroethene, trichloroethene, vinyl chloride and amphetamine (the latter was risked out due to very localised occurrence). In addition, it is recognised that the SSAC derived for environmental protection are much more stringent than the SSACs for Human Health and, therefore, there should be a negligible risk to off-Site residential receptors following remediation (this was also backed up by groundwater and surface water monitoring within the Beam Country Park).

Several contaminants (chlorinated aliphatics, chlorinated aromatics, BTEX and various pharmaceuticals) were found to exceed SSAC for protection of environmental receptors, the majority of which were recorded in groundwater.

3.3 Remediation Strategy

The Site Wide Detailed QRA (and its update) were utilised to devise the remediation strategy for the Site which was agreed with the EA, and discussed with the Local Authority (LA) in meetings. Remediation was deemed to be necessary in the following areas (relevant to the Site):

- ▲ D44 Landfill (eastern part of the Site – primarily within Zone 7);
- ▲ Three Remediation Priority Areas (RPAs);
- ▲ RPA 1 - western part of the Site adjacent to Site boundary (overlaps with retail development area further to the west);

- ▲ RPA 2 - eastern part of the Site adjacent to the southern boundary;
- ▲ RPA 3 - borders the north of the Site within area designated as the Science Park); and
- ▲ Site wide remediation areas in groundwater.

Remediation targets and methodologies (and validation plans) were agreed with the EA and are briefly summarised below. It is considered that remediation works within Back Plots A and B have been completed in accordance with the relevant Remediation Implementation Plans, have achieved the aims and objectives, and have been 'signed-off' from the LA and EA (London Borough of Barking & Dagenham Application 16/00926/CDN, dated 17th October 2016; attached as Appendix C).

Key remediation areas are shown on Figure 5.

3.4 D44 Landfill

3.4.1 Landfilled Materials

The remediation of the D44 landfilled material involved the following key scope of works:

- ▲ Contaminant reduction and breaking of source-pathway-receptor linkages;
- ▲ Asbestos – reduction of the amount of larger pieces of suspected asbestos containing material (ACM) found in the waste;
- ▲ Glassware – to break up glassware found in the waste; and
- ▲ Re-use and backfilling of validated materials.

The remediation of the D44 Landfill comprised a treatment train approach and included the following processes:

- ▲ Excavation of landfill materials;
- ▲ Material screening, segregation and crushing;
- ▲ Soil washing;
- ▲ Asbestos handpicking;
- ▲ Chemical oxidation of fines produced from soil washing; and
- ▲ Placement of materials at depth.

A water treatment plant was also used to process water from soil washing and dewatering of excavations where necessary with the treated water discharged under consent to foul sewer.

It is important to note that while approximately 50 tonnes of ACMs were removed during the remediation of the D44 Landfill materials it is stated in the ARCADIS/ EC Harris Validation Report that this process facilitated betterment with respect to asbestos but did not completely remove asbestos from remediated materials. A cover layer comprising approx. 100 mm recycled aggregate was placed over remediated materials which could still contain asbestos.

Backfill materials containing concentrations of arsenic above the Human Health SSAC were placed at a depth of >0.5 m bgl to manage the direct contact and dust inhalation pathways.

The remediation of the D44 Landfill material has been approved by both the EA and LA.

3.4.2 D44 Landfill Groundwater

Concentrations of target contaminants in groundwater recorded during a single monitoring visit within 6 months of the completion of the D44 landfilled material remediation did not record concentrations in excess of Human Health SSAC. Exceedances of environmental SSACs were, however, detected and the area defined for groundwater remediation has been identified as Defined Remediation Area 18 (DRA 18) in alignment with the Site-Wide Remediation nomenclature, discussed further in section 3.6.

The specific objective of the groundwater remediation in the D44 landfill area is to:

- ▲ Reduce contaminant concentrations of Site-specific quantified compounds within groundwater beneath the former D44 landfill area and demonstrate betterment through validation monitoring.

Performance criteria will be considered to have been met when one or more of the following criteria have been achieved:

- ▲ Contamination mass reduction (assessed through measurement of indicator compounds, sum of Site-specific pharmaceutical compounds and VOCs) reaches an asymptotic condition and or cost benefit analysis indicates that additional remediation works cannot be justified considering likely improvement to the Site condition that could be achieved versus environmental and financial considerations; and
- ▲ A revision of the risk assessment, justified by changes in the plume geometry or the conceptual understanding of the Site, indicates that the reduced residual mass of representative contaminants of concern (CoCs) do not present a potential risk to the identified receptors.

The remediation for DRA 18 consisted of groundwater pumping and treatment with Granular Activated Carbon (GAC) and discharge of treated water. It is understood that groundwater treatment in this area has been completed, and is encompassed as part of the ARCADIS Back Plot B Validation Report, which has been approved by the LA and EA.

3.5 Remediation Priority Areas

3.5.1 RPA 1

Located in the south-western part of Back Plot A (referred in earlier reports as Surplus Land Zone 3) in the vicinity of PRB Treatment Chamber 5 and comprises areas hydraulically up and down gradient of the PRB. This area is located **offsite** to the west of the subject Site. RPA 1 is immediately down gradient of former buildings where chemical storage occurred and mercury contaminated soils have previously been removed from RPA 1 area.

