M3 Junction 9 Improvement

Scheme Number: TR010055

6.3 Environmental Statement Appendix 13.1 - Drainage Strategy Report - Part 2 of 2

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Volume 6

November 2022

Appendix A Cavity Occurrence Assessment

TECHNICAL NOTE

Job Name: M3 Junction 9 Improvements

Job No: 48176

Note No: HE551511-VFK-EGT-X_XXXX_XX-TN-GE-0001 P02

Date: May 2021

Prepared By: Harry Gordon & Angelo Indelicato

Reviewed By: James Weddle

Subject: **Stantec Cavities Occurrence Assessment & Preliminary Risk Assessment**

Item	Subject
1.	**Introduction** Stantec have undertaken the following Cavities Occurrence Assessment for the site at M3 Junction 9, Winchester. This preliminary desk top assessment evaluates the potential for natural and non-coal mining cavities to be present within the latest Order Limits Boundary (OLB) provided by Volker Fitzpatrick (Figure 001 Date 15/09/2020), against the vulnerability of the proposed scheme to these specific hazards. This has enabled a preliminary risk assessment to be undertaken to define the risk of natural and mining hazards spatially within the scheme
2.	**Sources of Information** A number of desktop sources were used to assess the potential of natural and non-coal mining cavities within the Order Limit Boundary, these were limited to; • British Geological Survey GeoIndex • British Geological Survey (2011) 1:50,000 scale series, Winchester (Sheet 299, 2002), Solid and Drift Edition. • British Geological Survey Online Interactive Viewer [redacted] • Edmonds, C.N., 2001. Predicting Natural Cavities in Chalk. Land Surface Evaluation for Engineering Practice. The Geological Society, London. Engineering Geology Special Publications. • Environmental Data Search commissioned from Groundsure • Environmental Data Search commissioned from Landmark

DOCUMENT ISSUE RECORD

Technical Note No	Rev	Date	Prepared	Checked	Reviewed (Discipline Lead)	Approved (Project Director)
HE551511-VFK-EGT-X_XXXX_XX-TN-GE-0001	P01	30.10.20	HG	-AI	JW	RP
HE551511-VFK-EGT-X_XXXX_XX-TN-GE-0001	P02	14.05.21	HG	-AI	JW	RP

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	• Highways England Geotechnical Data Management Systems (HA GDMS) - Accessed October 2020 • Historical Mapping and Photograph (1873-2016, 1:10,560/1:10,000 scale) commissioned from Landmark • National Library of Scotland ([redacted] accessed October 2020) • Stantec Cavities Database
3.	**Stantec Natural Cavities Database Search** A search of the Stantec Natural Cavities Database indicated that there are 1 natural cavity record within a 500m radius buffer of the OLB, as shown in Table 1 below.

Table 1: Stantec Natural Cavities Database records

Approximate NGR	Approximate distance from site centre (m)	Recorded Location	Geology	Natural Cavity Details	Source
SU 491 315 SU 488 310 SU 484 305	190 (W)	Course of River Itchen, Winchester, Hampshire	**Superficial:** Alluvium River Terrace Deposits **Bedrock:** Chalk Group	10 x Solution Pipes	Winchester City Council

It should be noted that the absence of, or the presence of, existing natural cavities within the OLB should not be considered conclusive.

4.	**Stantec Non-Coal Mining Cavities Database Search** A search of the Stantec Mining Cavities Database indicated that there are no man-made mining cavity records within 1km of the OLB boundary. The closest recorded mining cavity is located approximately 1.5km east north east of the OLB site centre and the cavity was described as possible voids encountered during piling operations. It should be noted that the absence of, or the presence of, existing natural cavities within the OLB should not be considered conclusive.
5.	**British Geological Survey – Non-Coal Mine Plans** A review of the Non-Coal Mining Plans was undertaken through the British Geological Survey GeoIndex, which indicated no recorded mine plans located within the site boundaries or within 1km of the OLB boundary.
6.	**Review of HA Geotechnical Data Management System (HA GDMS)** Stantec have conducted a search of HA GDMS to evaluate the presence of non-coal mining related hazards within the area of the proposed scheme boundaries, Table 2 below summarises the available records and evaluated hazard ratings undertaken by others.

Table 2: Summary of Datasets relating to Non-Coal Mining Hazards HA GDMS

Dataset	Provider	Rating/ Records
BGS Mining Hazard (not including coal)	British Geological Survey	Very Low to Very High
BGS Recorded Mineral Sites	British Geological Survey	Opencast (Easton Down Chalk Pit (E 449900, N430462 and E 449583, N 13169), Upper Farm Chalk Pit (E 448208, N132717) &

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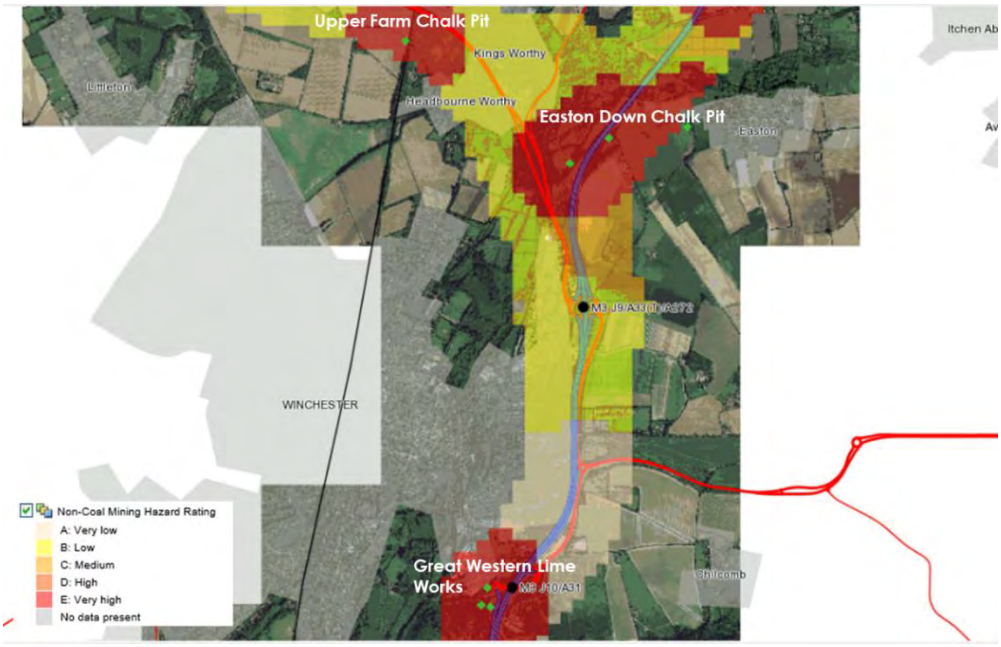
		Great Western Lime Works E 448892, N 128143)
Inventory of Closed Mining Waste	Environment Agency	No records
Mining Instability	Ove Arup & Partners	No records
Man Made Mining Cavities	Stantec UK Ltd	No records
Potential Mining Areas	Wardell Armstrong LLP	No records
Subterranean features	Landmark	No records

An extract of the HAGDMS Non-Coal Mining Hazard Rating, as evaluated by the British Geological Survey (BGS), is presented in Plate 1:

Plate 1: Extract of HA GDMS Non-Coal Mining Hazard Rating



7. Geology

With reference to online resources [redacted] the 1:50,000 scale BGS Solid and Drift Geological Map of the Area of Winchester (Sheet 299, 2002), and the the published geology within the Order Limits Boundary indicates the presence of the Winchester-East Meon Anticline towards the southern boundary, which assumes the form of an ellipsoidal dome with the principal axis trending east-west through Winchester. Towards Chilcomb and Bar End (south of the boundary), the core of the anticline has been eroded to expose the older Zig Zag Chalk Formation. This inlier is surrounded by progressively younger rings of chalk formations including the Holywell Nodular Chalk Formation, New Pit Chalk Formation and Seaford Chalk Formation, which presents the youngest and predominantly exposed chalk formation with the exception of a patchy outcrop of the Newhaven Chalk Formation within the designated Landscaping Area.

Superficial deposits within the site boundary vary depending on the topographic distribution and are discussed below;

Quaternary age Alluvium is present, tracing the River Itchen and forming flood-plain belts, occupied by marshes and meadow land. Deposits consist of loam, gravel, peat and tufaceous marl, arranged as overlapping sheets, but frequently merging into one another. The flood loam is silty, and usually contains some calcareous matter in the form of tufa and finely divided chalk. Isolated mounds or

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	"malm-knolls" of Calcareous Tufa are recorded within the Alluvium deposits of the Itchen valley. Their extent is considered greater than is recognised by the published geological maps, which indicates those only that outcrop at the surface. Clay-with-Flints deposits mantle much of the higher topographic levels in the area. These periglacial deposits occur as a residual deposit upon the Chalk outcrop, comprising weathered remnants of the former Palaeogene deposits, along with insoluble residue from the dissolution of the chalk surface. Two varieties of Head deposits are recorded within the site boundary. Such periglacial deposits are typically formed by nivation, which is a suite of weathering and slope processes that includes intensive freeze-thaw activity, enhanced chemical weathering, slopewash and accelerated solifluction of the parent Palaeogene/Quaternary lithology and Chalk under periglacial conditions. The older unit of Head (1) is associated with slope deposits and is generally recorded on the north facing slopes downslope from Clay-with-Flints deposits. This results in the composition of Head (1) comprising a gravelly content that includes Clay-with-Flint debris. The younger Head (2) deposits comprises sandy, silty clay with gravels including chalk and flint and are generally recorded within dry chalk valleys that incise the exposed chalk.
8.	**Hydrogeology** According to online resources [redacted], the published hydrogeological map Sheet 9: Hydrogeological Map of Hampshire and the Isle of Wight (1:100,000 scale – 1979) presents the condition at the site showing that the water table level within the chalk aquifer lies between 30 and 40 m AOD. Based on Ordnance Survey Terrain 50 DTM Data, viewed via the British Geological Survey GeoIndex, the topographic setting within the Order Limit Boundary is predominantly defined by the River Itchin Basin. The basin has a north-south orientation which has eroded through the chalk bedrock of the Winchester-East Meon Anticline. The anticline produces an east-west orientated ridgeline running through Winchester, from which land levels decline from and towards the River Itchen Basin. Dry chalk valleys incise the slope faces as they decline towards the basin, producing subtle, undulating surfaces. The area directly surrounding and within the River Itchen Basis forms a flood-plain which is occupied by marshes and meadow land. Geological deposits in these areas consist of approximately 6-10m of Alluvium and flood loams, directly overly the Chalk. In these areas, ground levels are generally at approximately 40m AOD and therefore, the groundwater would be expected to be at, or above the chalk interface. As ground levels rise away from the River Itchen Basin, the alluvial deposits become absent, exposing the chalk or being replaced by Head deposits or Clay-with-Flints at higher elevations. In these areas, the chalk interface is expected to rise above the groundwater level. As can be appreciated from the topographic variations within the Order Limit Boundary, the depth to the groundwater produces varying implications for both natural and mining cavities to have formed in the area.
9.	**Geomorphology** With reference to the Ordnance Survey Terrain 50 DTM data, viewed via the BGS GeoIndex, elevation levels across the OLB generally decline from the Chilcomb Down (453500E, 128830N) at c.130m AOD, towards the valley of the River Itchen at c.40m AOD. This produces a general north-west facing slope with aspects ranging between c.280-330°, with topographic variations observed due to the presence of east-west orientated dry valleys. Elevation levels along the M3 motorway within the OLB remain relatively consistent at c.59m AOD, with minor variations. The elevation of Easton Lane on the east side of the scheme is approximately 65.0m. The elevation of the A272 at the M3 junction is approximately 67m AOD and descends to a low point at

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	approximately 60m AOD, 300m south-west of the junction. Elevation of the A34 falls from 67m AOD at the junction with the M3 to approximately 40m AOD at marker post MP1/5 by the Kingsworthy Flyover. The chalk outcrop in this area has undergone a variety of erosional and depositional episodes, followed by tectonic uplift, and initial sub-aerial erosion of the chalk surface. During the late Cretaceous/early Palaeogene, the region experienced a series of marine and fluvio-lacustrine inundations and transgressions that resulted in the deposition of Palaeogene deposits such as the Lambeth Group and London Clay. Subsequent glaciofluvial and periglacial weathering initiated the erosion of the Palaeogene deposits. This largely resulted in the complete removal of the Palaeogene deposits in the area, with the exception of the higher topographic levels, where deposits of Clay-with-Flints were formed following the erosional degradation of the Lambeth Group. While much of the Clay-with-Flints is only approximately 1m thick, there are places where the deposit extends up to 3-4m in depth, infilling solution pipes that extend into the chalk below. These solution pipes result from the dissolution of the chalk by the downward percolating surface water and thawing ice rich permafrost, usually abound under patches of Clay-with-Flints; their own development stimulated by the slow but constant supply of acidulated soil-water seeping from the retentive loamy material within and above them. The Quaternary depositional environment was characterised by colder climatic conditions which occurred with glacial and periglacial episodes where ice cover would increase in thickness when water/sea levels fell. There were relatively short periods at the onset and finish of such conditions when groundwater table levels fell widely below the chalk surface level. During such times, downward percolation of groundwater occurred which likely initiated karstic weathering of the chalk surface, where favourable circumstances allowed. Such conditions might also have allowed more intense dissolution to occur more widely along bedding planes and fissures, steep sloping topography at times when cold groundwater was able to circulate through the chalk sequence. Colder groundwater has the capacity to hold more dissolved carbon dioxide making it more acidic along with humic and fulvic acids generated by the periglacial tundra. This karstic activity was only possible during times when the ground (and groundwater) was not frozen, such as spring thaws, summer periods, or where taliks (year-round unfrozen ground, often saturated with mineral salts) are present, typically underlying surface water bodies such as the River Itchen. Each time as the climate warmed after glacial and periglacial episodes, land drainage patterns were established. When permafrost had thawed or partially thawed and water table conditions were favourable, this allowed the infiltration of surface water, collecting upon cover deposits and discontinuous permafrost, to percolate downwards to initiate dissolution of the chalk below. As can be appreciated from the above events, there have been times when there were favourable conditions for solution feature development and other times when conditions were probably not favourable, together with times when solution features were actively destroyed by erosion.
10.	**Natural Cavities - Hazard Ratings** In areas underlain by Chalk, the interface with cover deposits often forms a karstic horizon where solution features (swallow holes, sinkholes and solution pipes) are found. The most prominent karstic horizon is the Palaeogene/Chalk interface, however at the site location, this horizon has been eroded away completely by periglacial and glaciofluvial erosion. An assessment of the site has been undertaken utilising the *Dr Edmonds Natural Cavity Prediction Model*. This approach considers the wider spatial area factors that pertain solution feature development in order to determine a Subsidence Hazard Rating value (SHRn) which represents the likelihood for cavities to be present. Given the geological, hydrogeological and geomorphological variation within the Order Limit Boundary, this has resulted in varying hazard ratings being implemented across the site. The hazard ratings are discussed below and are

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illustrated on the Natural Cavities Hazard Map (Figure 1a). The following hazard rating criterion was applied as part of this assessment.

(1) Where chalk is exposed and forms either the topographic hill top, or a slope face where Palaeogene/Quaternary deposits are absent at higher elevations, and therefore surface water is not anticipated to be directed towards, or accumulate in, areas of the chalk, the hazard rating for solution features to be present is considered **VERY LOW**.

(2) Where Alluvium overlies the Chalk, and groundwater is anticipated to be at or above the chalk interface due to the influence of the floodplain, the hazard rating for solution features to be present is considered **LOW**.

(3) Where chalk is exposed and forms a slope face where Palaeogene/Quaternary deposits are present at higher elevations, and therefore surface water is anticipated to have originated upon the cover deposits and be directed onto the Chalk, the hazard rating for solution features to be present is considered **MODERATELY LOW.**

(4) Where either Head (1) or Head (2) deposits are present, the irregular contact between the deposit and the chalk presents favourable conditions for solution piping, creating conduits for surface water to underdrain into the chalk below, resulting in a hazard rating of **MODERATE.**

(5) The Clay-with-Flints forms a younger, successive cover deposit over the chalk surface and commonly infills any hollows and dissolution pipes in the weathered chalk surface. This produces potential for underdrainage into the chalk below, creating favourable circumstances for solution feature development. Previous experience of studying sites underlain by Clay-with-Flints has shown that natural cavities are frequent and pose a risk of differential settlement and possible ground collapse. This subsequently results in a hazard rating of **MODERATELY HIGH.**

The likelihood of the occurrence (SHRn Hazard Rating) of natural cavities within the OLB has been determined in accordance with the criteria given in the following tables:

Table 3: Natural Cavities SHRn Hazard Rating Classification

	Criteria	Description
SHRn Hazard Rating	5: High	Near certain to occur, probably in numerous locations
	4: Moderately High	Likely to occur, possibly in numerous locations
	3: Moderate	May occur, probably on a single location
	2: Moderately Low	May occur, but unlikely
	1: Low	Not expected to occur

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11.	**Natural Cavities - Preliminary Risk Rating**

Stantec have assessed the spatial distribution of the likelihood for unrecorded natural cavities to be present within the Order Limit Boundary and have considered these against the vulnerability (magnitude of impact) of such features to the proposed land usage presented on scheme drawings. This has been undertaken to produce the Natural Cavities Risk Map (Figure 1b). The aim of this risk assessment is to identify elements of the scheme that are particularly vulnerable to natural cavity hazards. The risk assessment has been undertaken in accordance with the risk assessment methodology outlined in the GIR Appendix F (GIR GRR01 Rev 2). It is envisaged that this risk assessment will be continuously developed and updated throughout the project as the investigations and works progress.