The remediation of RPA 1 completed to date has significantly reduced contaminant concentration levels, however these are still above defined remediation target levels. Further remediation and monitoring is required in this area to satisfy the EA and to enable agreement to decommission the PRB in this area. The ongoing offsite remediation to address the residual contamination is not considered significant in the context of the proposed development of the Site.

Target compounds with respect to remediation in RPA 1 are as follows:

Groundwater	Unsaturated soils
N(1)-2-Pyridyl Sulfanilamide	Chloroform
Amphetamine	Elemental mercury
Ketoprofen	
3-ethylbenzophenone	
Carbendazim	
Toluene	
Chloroform	
Cis-1,2-Dichloroethene	
Chlorobenzene	

3.5.2 RPA 2

Located in the southern part of Surplus Land Zone 8

Located in the southern part of Surplus Land Zone 8, within the subject Sire area, in the vicinity of PRB treatment chambers 17 and 18/19 and comprises areas hydraulically up and down gradient of the PRB. RPA 2 was in close proximity to the Site effluent treatment plant and is also hydraulically down gradient of the D44 Landfill.

The remediation of RPA 2 was undertaken from September 2012 to May 2014 and consisted groundwater pumping and in-situ chemical oxidation (ISCO). The remediation of RPA 2 (as part of Back Plot B) has been approved by both the EA and LA.

Target compounds with respect to remediation in RPA 2 were as follows:

Groundwater	Unsaturated soils
N(1)-2-Pyridyl Sulfanilamide	No CoC selected
Ketoprofen	
3-ethylbenzophenone	
Carbofuran	
Chloroform	
Trichloroethene	
1,2-Dichlorobenzene	

3.5.3 RPA 3

Located within the vicinity of the former Building D34 (demolished in 2011) and boiler house in the retained land area which is part of the Science and Technology Park but immediately west of the subject Site. Chemicals were stored within the D34 building and immediately to the west of RPA 3 and a former solvent recovery plant was previously located in the area of the boiler house.

It is understood that the primary remediation works at RPA 3 were undertaken between November 2012 and July 2012. Further groundwater monitoring is currently ongoing (due completion February 2018) to demonstrate a stable or decreasing trend in order to satisfy the EA.

Target compounds with respect to remediation in RPA 3 are as follows:

Groundwater	Unsaturated soils
N(1)-2-Pyridyl Sulfanilamide	N(1)-2-Pyridyl Sulfanilamide*
Trichloroethene	
Toluene	
1,2-Dichlorobenzene	
Chlorobenzene	

*to be further assessed/ remediated by ARCADIS – RPA 3 located outside the subject Site area.

3.5.4 Remediation Performance Criteria

These were considered to have been met when one or more of the following have been achieved:

- ▲ The concentrations of CoC in soil and groundwater have met the performance criteria;
- ▲ A revision of the risk assessment, justified by changes in the plume geometry or the conceptual understanding of the Site indicates that the reduced mass of contaminants does not represent a risk to the identified receptors; or
- ▲ Contamination mass removal rates reach an asymptotic condition and cost benefit analysis indicates that remediation works cannot be justified considering likely improvement to the Site condition that could be achieved versus environmental and financial considerations.

For the RPAs 1 to 3, successful groundwater remediation was to be verified by 70-90% reduction in the concentrations of target compounds averaged over the network of validation monitoring wells and where achievable meeting the specific target levels where defined.

Given the concentrations and complexity of the contaminants involved this approach, was considered to be appropriate, and a practical demonstration of significant benefit is usually acceptable to the EA, as is the case here. This was to be backed up with validation monitoring both on and off-Site to the south to demonstrate that remediation performance criteria have been met and the PRB can be decommissioned.

3.5.5 Remediation Techniques

The following remediation techniques were proposed at the Site and have been implemented.

RPA 1

- ▲ Soil vapour extraction (SVE);
- ▲ Groundwater pumping (up and down gradient of PRB) and treatment with Granular Activated Carbon (GAC);
- ▲ Soil Flushing; and
- ▲ In Situ chemical oxidation (ISCO).

RPA 2

- ▲ Groundwater pumping (up and down gradient of PRB) and treatment with GAC and removal of any dense non-aqueous phase liquid (DNAPL); and
- ▲ ISCO both up and down-gradient of the PRB.

RPA 3

- ▲ Excavation and disposal; and
- ▲ ISCO.

3.6 Site-Wide Remediation

Several Site-wide remediation areas within groundwater have been identified through the risk assessment process, the majority of which are within, or adjacent to, the boundary of the Site of concern. These relate to several contaminants of concern, a number of which are the same as those targeted in the RPAs with some additional compounds identified as needing remediation. These areas have been split into Defined Remediation Areas (DRAs), with Back Plot A containing DRAs 2, 3, 4, 9 and 11 and Back Plot B containing DRAs 4, 6, 10, 13, 15, 16 and 18.

Similar performance criteria to the RPAs, as discussed in section 3.5.4, are in place for the DRAs and, for groundwater, including reducing contaminant concentrations by 70% from starting (baseline) concentrations and meeting applicable Human Health criteria (which, as indicated previously, are much less stringent than the environmental criteria).