Table 4: Natural Cavities Vulnerability (Magnitude of Impact)Classification

	Criteria	Description
Vulnerability (Magnitude of Impact)	5: Severe	Severe loss or damage to life or infrastructure
	4: High	Major loss or damage to life or infrastructure
	3: Medium	Substantial loss or damage to infrastructure
	2: Low	Moderate loss or damage to infrastructure
	1: Negligible	Minor loss or damage to infrastructure and landscaping

The rating of the risk has been assessed using the following Risk Assessment Matrix, and is defined in line with criteria given in the following tables:

Table 5: Natural Cavities Vulnerability Mapping: Risk Assessment Matrix

		SHRn Hazard Rating				
		Low (1)	Moderately Low (2)	Moderate (3)	Moderately High (4)	High (5)
Vulnerability (Magnitude of Impact)	Severe (5)	**5**	**10**	**15**	**20**	**25**
	High (4)	**4**	**8**	**12**	**16**	**20**
	Medium (3)	**3**	**6**	**9**	**12**	**15**
	Low (2)	**2**	**4**	**6**	**8**	**10**
	Negligible (1)	**1**	**2**	**3**	**4**	**5**

Table 6: Natural Cavities Risk Rating Classification

	Criteria	Description
Risk Rating	Critical (20-25)	Severe loss or loss to life - High probability of occurrence with a High impact on the proposed scheme
	High (13-19)	Major loss or serious injury - Moderate to High probability of occurrence and a Medium to High impact on the proposed scheme
	Medium (6-12)	Substantial loss or damage to infrastructure - Moderate to High probability of occurrence and a or a Medium to High impact on the proposed scheme.
	Low (2-5)	Moderate loss or damage to infrastructure - Low to Moderate probability of occurrence or a Low to Medium impact on the proposed scheme
	Very Low (1-2)	Minor loss or damage to infrastructure - Low probability of occurrence and a Negligible to Low impact on the proposed scheme

The varying risk ratings implemented across the site have been illustrated on the Natural Cavities Risk Map (Figure 1b). A breakdown of the spatial distribution of Risk Ratings, in accordance with the existing or proposed development is listed in Table 7 below;

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Table 7: Overview of Natural Cavities Risk Calculation Methodology

Designated Area	SHRn Value (Probability)	Magnitude of Impact (Severity)	Risk
Depositional Areas			
• Northern	Moderate (3)	Negligible (1)	Low (3)
• Central	Low (1)	Negligible (1)	Very Low (1)
• Central	Moderately High (4)	Negligible (1)	Low (4)
• Southern	Low (1)	Negligible (1)	Very Low (1)
Construction Compounds			
• Northern	Moderately Low (2)	Negligible (1)	Very Low (2)
• A33/A34	Moderately Low (2)	Negligible (1)	Very Low (2)
• Central	Moderately Low (2)	Negligible (1)	Very Low (2)
Landscaping Areas	Moderately High (4)	Negligible (1)	Low
	Moderate (3)	Negligible (1)	Low
	Moderately Low (2)	Negligible (1)	Very Low (2)
Piling/Crane Mats	Moderately Low (2)	Negligible (1)	Very Low
Road Development	Moderate (3)	High (4)	Medium
	Moderately Low (2)	High (4)	Medium
	Low (1)	High (4)	Low

12. **Non-Coal Mining Cavities - Hazard Ratings**

The most common uses of mined chalk were agricultural purposes to obtain lime to spread on clay-rich soils to improve their drainage, lighten the soil texture for ploughing and improve crop yields. Another common use was to obtain mined chalk to powder and mix with milled clay to make bricks and tiles.

In addition, whenever chalk mining took place in the past, it was always carried out in dry chalk above the water table. No instances are known where dewatering was employed to create dry chalk for mining.

While the Stantec Mining Cavities Database search did not indicate any recorded mining cavities within a 1km radius of the Order Limit Boundary (OLB), a review of the historical mapping of the area, along with the HA GDNS non-coal mining hazard data has identified 2no. locations where Old Chalk Pits have been recorded. From the available OS County Series (dated 1869-1870, 1:2,500 scale), two Chalk Pits are recorded within the OLB, towards the north/north-east, within a field annotated as 'Easton Down'. The eastern most of these chalk pits has been annotated as 'Easton Down Chalk Pit' by HA GDMS, as illustrated in *Plate 1* above. The two pits have been annotated as Feature 1 and Feature 2 on the Mining Cavities Hazard Map (Figure 2a).

With reference to the HA GDMS extract provided in *Plate 1* above, varying hazard ratings have been assigned along this section of the M3. A Very High hazard rating has been assigned to each locality of a recorded chalk pit or mining feature. In addition, it appears that a 500m radius buffer zone has been applied, also assigned as a Very High hazard. Stantec agree that at the locality of a recorded mining feature, the hazard rating should be Very High due to the known presence of mining activity and extraction, the buffer zone is considered to be conservative and does not reflect the surrounding ground conditions. Stantec consider a 50m radius buffer zone to be more suitable.

Stantec have undertaken a hazard assessment of the site, which has considered the variable geological, hydrogeological and geomorphological factors that pertain to the potential for historical chalk mining to have occurred. This has resulted in a variable hazard rating across the site. The hazard ratings are discussed in depth below and are illustrated on the Mining Cavities Hazard Map (Figure 2a) in accordance with the following numeric values.

(1) Feature 1 represents a chalk pit located within an area of exposed chalk, at approximately 45m AOD. At this location, it is expected that there would be at least 5m of dry chalk, allowing for viable mining; resulting in a **VERY HIGH** hazard rating. To the south and east of this pit, land levels increase, subsequently increasing the thickness of dry chalk that could be extracted. Therefore, a 50m radius buffer zone applies in this direction with a

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	hazard rating of **HIGH**. However, to the north of this recorded chalk pit, the topography declines sharply towards the basin of the River Itchen, where a significant thickness of Alluvium is present overlying the chalk, and the groundwater table is expected to be at, or above, the chalk level. This subsequently lowers the potential for chalk mining to have occurred, resulting in a **LOW** hazard rating. (2) Feature 2 represents Easton Down Chalk Pit which is located within an area of exposed chalk, at approximately 58m AOD. At this location, it is expected that there would be at least 18m of dry chalk, allowing for viable mining; resulting in a **VERY HIGH** hazard rating. Due to the potential for unrecorded adits extending from the chalk pit, a 50m radius buffer zone applies with a hazard rating of **HIGH**. (3) Where chalk is exposed, and a thickness of at least 5m of dry chalk is present above the groundwater level, there are potentially favourable conditions for chalk mining to have occurred, resulting in a hazard rating of **MODERATELY LOW**. (4) Where the chalk is overlain by superficial deposits, but a thickness of at least 5m of dry chalk is present above the groundwater level, there are potentially favourable conditions for chalk mining to have occurred, resulting in a hazard rating of **MODERATELY LOW**. (5) Where the chalk is overlain by Alluvium, OR where the groundwater level is less than 5m below the chalk interface, at the chalk interface, or above the chalk interface, ground conditions are unfavourable for chalk mining to have occurred, resulting in a hazard rating of **LOW.** Furthermore, historical mapping and HA GDMS identify five further mining features, as shown in *Plate 1* above, however these are positioned outside of the Order Limit Boundary. Each of these features have been discussed briefly below (Features 3 to 7), however due to their proximity outside of the Order Limit Boundary, these have not been included in Figure 2. Feature 3 is located outside of the Order Limit Boundary; approximately 75m east of the assigned Northern Deposition Area. This recorded chalk pit is not considered to influence the site or the proposed works. Feature 4, or Upper Farm Chalk Pit, has been identified by the HA GDMS dataset, however it is located approximately 950m north-west of the Order Limit Boundary, and 2.1km south-east of the assigned Northern Construction Compound. This recorded chalk pit is not considered to influence the site or the proposed works. Feature 5, 6, and 7 is associated with the Great Western Lime Works, comprising the Lime Works and two chalk pits. This locality is situated approximately 1.4km south-west, outside of the Order Limit Boundary. As the chalk is at, or near outcrop at this locality, it is considered unlikely that any underground mining, associated with the Lime Works, has occurred. Furthermore, given the distance of the works from the Order Limit Boundary, regardless of any unrecorded underground mining, the works are not considered to influence the site or the proposed works.

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13.	**Non-Coal Mining Cavities - Risk Ratings**

Stantec have assessed the spatial distribution of the likelihood for unrecorded non-coal mining cavities to be present within the Order Limit Boundary and have considered these against the vulnerability (magnitude of impact) of such features to the proposed land usage presented on scheme drawings. This has been undertaken to produce the Non-Coal Mining Risk Map (Figure 2b). The aim of this risk assessment is to identify elements of the scheme that are particularly vulnerable to mining cavity hazards. The risk assessment has been undertaken in accordance with the risk assessment methodology outlined in the GIR Appendix F (GIR GRR01 Rev 2). It is envisaged that this risk assessment will be continuously developed and updated throughout the project as the investigations and works progress.

The likelihood of the occurrence and impact of non-coal mining cavities upon the site has been determined in accordance with the criteria given in the following tables:

Table 8: Non-Coal Mining Cavities Probability of Occurrence Classification

	Criteria	Description
Probability of Occurrence	6: Very High	Recorded occurrence
	5: High	Near certain to occur, probably in numerous locations
	4: Moderately High	Likely to occur, possibly in numerous locations
	3: Moderate	May occur, probably on a single location
	2: Moderately Low	May occur, but unlikely
	1: Low	Not expected to occur

Table 9: Non-Coal Mining Cavities Magnitude of Impact Classification

	Criteria	Description
Vulnerability (Magnitude of Impact)	5: Severe	Severe loss or damage to life or infrastructure
	4: High	Major loss or damage to life or infrastructure
	3: Medium	Substantial loss or damage to infrastructure
	2: Low	Moderate loss or damage to infrastructure
	1: Negligible	Minor loss or damage to infrastructure

The rating of the risks has been assessed using the following Risk Assessment Matrix, and is defined in line with criteria given in the following tables:

Table 10: Non-Coal Mining Cavities Vulnerability Mapping: Risk Assessment Matrix

		Probability of Occurrence					
		Low (1)	Moderately Low (2)	Moderate (3)	Moderately High (4)	High (5)	Very High (6)
Vulnerability (Magnitude of Impact)	Severe (5)	**5**	**10**	**15**	**20**	**25**	**30**
	High (4)	**4**	**8**	**12**	**16**	**20**	**24**
	Medium (3)	**3**	**6**	**9**	**12**	**15**	**18**
	Low (2)	**2**	**4**	**6**	**8**	**10**	**12**
	Negligible (1)	**1**	**2**	**3**	**4**	**5**	**6**

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Table 11: Non-Coal Mining Cavities Risk Rating Classification

	Criteria	Description
Risk Rating	Critical (20-30)	High probability of occurrence with a High impact on the proposed scheme
	High (13-19)	Moderate to High probability of occurrence and a Medium to High impact on the proposed scheme
	Medium (6-12)	Moderate to High probability of occurrence and a or a Medium to High impact on the proposed scheme.
	Low (2-5)	Low to Moderate probability of occurrence or a Low to Medium impact on the proposed scheme
	Very Low (1-2)	Low probability of occurrence and a Negligible to Low impact on the proposed scheme

The varying risk ratings implemented across the site have been illustrated on the *Mining Cavities Risk Map* (Figure 2b):

Table 12: Overview of Non-Coal Mining Cavities Risk Calculation Methodology

Designated Area	Probability of Occurrence	Vulnerability (Magnitude of Impact)	Risk
Depositional Areas			
• Northern	Moderately Low (2)	Negligible (1)	Very Low
• Central	Moderately Low (2)	Negligible (1)	Very Low
• Southern	Moderately Low (2)	Negligible (1)	Very Low
Construction Compounds			
• Northern	Moderately Low (2)	Negligible (1)	Very Low
• A33/A34	Moderately Low (2)	Negligible (1)	Very Low
• Central	Moderately Low (2)	Negligible (1)	Very Low
Landscaping Areas	Moderately Low (2)	Negligible (1)	Very Low
Piling/Crane Mats	Moderately Low (2)	Negligible (1)	Very Low
Road Development	Low (1)	High (4)	Low
	Moderately Low (2)	High (4)	Medium
	Very High (6)	Negligible (1)	Medium
	Very High (6)	Moderate (3)	High

14. Recommendations

As the project progresses, and more ground truthing data becomes available, the Hazard and Risk Maps appended to this report, should be revised and maintained to reflect the increased understanding of the ground conditions.

If during site investigation or construction, abnormal ground conditions are encountered, such as loose or very loose material or voiding, an experienced engineering geologist or geotechnical engineer with a background in geohazards should be consulted prior to continuing.

It would be prudent for foundation and drainage designers to make reference to CIRIA C574 (2002) “Engineering in chalk”.

N

1a Natural Cavities Hazard Map

N

0 0.5 1 km

1b Natural Cavities Risk Map

KEY

- Indicative Application Boundary
- OS Mastermap

Natural Cavities Hazard Rating

- Low
- Moderate - Low
- Moderate
- Moderate - High

Natural Cavities Risk Rating

- Very Low
- Low
- Moderate

Figure Status: FOR INFORMATION

Project Title: M3 JUNCTION 9 IMPROVEMENT

VolkerFitzpatrick

Figure Title: NATURAL CAVITY HAZARD AND RISK MAP

Client: highways england

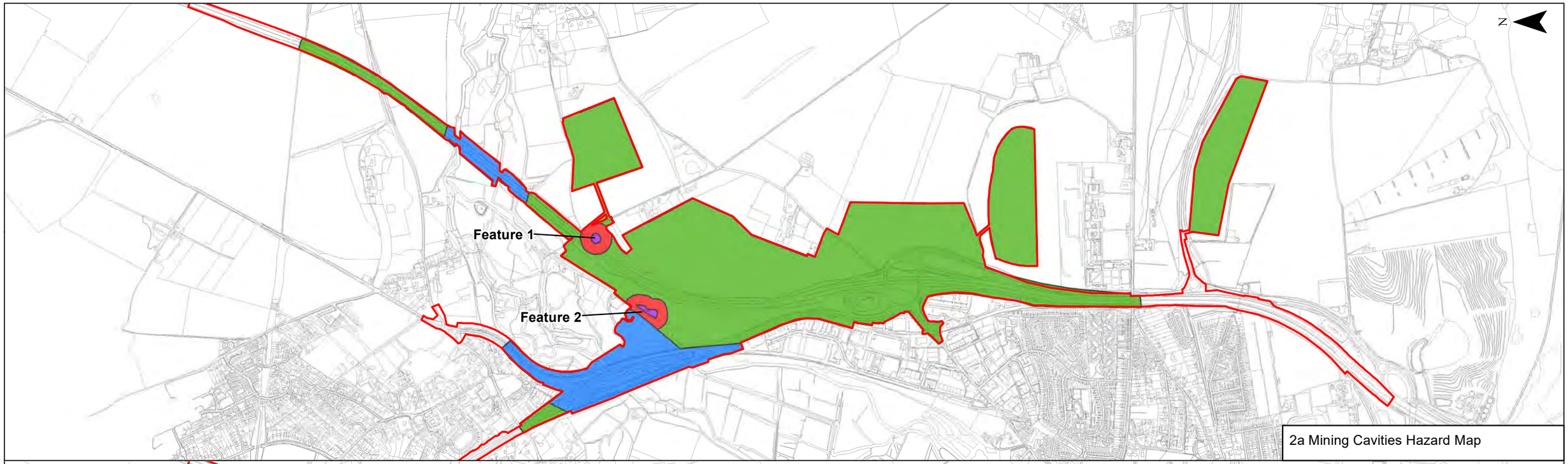
Scale: 1:18,000	Designed: TL	Drawn: TL	Checked: HG	Approved: HG
Original Size: A3	Date: 14/05/2021	Date: 14/05/2021	Date: 14/05/2021	Date: 14/05/2021