Remediation methodologies deployed in the Site-wide remediation areas are similar to those within the RPAs and include:

- ▲ Groundwater pumping and treatment with GAC;
- ▲ Groundwater pumping with SVE;
- ▲ Groundwater pumping with light non-aqueous phase liquid (LNAPL) removal followed by ISCO; and
- ▲ Air Sparging with SVE followed by ISCO.

3.7 Remediation Status

It is understood that the wider site active remediation in the RPAs and DRAs within the development area was largely completed by the end Q4 2014, with isolated remediation ongoing in the PRB Wayleave (small area within RPA 1), and ongoing monitoring in RPA 3. Following the completion of remediation activities, groundwater validation monitoring consisted of quarterly monitoring visits across twelve months, and was completed in 2015 for the remediation areas within the Site boundary (both Back Plots A and B). Performance monitoring is understood to be ongoing in RPA 3 and DRA 14, **both located off-Site**, in the Science and Technology Park.

The remediation works undertaken in Back Plot A are reported as:

- ▲ All human health SSAC in groundwater having been met;
- ▲ Performance criteria having been met or bettered for all 17 targeted compounds;
- ▲ 50 kg of VOC removed;
- ▲ 10 kg of site specific compounds removed;
- ▲ Material management has been undertaken under full duty of care;
- ▲ Quality of laboratory data confirmed from analysis reproducibility; and
- ▲ Non-target compounds measured during the works were not considered to present any significant residual risk to receptors.

The remediation works undertaken in Back Plot B are reported as:

- ▲ All human health SSAC having been met;
- ▲ Performance criteria having been met or bettered for all targeted compounds;
- ▲ Over 40 kg of VOC removed;
- ▲ 22 kg of site specific compounds removed;
- ▲ Quality of laboratory data confirmed; and
- ▲ Non-target compounds measured during the works were not considered to present any significant residual risk to receptors.

From review of the Validation Reports for Back Plots A and B, it is considered that the remediation works within the subject Site area have been completed in accordance with the relevant Remediation Implementation Plans and have achieved the aims and objectives; the contaminant load would appear to have been reduced significantly (90%). Notwithstanding this it is recognised that that some locations have not fully met all validation criteria, although in the context of the full data set and distribution these localised areas are not considered significant by ARCADIS - though in many cases one of the supporting justifications for this conclusion is that the 'hotspot' is isolated and wells closer to the receptor/ boundary are clean, therefore, indicating contamination is not migrating.

The Validation Reports were subsequently approved under a planning application to the Local Planning Authority to discharge Conditions 9 and 10 (planning approval presented as Appendix C), relevant to Back Plots A and B (including the subject Site area).

For the soil in RPA 1, elemental mercury was identified as a targeted CoC, speciated mercury analysis of soils in RPA 1 was carried out and concentrations in soil were not identified in exceedance of human health SSAC, as such remediation action for mercury was not deemed necessary by ARCADIS.

3.8 Boyer's Pond Quantitative Risk Assessment

Given the potential for dissolved phase contaminants to have historically entered Boyer's Pond (located approximately 80 m south of the Site within the Beam Valley Country Park) specifically prior to installation of the PRB in 2000, ARCADIS was instructed to carry out an assessment to confirm hydraulic continuity with groundwater within the surrounding shallow aquifer, conduct sampling (sediment and surface water) to establish any evidence of a link between potential impacts and the Sanofi Facility and determine if any impacts identified pose a potential risk.

Boyer's Pond was formerly a gravel pit (now used for permitted coarse fishing) so is considered likely to be in hydraulic continuity with the River Terrace Deposits (gravels) aquifer and this was concluded to be the case through groundwater and surface water level monitoring.

With the exception of a marginal concentration of toluene (3 µg/L) no VOCs, or Site-specific compounds, were recorded above the laboratory method detection limit (MDL) in the surface water samples, although some low concentrations of heavy metals (Arsenic, Boron, Chromium, Mercury, Nickel, & Zinc) were recorded. It was concluded that these may, or may not, be attributable to natural or background anthropogenic sources.

No VOCs above laboratory MDL were detected in the sediment analysis, although five Site-specific quantified contaminants were detected plus various heavy metals including mercury which was detected in each sample.

It was, therefore, considered possible that the Dagenham facility was the primary source of the Site-specific quantified contaminants and possibly the mercury within the sediment samples prior to installation of the PRB (but were not detected in the surface waters (with the exception of mercury) sampled on three occasions in 2011/2012)).

A QRA was undertaken to assess the potential risks to Human Health receptors, water resources and ecological receptors associated with Boyer's Pond based upon the results from the sediment and surface water sampling. The report concluded that there were no unacceptable risks to the receptors identified and that based upon the remediation being carried out at the Site and validation monitoring the risk to the pond should be deemed to be acceptable at the time of the proposed future decommissioning of the PRB.

The EA agreed with the findings of the QRA but indicated that groundwater monitoring will be required up and down gradient of the PRB following decommissioning.

Continued water monitoring of Boyers Pond has been part of the bi-annual groundwater monitoring discussed further in section 3.10 below. In the most recent round of water monitoring there was no detection of VOCs, and no detection of site specific quantified compounds in the surface water samples from Boyers Pond.

It is also worth noting that it is reported that a large area of the Beam Valley Country Park (including the area within which Boyer's Pond is situated) is indicated to be a Local Authority historical landfill with infilling of former gravel pits undertaken across much of the area. It is, therefore, possible that these activities may have had an impact on soil and water conditions at the pond.

3.9 PRB Monitoring

Bi-annual monitoring of the PRB is undertaken by ARCADIS. The specific objectives of this monitoring are to:

- ▲ Assess the efficiency of the PRB to remove VOC contaminants from groundwater; and
- ▲ Recommend necessary improvement to the operation of the PRB based upon the data collected.

As part of the regular assessment of the PRB effectiveness water samples are collected from the PRB Treatment Units (TUs) comprising Treatment and Recharge Chambers (TCs and RCs) and analysed predominantly for VOCs. For example, in the October 2014 assessment the concentration of VOCs within TC014 was 1,193 µg/l and this was reduced to below the laboratory method limit of detection (MDL) in the respective recharge chamber (RC014).

As part of the October 2014 monitoring, pre and post treatment groundwater samples were collected from nine of the 20 Treatment Units (TUs) associated with the PRB. The remaining TUs were not sampled as they were

closed following removal of GAC (part of ongoing refurbishment works) and/or due to remediation works within RPA 1 and RPA 2.

None of the nine units assessed measured sum VOC concentrations greater than 1000 µg/l in treated water and two of these have achieved a >75% reduction in VOC concentrations to below the MDL. A further four of the active TUs had measured concentrations either <25 µg/l or below the MDL in both treatment and recharge chambers. TU001 recorded a 36% reduction in VOC concentrations with recharge concentrations at 284 µg/l. TU002 and TU021 did not record any reductions in VOC concentrations but recharge concentrations were relatively low at 522 µg/l and 335 µg/l respectively.

Overall, the PRB is considered as having been effective in significantly reducing contaminant concentrations in groundwater, although the barrier's effectiveness needs to be monitored carefully and maintained to ensure this continues, particularly when the TUs in the vicinity of the RPAs are re-opened.

The ARCADIS/ EC Harris October 2014 report recommended that:

- ▲ The remaining PRB refurbishment works be completed as soon as can be safely undertaken and that further assessment of the treatment performance is undertaken following completion of these works and re-opening of each chamber; and
- ▲ The biannual PRB monitoring programme should be continued to assess ongoing contaminant reduction efficiency of individual TUs and to assess the longer-term impact of the groundwater remediation works, in particular, within RPA 1 (where elevated concentrations of contaminants remained at the time of the PRB monitoring).

As reported earlier, some contamination had been identified in the immediate down gradient vicinity of the PRB which may reflect off-Site contamination migration prior to the PRB installation. Remediation in RPA 1 and RPA 2, however, does include areas both up and down gradient of the PRB and monitoring of groundwater and surface waters within the Beam Country Valley Park has not detected significant concentrations of contaminants away from the PRB.

Following the updated decision notice from the London Borough of Barking and Dagenham, dated 14th October 2016, for application 16/01017/FUL, granted permission for the decommissioning of the PRB, which is the responsibility of Sanofi/ ARCADIS, (decision notice presented as Appendix D) with two conditions; that no development (i.e. decommissioning) is to take place until a Long Term Monitoring and Maintenance Plan in respect to contamination is approved by the LA, and during decommissioning of the PBR, if previously unidentified contamination is found, no further works to be carried out until remediation strategy is submitted to the Local Planning Authority. This will require some off-site wells will be retained/ maintained for future monitoring.

3.10 Biannual Site-Wide Groundwater Monitoring

Biannual Site-Wide Groundwater Monitoring is being undertaken by ARCADIS which commenced in August/ Sept 2010.

The objectives of this monitoring are to:

- ▲ Collect groundwater data from on-Site and off-Site monitoring wells to assess groundwater quality beneath the Dagenham facility and hydraulically down-gradient;
- ▲ Assess trends in groundwater quality;
- ▲ Collect surface water samples from old fire lagoon to assess water quality; and
- ▲ Collect surface water samples from hydraulically up and down gradient off-Site receptors.

This monitoring was, therefore, key to determining whether contamination has migrated, or is migrating, off-Site at concentrations of concern.

As part of this environmental summary, Delta-Simons has reviewed the ARCADIS/ EC Harris reports dated June 2014, January 2015 and May 2016 which provide comparisons with previous monitoring events.

The main conclusions of the most recent report are:

- ▲ The highest measured CoCs in groundwater are VOCs and are generally associated with the RPAs 1 to 3 and have generally shown a decrease following remediation, consistent with validation monitoring;
- ▲ Measured concentrations of site specific compounds across the Dagenham Facility have reduced from concentrations measured before remediation commenced (2010 to 2012) and were consistent with validation monitoring data;
- ▲ Monitoring well AS4BH044 located within Back Plot B had a spike in chloroform concentrations during the latest round of monitoring. It was concluded that the elevated concentrations are isolated and unlikely to present a significant risk to receptors associated with the Site based on a future commercial end use;
- ▲ The highest concentrations of dissolved metals measured in groundwater were found within the eastern extent of Back Plot B (former D44 landfill) comprising predominantly arsenic and chromium. These concentrations are consistent with previous validation monitoring of the former D44 landfill area. Groundwater sampled from monitoring wells in the country park hydraulically down gradient of the Site have lower concentrations of dissolved metals, demonstrating that dissolved metal concentrations continue to attenuate as groundwater migrates away from the former D44 landfill;
- ▲ Majority of off-Site monitoring wells did not have elevated concentrations of CoC in groundwater;
- ▲ Elevated VOC concentrations were recorded in groundwater sampled from off-Site monitoring well AC1BH007, located hydraulically down gradient of RPA 2, and downgradient of the PRB. Fluctuating trends have been observed over the monitoring period (2010 to 2016). Source remediation works were not undertaken directly in this area but were undertaken in up gradient areas. As such the risk to receptors has been monitored and assessed by measuring concentrations in down gradient off site wells. It was concluded that there is no significant risk to future commercial workers or water resource receptors from the observed trends in groundwater concentrations;
- ▲ No detections of VOCs or site specific compounds were measured above MDL in the ten surface water samples collected in this phase of monitoring;
- ▲ One of the three surface water samples collected from the on Site Former Fire Water Lagoon had a marginal exceedance (6.1 µg/l) of the chromium environmental quality standard (4 µg/l). Biannual monitoring rounds in completed in 2015 identified similar trace levels of chromium in water samples collected from the on Site fire water lagoon (7 µg/l), as well as the Wantz Brook (11 µg/l) and River Beam (7 µg/l) located off-Site. The former Fire Water Lagoon is fed by rain water and a drainage ditch to the north, given the absence of dissolved chromium in groundwater sampled around the lagoon, the concentrations of chromium are considered to be representative of background concentrations rather than a result of Site based activities; and
- ▲ Three surface water samples had measured concentrations of zinc (13 to 45 µg/l) in excess of the environmental quality standard (8 µg/l). The samples were taken from the River Beam up and down gradient of the Site and from the Wantz Brook down gradient of the Site. Given the presence of zinc in surface water features hydraulically up gradient of the Site and the absence of measured concentrations of zinc in monitoring wells between Site and Surface Waters sampled, the concentrations of zinc are considered to be representative of background levels.

A review of the data going back to 2010 indicates that the majority of wells down gradient of the PRB have not recorded concentrations of chlorinated aliphatics, chlorinated aromatics, BTEX, Sulphonamides, barbiturates, miscellaneous pharmaceuticals or pesticides above the laboratory MDL.

Where contaminants have been detected these have typically been in very close proximity to the PRB, particularly in the vicinity of RPA 2 where remediation includes areas both up and down gradient of the PRB (and further to the east beyond the subject Site boundary and beyond the extent of the PRB). It should be noted that groundwater remediation in RPA 1 also extends to the south of the PRB.

Since surface water sampling was first undertaken, occasional detections of Site-specific quantified compounds have been reported above the MDL but at very low levels (< 65 µg/l) and CoCs have not been detected above laboratory MDL in the surface water samples collected within the Beam Valley Country Park during recent monitoring events.

This provides strong evidence that contamination is not migrating off-Site at concentrations of concern to nearby surface waters, or to off-Site residential receptors further to the south.

The report found that contaminant mass in groundwater is consistent with the validation monitoring so far completed, with concentrations having reduced in the DRAs. However, remediation in some areas of RPA 1 is still ongoing and validation monitoring had not been completed in RPA 3 and DRA 14 at the time of this report.

3.11 Ground Gas Monitoring

Delta-Simons undertook seven rounds of ground gas monitoring over three months between July and October 2016 to clarify the risk of potential elevated ground gas concentrations with respect to the proposed end development at the Site.

The gas monitoring identified elevated concentrations of carbon dioxide (maximum concentration of 7.20% v/v) and methane (concentration of 12.7% v/v). Elevated VOC's to a maximum concentration of 1389 ppm were also identified at a number of boreholes, associated with residual contamination across the Site.

A gas screening value (GSV) classification for the site was calculated as 0.152 l/hr, classifying the site as a Characterisation Situation (CS) 2 – Low Risk. It was recommended that gas protection measures be increased to include a hydrocarbon/ VOC resistance membrane due to the elevated VOC's recorded.

4.0 Conceptual Site Model

4.1 Introduction

A CSM represents the relationships between contaminant sources, pathways and receptors, to support the identification and assessment of possible pollutant linkages (PPL) and an assessment of known pollutant linkages, where identified from existing information.

Where PPLs are identified, a risk assessment is carried out to assess the likelihood that each possible linkage exists and to decide whether these pose potentially unacceptable risks to identified receptors and require further assessment. Where this linkage is of a form that subsequently leads to land being identified as 'contaminated land' under the terms of Part 2A of the Environmental Protection Act (EPA) 1990, the linkage is termed a significant pollutant linkage.

Assessing risks from land contamination underpins the "suitable for use" approach adopted for Part 2A of the EPA 1990 regulatory regime and the National Planning Policy Framework (NPPF).

4.2 Conceptual Model

The Conceptual Site Model formulated for the Site is presented in diagrammatic format as Figure 6 and detailed in the sections below.

4.2.1 Contaminant Sources

Following the contamination and remediation review, the following on-Site sources of contamination are considered relevant:

- ▲ Residual contaminants in soils; and
- ▲ Residual contaminants in groundwater.