FIGURE 1

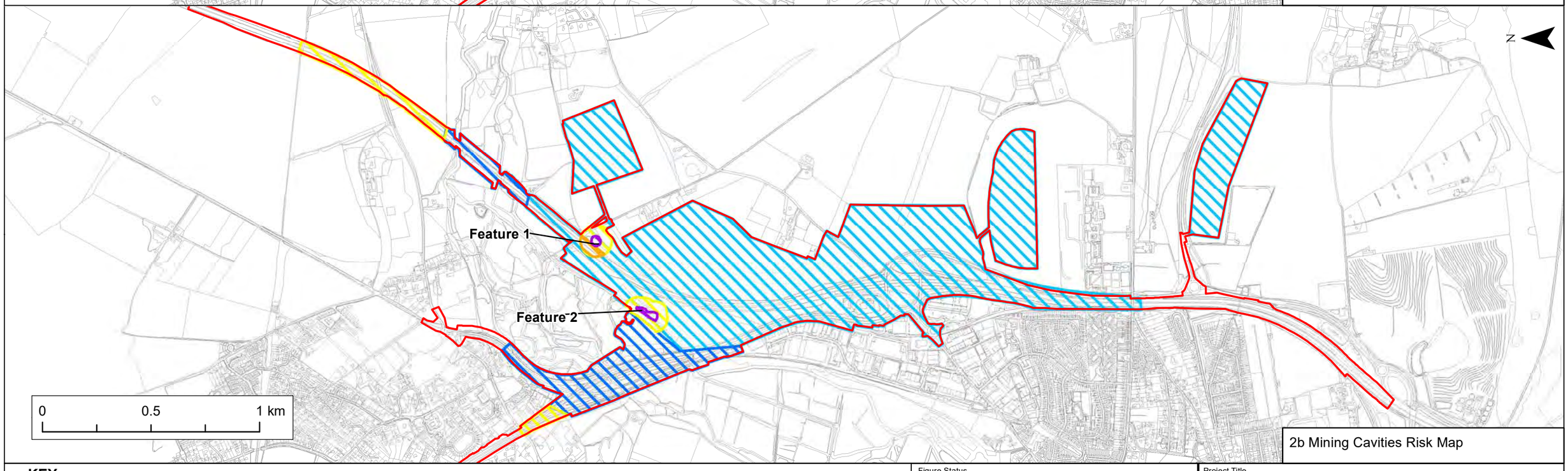
Project Ref No. 48176

Revision: A

Document Path: Z:\Projects\48176\02_mxd\Geophys\48176_Geo_Cavities_HazardVulnerabilityMap.mxd



2a Mining Cavities Hazard Map



2b Mining Cavities Risk Map

KEY

- Indicative Application Boundary
- OS Mastermap

Mining Cavities Hazard Rating

- Low
- Moderate - Low
- Old Chalk Pit Moderate
- High

Mining Cavities Risk Rating

- Very Low
- Low
- Moderate
- High
- Old Chalk Pit - Very High

Figure Status: FOR INFORMATION

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENT

Figure Title: MINING CAVITY HAZARD AND RISK MAP

Scale: 1:18,000	Designed: TL	Drawn: TL	Checked: HG	Approved: HG
Original Size: A3	Date: 14/05/2021	Date: 14/05/2021	Date: 14/05/2021	Date: 14/05/2021

FIGURE 2

Project Ref No. 48176

Revision: A

Document Path: Z:\Projects\48176\02_mxd\Geophys\48176_Mining_Cavities_HazardVulnerabilityMap.mxd

Appendix B Stantec Methodology for the Assessment of Contaminated Land

Stantec Guide: Methodology for Assessment of Land Contamination (England)

1 INTRODUCTION

This document defines the approach adopted by Stantec in relation to the assessment of land contamination in England. The aim is for the approach to (i) be systematic and objective, (ii) provide for the assessment of uncertainty and (iii) provide a rational, consistent, transparent framework.

When preparing our methodology, we have made reference to various technical guidance documents and legislation referenced in Section 7 of which the principal documents are (i) Contaminated Land Statutory Guidance (Defra 2012), (ii) online guidance Land Contamination: Risk Management (LC:RM) accessed from GOV.UK which is expected to replace Contaminated Land Research (CLR) Report 11: Model Procedures for the Management of Contamination (EA 2004). It should be noted that LCRM is currently due to be revised following consultation and CLR 11 is archived, (iii) Contaminated land risk assessment: A guide to good practice (C552) (CIRIA 2001) (iv) National Planning Policy Framework (NPPF, 2019) (v) BS 10175 Investigation of potentially contaminated sites - Code of Practice (BSI 2017) and (vi) The series of British Standards on Soil Quality BS 18400.

2 DEALING WITH LAND CONTAMINATION

Government policy on land contamination aims to prevent new contaminated land from being created and promotes a risk-based approach to addressing historical contamination. For historical contamination, regulatory intervention is held in reserve for land that meets the legal definition and cannot be dealt with through any other means, including through planning. Land is only considered to be "*contaminated land*" in the legal sense if it poses an unacceptable risk.

UK legislation on contaminated land is principally contained in Part 2A of the Environmental Protection Act, 1990 (which was inserted into the 1990 Act by section 57 of the Environment Act 1995). Part 2A was introduced in England on 1 April 2000 and provides a risk-based approach to the identification and remediation of land where contamination poses an unacceptable risk to human health or the environment.

The Model Procedures for the Management of Land Contamination (CLR 11), were developed to provide the technical framework for applying a risk management process when dealing with land affected by contamination. The process involves identifying, making decisions on, and taking appropriate action to deal with land contamination in a way that is consistent with government policies and legislation within the UK. The approach, concepts and principles for land contamination management promoted by LC:RM (and its predecessor CLR 11) are applied to the determination of planning applications. The guidance given in LC:RM follows the same principles.

Other legislative regimes may also provide a means of dealing with land contamination issues, such as the regimes for waste, water, environmental permitting, and environmental damage. Further, the law of statutory nuisance may result in contaminants being unacceptable to third parties whilst not attracting action under Part 2A or other environmental legislation.

2.1 Part 2A

The Regulations and Statutory Guidance that accompanied the Act, including the Contaminated Land (England) Regulations 2006, has been revised with the issue of The Contaminated Land (England) (Amendment) Regulations 2012 (SI 2012/263) and the Contaminated Land Statutory Guidance for England 2012.

Part 2A defines contaminated land as "*land which appears to the Local Authority in whose area it is situated to be in such a condition that, by reason of substances in, on or under the land that significant harm is being caused, or there is a significant possibility that such significant harm (SPOSH) could be caused, or significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution (SPOSP) being caused*".

Harm is defined as "*harm to the health of living organisms or other interference with the ecological systems of which they form part, and in the case of man, includes harm to his property*".

Part 2A provides a means of dealing with unacceptable risks posed by land contamination to human health and the environment, and under the guidance enforcing authorities should seek to find and deal with such land. It states that "*under Part 2A the starting point should be that land is not contaminated land unless there is reason to consider otherwise. Only land where unacceptable risks are clearly identified, after a risk assessment has been undertaken in accordance with the Guidance, should be considered as meeting the Part 2A definition of contaminated land*". Further, the guidance makes it clear that *"regulatory decisions should be based on what is reasonably likely, not what is hypothetically possible".*

The overarching objectives of the Government's policy on contaminated land and the Part 2A regime are:

"(a) To identify and remove unacceptable risks to human health and the environment.

(a) To seek to ensure that contaminated land is made suitable for its current use.

(b) To ensure that the burdens faced by individuals, companies and society as a whole are proportionate, manageable and compatible with the principles of

sustainable development".

The enforcing authority may need to decide whether and how to act in situations where decisions are not straight forward, and where there is uncertainty. "*In so doing, the authority should use its judgement to strike a reasonable balance between: (a) dealing with risks raised by contaminants in land and the benefits of remediating land to remove or reduce those risks; and (b) the potential impacts of regulatory intervention including financial costs to whoever will pay for remediation, health and environmental impacts of taking action, property blight, and burdens on affected people".*

The authority is required to "*take a precautionary approach to the risks raised by contamination, whilst avoiding a disproportionate approach given the circumstances of each case".* The aim is "*that the regime produces net benefits, taking account of local circumstances*".

The guidance recognises that *"normal levels of contaminants in soils should not be considered to cause land to qualify as contaminated land, unless there is a particular reason to consider otherwise".* Normal levels are quoted as:

"a) *natural presence of contaminants'* such as from underlying geology *'that have not been shown to pose an unacceptable risk to health and the environment*

b) *…low level diffuse pollution, and common human activity…"*

Similarly the guidance states that significant pollution or significant possibility of significant pollution of controlled waters is required for land to be considered contaminated and the "*fact that substances are merely entering water"* or "*where discharge from land is not discernible at a location immediately downstream"* does not constitute contaminated land.

To help achieve a more targeted approach to identifying and managing contaminated land in relation to the risk (or possibility) of harm to human health, the revised Statutory Guidance presented a new four category system for considering land under Part 2A, ranging from Category 4, where there is no risk that land poses a significant possibility of significant harm (SPOSH), or the level of risk is low, to Category 1, where the risk that land poses a significant possibility of significant harm (SPOSH) is unacceptably high.

For land that cannot be readily placed into Categories 1 or 4 further assessment is required. If there is sufficient concern that the risks could cause significant harm or have the significant possibility of significant harm the land is to be placed into Category 2. If the concern is not met land is considered Category 3.