Specific contaminants include:

- ▲ Asbestos;
- ▲ Arsenic;
- ▲ Mercury;
- ▲ Chlorinated aliphatics and aromatics;
- ▲ BTEX and trimethyl-benzenes;
- ▲ Extractable Petroleum hydrocarbons (EPH);
- ▲ Polychlorinated biphenyls;
- ▲ Pharmaceuticals;
- ▲ Pesticides (herbicides, insecticides and fungicides);
- ▲ Other miscellaneous compounds; and
- ▲ Unidentified compounds.

4.2.2 Potential Receptors

Potential receptors to the identified contamination present beneath the Site are identified as follows:

- ▲ Future on-Site development and commercial workers;
- ▲ Surface water features; and
- ▲ Current off-Site residential buildings and occupants.

4.2.3 Potential Pathways

The main pathways that can be considered at the Site include:

- ▲ Exposure via inhalation of volatile vapours;
- ▲ Exposure via incidental direct contact and ingestion during redevelopment works and in any landscaped areas following redevelopment; and
- ▲ Off-Site migration of contaminated groundwater in the direction of groundwater flow and subsequent volatilisation.

4.3 Summary of Significant Pollutant Linkages and Mitigation Measures

4.3.1 Soil Contamination to Site Workers/Site End Users

Residual contamination in shallow soils may pose a risk to Site construction and services personnel and Site end users.

Residual asbestos containing materials and asbestos fibres may be encountered in shallow soils buried under 100 mm of recycled aggregate in the D44 Landfill area. Furthermore, the presence of asbestos fibres and asbestos containing materials in other areas of Made Ground cannot be discounted.

To mitigate against such risks, it is recommended that construction workers and services personnel should follow guidance stated in 'HSG 66 Protection of Workers and the General Public during Redevelopment of Contaminated Land' during development works. Adequate standard personal protective equipment (PPE) and the development of basic hygiene measures should be undertaken.

The Site is relatively flat, however, there is a requirement for a degree of cut a fill to create large level development platforms. Cut depths are only anticipated to comprise depths between 0 and 2 m, and will therefore predominantly comprises unsaturated granular shallow soils. It is considered that earthworks reprofiling activities will not fundamentally alter the conceptual site model.

Site end users will be protected against any such risks due to the nature of the proposed development, comprising either building footprint or hardstanding. Any landscaped areas/ verge dressing, should be capped with an appropriate topsoil/ subsoil to provide a suitable growing medium which will also protect Site users from any residual contamination in underlying soils, which should be separated by a geotextile marker membrane and capillary break layer.

4.3.2 Soil Contamination to Groundwater and Off-Site Receptors

Remediation of soils and groundwater with respect to the subject Site area has been completed by Sanofi/ ARCADIS, addressing risks associated with groundwater and off-Site receptors contamination (as detailed in Section 3.0). It is understood that the PRB has been granted permission for decommissioning by the LA and EA, to be undertaken by Sanofi/ ARCADIS, conditioned to the submission of a Long Term Monitoring and Maintenance Plan, and that no previously unidentified contamination is encountered in the process of decommission.

4.3.3 Soil/Groundwater and Ground Gas Contamination to Indoor Receptors

Previous investigations identified contamination which represents a potential risk via the indoor inhalation pathway. Although it is anticipated that Human Health target values will be achieved, an allowance for a hydrocarbon resistant membrane should be considered. A three month ground gas monitoring scheme was completed in 2016, the results of which classified the Site as a CS2 (as detailed in Section 3.11) and ground gas protection measures in accordance with BS8485:2015 are to be incorporated where any ground level commercial enclosed spaces are proposed.

4.3.4 Soil Contamination to Water Supply Pipes

Hydrocarbons, especially aromatics and chlorinated solvents, are known to permeate plastic pipes, particularly when encountered at high concentrations. The provision of upgraded pipes may be required as part of the proposed redevelopment.

4.4 Plausible Pollutant Linkages

It is considered that following the completion of soil and groundwater remediation (which is the responsibility of Sanofi/ ARCADIS), and implementation of mitigation measures comprising importation of a topsoil capping layer, gas protection measures (if required), and upgraded water supply pipes, that no plausible pollutant linkages would remain with respect to on-Site Human Health.

5.0 Assessment of Risks and Liabilities

This Assessment considers both perceived and actual risks using the Source, Pathway, Receptor concept, with the principal measure of risk being whether significant harm (to people, animals, property (including buildings, cattle etc.), or ecosystems) or pollution of controlled waters (surface water bodies, aquifers, coastal waters, or territorial waters) is being caused, or whether there is a significant possibility of such harm being caused.

The overall risk classification, based on the source-pathway-receptor principle, adopted for this preliminary Assessment, is defined as follows:

- ▲ Low risk – issue unlikely to present a liability or cost;
- ▲ Moderate risk – issue may present a liability or cost, but these may be limited; and
- ▲ High risk – likely that significant liabilities and/or costs exist.