The technical guidance clearly states that the currently published Soil Guidance Values (SGV's) and Generic Assessment Criteria (GAC's) represent *"cautious estimates of level of contaminants in soils"* which should be considered *"no risk to health or, at most, a minimal risk"*. These values do not represent the boundary between categories 3 and 4 and "*should be considered to be comfortably within Category 4".*

At the end of 2013 technical guidance in support of Defra's revised Statutory Guidance (SG) was published and then revised in 2014 (CL: AIRE 2014) which provided:

- A methodology for deriving C4SLs for four generic land-uses comprising residential, commercial, allotments and public open space; and

- A demonstration of the methodology, via the derivation of C4SLs for six substances – arsenic, benzene, benzo(a)pyrene, cadmium, chromium (VI) and lead.

For controlled waters, the revised Statutory Guidance states that the following types of pollution should be considered to constitute significant pollution of controlled waters:

"(a) Pollution equivalent to "environmental damage" to surface water or groundwater as defined by The Environmental Damage (Prevention and Remediation) Regulations 2009, but which cannot be dealt with under those Regulations.

(b) Inputs resulting in deterioration of the quality of water abstracted, or intended to be used in the future, for human consumption such that additional treatment would be required to enable that use.

(c) A breach of a statutory surface water Environment Quality Standard, either directly or via a groundwater pathway.

(d) Input of a substance into groundwater resulting in a significant and sustained upward trend in concentration of contaminants (as defined in Article 2(3) of the Groundwater Daughter Directive (2006/118/EC)".

The guidance also states that, in some circumstances, significant concentrations at a compliance point (in groundwater or surface water) may constitute pollution of controlled waters.

As with SPOSH for human health, the revised Statutory Guidance presents a four-category system for Significant Pollution of controlled waters. Category 1 covers land where there is a strong and compelling case for SPOSP, for example where significant pollution would almost certainly occur if no action was taken to avoid it. Category 4 covers land where there is no risk or the risk is low, for

example, where the land contamination is having no discernible impact on groundwater or surface water quality. Category 2 is for land where the risks posed to controlled waters are not high enough to consider the land as Category 1 but nonetheless are of sufficient concern to constitute SPOSP, Category 3 is for land where the risks posed to controlled waters are higher than low but not of sufficient concern to constitute SPOSP.

2.2 Planning

The Local Planning Authority (LPA) is responsible for the control of development, and in doing so it has a duty to take account of all material considerations, including contamination.

The principal planning objective is to ensure that any unacceptable risks to human health, buildings and other property and the natural and historical environment from the contaminated condition of the land are identified so that appropriate action can be considered and taken to address those risks.

The National Planning Policy Framework (NPPF, 2019), includes the following.

Paragraph 118 states that planning policies and decisions should "*(c) give substantial weight to the value of using suitable brownfield land within settlements for homes and other identified needs, and support appropriate opportunities to remediate despoiled, degraded, derelict, contaminated or unstable land*."

Paragraph 179 states "*Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner*".

Paragraph 170 states "*planning policies and decisions should contribute to and enhance the natural and local environment by:*

(e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; *and*

(f) remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate."

Paragraph 178 describes the policy considerations the Government expects LPA's to have in regard to land affected by contamination when preparing policies for development plans and in taking decisions on applications.

Paragraph 178 states "*planning policies and decisions should ensure that:*

(a) a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation);

(b) after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and

c) adequate site investigation information, prepared by a competent person, is available to inform these assessments."

Paragraph 183 states "*The focus of planning policies and decisions should be on whether proposed development is an acceptable use of land, rather than the control of processes or emissions (where these are subject to separate pollution control regimes). Planning decisions should assume that these regimes will operate effectively. Equally, where a planning decision has been made on a development, the planning issues should not be revisited through the permitting regimes operated by pollution control authorities.*"

The Glossary in Annex 2 provides the following:

***Brownfield land registers**: Registers of previously developed land that local planning authorities consider to be appropriate for residential development, having regard to criteria in the Town and Country Planning (Brownfield Land Registers) Regulations 2017. Local planning authorities will be able to trigger a grant of permission in principle for residential development on suitable sites in their registers where they follow the required procedures.*

***Competent person (to prepare site investigation information)**: A person with a recognised relevant qualification, sufficient experience in dealing with the type(s) of pollution or land instability, and membership of a relevant professional organisation.*

***Previously developed land**: Land which is or was occupied by a permanent structure, including the curtilage of the developed land (although it should not be assumed that the whole of the curtilage should be developed) and any associated fixed surface infrastructure. This excludes: land that is or was last occupied by agricultural or forestry buildings; land that has been developed for minerals extraction or waste disposal by landfill, where provision for restoration has been made through development management procedures; land in built-up areas such as residential gardens, parks, recreation grounds and allotments; and land that was previously developed but where the*

remains of the permanent structure or fixed surface structure have blended into the landscape.

***Site investigation information**: Includes a risk assessment of land potentially affected by contamination, or ground stability and slope stability reports, as appropriate. All investigations of land potentially affected by contamination should be carried out in accordance with established procedures (such as BS10175 Investigation of Potentially Contaminated Sites – Code of Practice).*

Stantec adopt the principle that a Preliminary Investigation (Desk Study and Site Reconnaissance) and Preliminary Risk Assessment (see below) is the minimum assessment requirement to support a planning application.

The level at which contamination is deemed to be unacceptable, or, gives rise to adverse effects under a planning context has not been identified but is envisaged to be more precautionary than the level required to determine land as contaminated under Part 2A.

2.3 Building Control

The building control department of the local authority or private sector approved inspectors are responsible for the operation and enforcement of the Building Regulations (DCLG 2010) to protect the health, safety and welfare of people in and around buildings. Approved Document C requires the protection of buildings and associated land from the effects of contamination, to be applied (non-exclusively) in all changes of use from commercial or industrial premises, to residential property.

3 APPROACH

As with CLR11 the guidance given in LC:RM presents three stages of risk management: -

(a) Stage 1 - Risk Assessment;

(b) Stage 2 - Options Appraisal; and

(c) Stage 3 - Remediation.

Each stage has three tiers. The three tiers of Stage 1 Risk Assessment are: -

- Tier 1 - Preliminary Risk Assessment (PRA) - first tier of RA that develops the outline conceptual model (CM) and establishes whether there are any potentially unacceptable risks.

- Tier 2 - Generic Quantitative Risk Assessment (GQRA) - carried out using generic assessment criteria and assumptions to estimate risk.

- Tier 3 - Detailed Quantitative Risk Assessment (DQRA) - carried out using detailed site-specific information to generate Site Specific Assessment Criteria (SSAC) as risk evaluation criteria.

For each tier of a Stage 1 - Risk Assessment you must:

1. Identify the hazard - establish contaminant sources.

2. Assess the hazard - use a source-pathway-receptor (S-P-R) pollutant linkage approach to find out if there is the potential for unacceptable risk.

3. Estimate the risk - predict what degree of harm or pollution might result and how likely it is to occur.

4. Evaluate the risk - decide whether a risk is unacceptable.

A Stantec Preliminary Investigation report normally comprises a desk study, walkover site reconnaissance and preliminary risk assessment (PRA). The project specific proposal defines the actual scope of work which might include review of ground investigation data in which case the report includes a GQRA.

Risk estimation involves identifying the magnitude of the potential consequence (taking into account both the potential severity of the hazard and the sensitivity of the receptor) and the magnitude of the likelihood i.e. the probability (taking into account the presence of the hazard and the receptor and the integrity of the pathway). This approach is promoted in current guidance such as R&D 66 (NHBC 2008).

For a PRA, Stantec's approach is that if a pollution linkage is identified then it represents a potentially unacceptable risk which either (1) remediation / direct risk management or (2) progression to further tiers of risk assessment (GQRA and GQRA) requiring additional data collection and enabling refinement of the CM using the site specific data.

4 IDENTIFICATION OF POLLUTANT LINKAGES AND DEVELOPMENT OF A CONCEPTUAL MODEL (CM)

For all Tiers of a Stage 1 Risk Assessment, the underlying principle to ground condition assessment is the identification of *pollutant linkages* in order to evaluate whether the presence of a source of contamination could potentially lead to harmful consequences. A pollutant linkage consists of the following three elements: -

- A source/hazard – a substance or situation which has the potential to cause harm or pollution;
- A pathway – a means by which the hazard moves along / generates exposure; and
- A receptor/target – an entity which is vulnerable to the potential adverse effects of the hazard.

The *Conceptual Model* identifies the types and locations of potential contaminant sources/hazards and potential receptors and potential migration/transportation pathway(s). The CM is refined through progression to further tiers of risk assessment (GQRA and GQRA) requiring additional data collection.

4.1 Hazard Identification

A hazard is a substance or situation that has the potential to cause harm. Hazards may be chemical, biological or physical.

In a PRA the potential for hazards to be present is determined from consideration of the previous or ongoing activities on or near to the site in accordance with the criteria presented in the **Table 1**.