5.1 Planning Responsibilities in Relation to Remediation

Sanofi were responsible for discharging conditions 8, 9 and 10 relating to outline planning (15/00951/OUT) for the Site which were as follows:

- ▲ Condition 8 – Prior to commencement of development a scheme to deal with contamination risks to be submitted and approved by the Local Planning Authority (LPA);
- ▲ Condition 9 – Prior to occupation of development in an area, a verification report demonstrating completion of the works set out in the approved remediation strategy for that area shall be submitted and approved by the LPA; and
- ▲ Condition 10 – Prior to commencement of development the approved remediation scheme must be carried out.

Sanofi has successfully discharged Conditions 8, 9 and 10 at the Site, following the approval of the validation reports by the LA and EA (Appendix D). Permission for the decommissioning of the PRB has also been granted, conditioned to a Long Term Monitoring and Maintenance Plan, and that no previously unidentified contamination is found during decommissioning (decision notice attached as Appendix E). Following decommissioning a five-year period of monitoring will be undertaken by Sanofi to confirm that groundwater and off-Site surface receptors are not being impacted.

Monitoring wells may still need to be retained/ maintained within the purchaser's Site during PRB decommissioning works and early phases of development. Responsibility for the retaining and decommissioning of on-Site monitoring wells will rest with Client. However, some off-Site monitoring wells will be required as part of PRB decommissioning scheme. Sanofi will maintain responsibility for maintenance and operation of the PRB until decommissioning occurs; the Client will need maintain appropriate access along the line of the PRB.

Condition 11 relates to dealing with any additional contamination identified during development which will be the responsibility of the developer. On the basis of the long industrial history of the Site and despite the thorough levels of investigation it is likely that small additional 'hotspots' of contamination will be encountered during groundworks.

Condition 13 relates to piling or any other foundation designs using penetrative methods shall not be permitted unless it has been demonstrated that there is no resultant unacceptable risk to ground water.

5.2 Regulatory Body Enforcement

5.2.1 Part 2A of the Environmental Protection Act 1990

Based upon available information, Delta-Simons considers that the LA is not likely to request additional investigatory works to determine the contamination status of the Site as part of their Contaminated Land Inspection Strategy. Remediation and validation monitoring has been completed and approved at the Site in accordance with planning conditions 8, 9 & 10 applied by the LA. The LA and EA have granted permission for

the decommissioning of the PBR, with conditions. These works and decommissioning of the PRB remain the responsibility of Sanofi/ ARCADIS.

Any previously unidentified contamination should be captured in relation to planning condition 11 and, it is, therefore, considered that there is a low risk of further remediation of the Site being enforced by the LA under the terms of Part 2A. A Piling Risk assessment will be required in relation to Condition 13.

5.2.2 Planning and Development Control

There is a low risk of significant contamination planning liabilities arising as a result of Site ownership, as Sanofi/ ARCADIS will remain responsible for discharge of relevant outline planning conditions 8, 9 and 10 as detailed above. In addition, condition 11(15/00951/OUT) will be addressed during the development programme as also detailed above.

5.2.3 Water Resources Act

Based on the available information, Delta-Simons considers there to be a low risk that the Site is likely to present a risk of pollution to controlled waters likely to invoke prosecution under the Water Resources Act (WRA), as groundwater remediation has been undertaken and approved, and remains the responsibility of Sanofi/ ARCADIS.

5.3 Third Party Liability

Delta-Simons considers that the risk of legal action from a third party with regard to historical contamination migration from the Site is low, based upon the results of the monitoring undertaken in off-site locations.

The risk of third party liability in terms of the future migration of contamination is considered to be low as remediation has been undertaken and is largely complete, with on-Site validation having been accepted by the LA and EA. In addition, the PRB has been approved for decommission, with additional Long Term Monitoring and Maintenance to be undertaken by Sanofi/ ARCADIS, who will retain responsibility for liaising with the regulators.

6.0 Conclusions and Recommendations

6.1 Conclusions

The Site area comprises an area formerly occupied by chemical manufacture facilities (agrochemical and pharmaceutical) and a landfill (D44). Now non-operational with all buildings demolished and having undergone remediation, monitoring and PRB maintenance by Sanofi/ ARCADIS.

A summary of the contamination risk assessment undertaken by Sanofi/ ARCADIS is outlined below:

- ▲ Site-Wide DQRA selected 55 representative contaminants of concern;
- ▲ The DQRA was undertaken on the assumption that the PRB was not present (this approach was supported by the EA);
- ▲ Off-Site residential receptors to the south of the Site, approximately 150 m at their closest point, were considered by the DQRA;
- ▲ Exceedances of Site Specific Assessment Criteria relevant to the Site were identified in terms of both Human Health (on-Site) and environmental receptors (on and off-Site);
- ▲ Potential off-Site risks to neighbouring residents were identified with respect to recorded concentrations of contaminants in groundwater, but there should be a negligible risk to off-Site residential receptors following remediation;
- ▲ DQRA identified the requirement for remediation of soils and groundwater and a Remediation Strategy was developed and agreed with the EA; and
- ▲ The aim of the remediation was to address contamination in soil and groundwater with the ultimate aim being to achieve agreement with the EA to decommission the PRB.

Remediation targets and methodologies (and validation plans) were agreed with the EA and were focussed on (in general terms):

- ▲ Contamination mass reduction to meet applicable Human Health criteria;
- ▲ 70-90% reduction in the concentrations of target compounds in groundwater averaged over the network of validation monitoring wells; and
- ▲ Given the concentrations and complexity of the contaminants involved this approach is considered to be appropriate with validation based on a practical demonstration of significant betterment backed up with validation monitoring.