Based on the land use information Contaminants of Potential Concern (COPC) are identified. The COPC direct the scope of the collection of site-specific data and the analytical testing selected for subsequent Tiers.

At Tier 2 the site-specific data is evaluated using appropriate published assessment criteria (refer to Stantec document entitled Rationale for the Selection of Evaluation Criteria for a Generic Quantitative Risk Assessment (GQRA)). In general, published criteria have been developed using highly conservative assumptions and therefore if the screening criterion is not exceeded (and if enough samples from appropriate locations have been analysed) then the COPC is eliminated as a potential Hazard. It should be noted that exceedance does not necessarily indicate that a site is contaminated and/or unsuitable for use only that the COPC is retained as a potential Hazard. Published criteria are generated using models based on numerous and complex assumptions. Whether or not these assumptions are appropriate or sufficiently protective requires confirmation on a project by project basis. Manipulation of the default assumptions would normally form part of a Tier 3 Detailed Quantitative Risk Assessment (DQRA).

When reviewing or assessing site specific data Stantec utilise published guidance on comparing contamination data with a critical concentration (CL:AIRE/CIEH 2008) which presents a structured process for employing statistical techniques for data assessment purposes.

4.2 Receptor and Pathway Identification

For all Tiers the potential receptors (for both on site and adjoining land) that will be considered are:

- Human Health – including current and future occupiers, construction and future maintenance workers, and neighbouring properties/third parties;
- Ecological Systems; [1]
- Controlled Waters [2] – Under section 78A(9) of Part 2A the term "pollution of controlled waters" means the entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter. The term "controlled waters" in relation to England has the same meaning as in Part 3 of the Water Resources Act 1991, except that "ground waters" does not include waters contained in underground strata but above the saturation zone.
- Property - Animal or Crop (including timber; produce grown domestically, or on allotments, for consumption; livestock; other owned or domesticated animals; wild animals which are the subject of shooting or fishing rights); and
- Property - Buildings (any structure or erection, and any part of a building including any part below ground level, but does not include plant or machinery comprised in a building, or buried services such as sewers, water pipes or electricity cables including archaeological sites and ancient monuments).

If a receptor is taken forward for further assessment it will be classified in terms of its sensitivity, the criteria for which are presented in **Table 2**. Table 2 has been generated using descriptions of environmental receptor importance/value given in various guidance documents including R&D 66 (NHBC 2008), EA 2017 and Transport Analysis Guidance (based on DETR 2000). Human health and buildings classifications have been generated by Stantec using the attribute description for each class. Surface water sensitivity is classified using the Water Framework Directive (WFD) status for the River Basin obtained from: [redacted]

[1] International or nationally designated sites (as defined in the statutory guidance (Defra Circular 04/12)) "*in the local area*" will be identified as potential ecological receptors. A search radius of 1, 2 or 5km will be utilised depending on the site-specific circumstances (see also pathway identification). The Environment Agency has published an ecological risk assessment framework (EA 2008) which promotes (as opposed to statutorily enforces) consideration of additional receptors to include locally protected sites and protected or notable species. These additional potential receptors will only be considered if a Phase 1 habitat survey, undertaken in accordance with guidance (JNCC 1993), is commissioned and the data provided to Stantec. It should be noted that without such a survey a Land Contamination risk assessment may conclude that the identification of potential ecological receptors is inconclusive (refer to Stantec Specification for a Preliminary Investigation (Desk Study and Site Reconnaissance).

[2] The definition of "pollution of controlled water" was amended by the introduction of Section 86 of the Water Act 2003. For the purposes of Part 2A groundwater does not include waters above the saturated zone and our assessment does not therefore address perched water other than where development causes a pathway to develop.

The exposure pathway and modes of transport that will be considered are presented in **Table 3**.

4.3 Note regarding Ecological Systems

The Environment Agency (EA) has developed an ecological risk assessment framework which aims to provide a structured approach for assessing the risks to ecology from chemical contaminants in soils (EA 2008). In circumstances where contaminants in water represent a potential risk to aquatic ecosystems then risk assessors will need to consider this separately.

The framework consists of a three-tiered process: -

- Tier 1 is a screening step where the site soils chemical data is compared to a soil screening value (SSV)
- Tier 2 uses various tools (including surveys and biological testing) to gather evidence for any harm to the ecological receptors
- Tier 3 seeks to attribute the harm to the chemical contamination

Tier 1 is preceded by a desk study to collate information about the site and the nature of the contamination to assess whether pollutant linkages are feasible. The framework presents ten steps for ecological desk studies and development of a conceptual model as follows.

1. Establish Regulatory Context
2. Collate and Assess Documentary Information
3. Summarise Documentary Information
4. Identify Contaminants of Potential Concern
5. Identify Likely Fate Transport of Contaminants
6. Identify Potential Receptors of Concern
7. Identify Potential Pathways of Concern
8. Create a Conceptual Model
9. Identify Assessment and Measurement Endpoints
10. Identify Gaps and Uncertainties

The information in a standard PRA report covers Steps 1 to 4 inclusive. Step 5 considers fate and transport of contaminants and it should be noted that our standard report adopts a simplified approach considering only transport mechanisms. A simplified approach has also been adopted in respect of Steps 6 and 7 receptors (a detailed review of the ecological attributes has not been undertaken) and pathways (a food chain assessment has not been undertaken). Step 9 is outside the scope of our standard PRA report.

It should be noted that the PRA report will present an assessment for ecological systems (where identified as a receptor for a land contamination assessment) considering the viability of the mode of transport given the site-specific circumstances and not specific pathways. The PRA may conclude that the risk to potential ecological receptors is inconclusive.

4.4 Note regarding controlled waters

Controlled waters are rivers, estuaries, coastal waters, lakes and groundwaters, but not perched waters.

The EU Water Framework Directive (WFD) 2000/60/EC provides for the protection of sub-surface, surface, coastal and territorial waters through a framework of river basin management. The EU Updated Water Framework Standards Directive 2014/101/EU amended the EU WFD to update the international standards therein; it entered into force on 20 November 2014 with the requirements for its provisions to be transposed in Member State law by 20 May 2016. Other EU Directives in the European water management framework include:

- the EU Priority Substances Directive 2013/39/EU;
- EU Groundwater Pollutants Threshold Values Directive 2014/80/EU amending the EU Groundwater Directive 2006/118/EC; and
- EU Biological Monitoring Directive 2014/101/EU.

The Ground Water Daughter Directive (GWDD) was enacted by the Groundwater Regulations (2009), which were subsumed by the Environmental Permitting Regulations (2010) which provide essential clarification including on the four objectives specifically for groundwater quality in the WFD: -

Achieve ‘Good’ groundwater chemical status by 2015, commonly referred to as ‘status objective’;
Achieve Drinking Water Protected Area Objectives;
Implement measures to reverse any significant and sustained upward trend in groundwater quality, referred to as ‘trend objective’; and

Prevent or limit the inputs of pollutants into groundwater, commonly referred to as ‘prevent or limit’ objectives

The Water Act 2003 (Commencement No.11) Order 2012 amends the test for 'contaminated land' which relates to water pollution so that pollution of controlled waters must now be "significant" to meet the definition of contaminated land.

The Water Framework Directive (WFD) requires the preparation, implementation and review of River Basin Management Plans (RBMP) on a six-year cycle. River basins are made up of lakes, rivers, groundwaters, estuaries and coastal waters, together with the land they drain. River Basin Districts (RBD) and the WFD Waterbodies that they comprise are important spatial management units, regularly used in catchment management studies. River Basin Management Plans (RBMP) have been developed for the 11 River Basin Districts in England and Wales.

These were released by Defra in 2009 (Defra 2009) and updated in 2015.

These RBMP's establish the current status of waters within the catchments of the respective Districts and the current status of adjoining waters identified. As part of a Tier 2 risk assessment water quality data is screened against the WFD assessment criteria. Comparison with the RBMP's current status of waters for the catchment under consideration would form part of a Tier 3 assessment.

5 RISK ESTIMATION

Risk estimation classifies what degree of harm might result to a receptor (defined as consequence) and how likely it is that such harm might arise (probability).
At Tier 1 the consequence classification is generated by multiplying the hazard classification score and the receptor sensitivity score. This approach follows that presented in the republished R&D 66 (NHBC 2008).

The criteria for classifying probability are set out in **Table 4** and have been taken directly from Table 6.4 CIRIA C552 (CIRIA 2001). Probability considers the integrity of the exposure pathway.

The consequence classifications detailed in **Table 5** have been adapted from Table 6.3 presented in C552 and R&D 66 (Annex 4 Table A4.3).

The Tier 1 risk classification is estimated for each pollutant linkage using the matrix given in **Table 6** which is taken directly from C552 (Table 6.5).