Delta-Simons considers that the remediation works have been completed in accordance with the relevant Remediation Implementation Plans and have achieved the aims and objectives; the contaminant load appears to have been reduced significantly (90%). Some locations have not fully met all validation criteria, although in the context of the full data set and distribution these localised areas are not considered significant by ARCADIS - though in many cases one of the supporting justifications for this conclusion is that the 'hotspot' is isolated and wells closer to the receptor/ boundary are clean, therefore, indicating contamination is not migrating.

The validation reports for Back Plot A and Back Plot B have been accepted by the LA and EA. Likewise, the PRB has been cleared for decommissioning by the LA subject to conditions to ensure that no decommissioning is to take place until a Long Term Monitoring and Maintenance Plan in respect to contamination is in place, and that no previously unidentified contamination is encountered during decommissioning of the PRB.

Development specific mitigation measures will be required against risks associated with residual asbestos contamination (located in the area of the Former D44 landfill) following guidance stated in 'HSG 66 Protection of Workers and the General Public during Redevelopment of Contaminated Land' during development works and using personal protective equipment (PPE). All new service trenches should be backfilled with clean Site won or imported materials and/ or the use of upgraded pipework may be required subject to agreement with the relevant utility provider. Site end users will be protected against any such risks due to the nature of the proposed development, comprising either building footprint or hardstanding. Any landscaped areas/ verge dressing, should be capped with an appropriate topsoil/ subsoil to provide a suitable growing medium which will also

protect Site users from any residual contamination in underlying soils, which should be separated by a geotextile marker membrane and capillary break layer.

Delta-Simons has completed a three-month gas monitoring programme across the Site on an approximately 50 m grid, to assess the requirements for ground gas protection measures in ground floor structures, which classified the Site as Characterisation Situation 2 – low risk. It is recommended that gas protection measures be increased to include a hydrocarbon/ VOC resistant membrane due to the elevated VOC's recorded.

It is considered that following the completion of soil and groundwater remediation and PRB decommissioning (which is the responsibility of Sanofi/ ARCADIS), and implementation of mitigation measures comprising importation of a topsoil capping layer, gas protection measures, and upgraded water supply pipes, that no plausible pollutant linkages would remain with respect to Human Health.

Following an assessment of risks and liabilities, an overall Low risk is considered for the Site and surrounding area in terms of risk to Human Health and controlled waters apply in the context of the proposed end use of the Site.

6.2 Recommendations

A geotextile membrane and minimum 600 mm of certified suitable for use top soil and subsoil overlying a geotextile marker membrane and capillary break layer will be incorporated into all new landscaped areas.

Ground gas protection measures, in accordance with BS8485:2015, are required for any new buildings proposed at the Site (upgraded to include a hydrocarbon/ VOC resistant membrane).

The local water authority will require upgraded potable water pipes and/or dedicated isolated clean sewer runs in order to mitigate any residual risks associated with the remediated Site.

A 'Hotspot' protocol will be in place for groundworkers and sub-surface maintenance workers to act upon should areas of suspected contamination be identified during the groundworks. Appropriate budget allowances should be included in the redevelopment costs to deal with any additional contamination identified during development works. As discussed in Section 3.7, some isolated 'hotspot' locations have not fully met all validation criteria, although in the context of the full data set and distribution these localised areas are not considered significant.

Any ground/ construction workers who are required to undertake sub-surface work at the Site will be made aware of the possibility of encountering localised contamination (specifically residual asbestos within D44 Landfill area) and safe working practices and use of appropriate PPE should be implemented to mitigate the risks.

It is understood that earthworks will be required in order to form developable platforms, and to enable obstruction removal works to facilitate piling (to be undertaken in accordance with a Piling Risk Assessment). A Materials Management Plan will be developed, giving consideration to the waste hierarchy, in order to reduce the amount of material requiring off-Site disposal. If considered necessary, a waste classification exercise could be completed in order to determine the likely disposal costs of soils requiring off-Site disposal (which may be complicated given the range of contaminants, including pharmaceuticals).

6.3 Statement of Risk

Based on the available information, Delta-Simons considers that in the context of a future commercial use of the Site, the following risk and liability statements can be made. ***These statements are provided in the context of an investor or occupier, based on Sanofi/ ARCADIS having completed the remediation works, and will be responsible for the decommissioning of the PRB, and an insurance policy being in place to cover off-Site historical liabilities associated with the potential migration of contamination in groundwater.***

Regulatory Body Enforcement under Part 2A or WRA	There is considered to be a Low risk of enforcement action under Part 2A or WRA.
Third Party Liability	Potential for legal action by surrounding landowners based on the potential for contamination to migrate off-Site is considered to be Low.
Investment Impact	Delta-Simons considers there to be a Low risk of impact on the commercial value of the Site in terms of investment from significant contamination issues.
Overall Statement of Risk	On the basis of available information, Delta-Simons considers that with regard to potential soil and groundwater contamination issues and associated environmental liabilities, the Site represents an investment opportunity with a Low overall risk status.