Subsequent Tiers refine the CM through retention or elimination of potential hazards and pollutant linkages.

6 RISK EVALUATION

Evaluation criteria are the parameters used to judge whether harm or pollution needs further assessment or is unacceptable. The evaluation criteria used will depend on:

- the reasons for doing the RA and the regulatory context such as Part 2A or planning;
- the CM and pollutant linkages present;
- any criteria set by regulators;
- any advisory requirements such as from Public Health England;
- the degree of confidence and precaution required;
- the level of confidence required to judge whether a risk is unacceptable;
- how you've used or developed more detailed assessment criteria in the later tiers of RA;
- the availability of robust scientific data;
- how much is known - for example, about the pathway mechanism and how the contaminants affect receptors; and
- any practical reasons such as being able to measure or predict against the criteria.

In order to put the Tier 1 risk classification into context the likely actions are described in **Table 7** which is taken directly from Table 6.6 of C552 (CIRIA 2001).

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BSI 2019 BS 8485:2015+A1:2019 Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings

CIRIA 2001: Contaminated land risk assessment – a guide to good practice C552.

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Stantec Methodology for Assessment of Land Contamination (England)

Table 1: Criteria for Classifying Hazards / Potential for Generating Contamination

Classification/Score	Potential for generating contamination/gas based on land use
Very Low 1	Land Use: Residential, retail or office use, agriculture Contamination: Limited. Gas generation potential: Soils with low organic content
Low 2	Land Use: Recent small scale industrial and light industry Contamination: locally slightly elevated concentrations. Gas generation potential: Soils with high organic content (limited thickness)
Moderate 3	Land Use: Railway yards, collieries, scrap yards, engineering works. Contamination: Possible widespread slightly elevated concentrations and locally elevated concentrations. Gas generation potential: Dock silt and substantial thickness of organic alluvium/peat
High 4	Land Use: Heavy industry, non-hazardous landfills. Contamination: Possible widespread elevated concentrations. Gas generation potential: Shallow mine workings Pre 1960s landfill
Very High 5	Land Use: Hazardous waste landfills, gas works, chemical works, Contamination: Likely widespread elevated concentrations. Gas generation potential: Landfill post 1960

"Greenfield" is land which has not been developed and there has been no use of agrochemicals

Table 2: Criteria for Classifying Receptor Sensitivity/Value

Classification	Definition
Very Low 1	Receptor of limited importance • Groundwater: Unproductive strata (Strata with negligible significance for water supply or river baseflow) (previously Non-aquifer), Secondary B (water-bearing parts of non-aquifers), Secondary undifferentiated (previously minor or non-aquifer, but information insufficient to classify as secondary A or B) • Surface water: WFD Surface Water status Bad • Ecology: No local designation • Buildings: Replaceable • Human health: Unoccupied/limited access
Low 2	Receptor of local or county importance with potential for replacement • Groundwater: Secondary A aquifer • Surface water: WFD Surface Water status Poor • Ecology: local habitat resources • Buildings: Local value • Human health: Minimum score 4 where human health identified as potential receptor
Moderate 3	Receptor of local or county importance with potential for replacement • Groundwater: Principal aquifer • Surface water: WFD Surface Water status Moderate • Ecology: County wildlife sites, Areas of Outstanding Natural Beauty (AONB) • Buildings: Area of Historic Character • Human health: Minimum score 4 where human health identified as potential receptor
High 4	Receptor of county or regional importance with limited potential for replacement • Groundwater: Source Protection Zone 2 or 3 • Surface water: WFD Surface Water status Good • Ecology: SSSI, National or Marine Nature Reserve (NNR or MNR) • Buildings: Conservation Area • Human health: Minimum score 4 where human health identified as potential receptor
Very High 5	Receptor of national or international importance • Groundwater: Source Protection Zone (SPZ) 1 • Surface water: WFD Surface Water status High • Ecology: Special Areas of Conservation (SAC and candidates), Special Protection Areas (SPA and potentials) or wetlands of international importance (RAMSAR) • Buildings: World Heritage site • Human health: Residential, open spaces and uses where children are present

Table 3: Exposure Pathway and Modes of Transport

Receptor	Pathway	Mode of transport
Human health	Ingestion	Fruit or vegetable leaf or roots
		Contaminated water
		Soil/dust indoors
		Soil/dust outdoors
	Inhalation	Particles (dust / soil) – outdoor
		Particles (dust / soil) - indoor
		Vapours – outdoor - migration via natural or anthropogenic pathways
		Vapours - indoor - migration via natural or anthropogenic pathways
	Dermal absorption	Direct contact with soil
		Direct contact with waters (swimming / showering)
		Irradiation
Groundwater	Leaching	Gravity / permeation
	Migration	Natural – groundwater as pathway Anthropogenic (e.g. boreholes, culverts, pipelines etc.)
Surface Water	Direct	Runoff or discharges from pipes
	Indirect	Recharge from groundwater
	Indirect	Deposition of windblown dust
Buildings	Direct contact	Sulphate attack on concrete, hydrocarbon corrosion of plastics
	Gas ingress	Migration via natural or anthropogenic paths
Ecological systems	See Notes	Runoff/discharge to surface water body
	See Notes	Windblown dust
	See Notes	Groundwater migration
	See Notes	At point of contaminant source
Animal and crop	Direct	Windblown or flood deposited particles / dust / sediments
	Indirect	Plants via root up take or irrigation. Animals through watering
	Inhalation	By livestock / fish - gas / vapour / particulates / dust
	Ingestion	Consumption of vegetation / water / soil by animals

Table 4: Classification of Probability

Classification	Definition
High likelihood	There is a pollution linkage and an event either appears very likely in the short-term and almost inevitable over the long-term, or there is already evidence at the receptor of harm / pollution.
Likely	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short-term and likely over the long-term.
Low likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter-term.
Unlikely	There is a pollution linkage, but circumstances are such that it is improbable that an event would occur even in the very long-term.

Table 5: Classification of Consequence (score = magnitude of hazard and sensitivity of receptor)

Classification / Score	Examples
Severe **17-25** **(3 out of 25 outcomes)**	Human health effect - exposure likely to result in "significant harm" as defined in the Defra (2012) Part 2A Statutory Guidance [1]. Controlled water effect - short-term risk of pollution (note: Water Resources Act contains no scope for considering significance of pollution) of sensitive water resource. Equivalent to EA Category 1 incident (persistent and/or extensive effects on water quality leading to closure of potable abstraction point or loss of amenity, agriculture or commercial value. Major fish kill. Ecological effect - short-term exposure likely to result in a substantial adverse effect. Catastrophic damage to crops, buildings or property
Medium **10-16** **(7 out of 25 outcomes)**	Human health effect - exposure could result in "significant harm" [1]. Controlled water effect - equivalent to EA Category 2 incident requiring notification of abstractor Ecological effect - short-term exposure may result in a substantial adverse effect. Damage to crops, buildings or property
Mild **5-9** **(7 out of 25 outcomes)**	Human health effect - exposure may result in "significant harm" [1]. Controlled water effect - equivalent to EA Category 3 incident (short lived and/or minimal effects on water quality). Ecological effect - unlikely to result in a substantial adverse effect. Minor damage to crops, buildings or property. Damage to building rendering it unsafe to occupy (for example foundation damage resulting in instability).
Minor **1-4** **(8 out of 25 outcomes)**	No measurable effect on humans. Protective equipment is not required during site works. Equivalent to insubstantial pollution incident with no observed effect on water quality or ecosystems. Repairable effects to crops, buildings or property. The loss of plants in a landscaping scheme. Discolouration of concrete.

[1] Significant harm includes death, disease, serious injury, genetic mutation, birth defects or impairment of reproductive function. The local authority may also consider other health effects to constitute significant harm such as physical injury; gastrointestinal disturbances; respiratory tract effects; cardio-vascular effects; central nervous system effects; skin ailments; effects on organs such as the liver or kidneys; or a wide range of other health impacts. Whether or not these would constitute significant harm would depend on the seriousness of harm including impact on health, quality of life and scale of impact.

Table 6: Classification of Risk (Combination of Consequence Table 5 and Probability Table 4)

	Consequence			
Probability	***Severe***	***Medium***	***Mild***	***Minor***
High likelihood	Very high	High	Moderate	Low
Likely	High	Moderate	Moderate/	Low
Low likelihood	Moderate	Moderate	Low	Very low
Unlikely	Low	Low	Very low	Very low

Table 7: Description of Risks and Likely Action Required

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

Stantec Guide: Generic Quantitative Risk Assessment - Evaluation Criteria (England)

1 INTRODUCTION

The aim of this document is to present an explanation for the selection of the evaluation criteria routinely used by Stantec UK Ltd when undertaking a land contamination Tier 2 Generic Quantitative Risk Assessment (GQRA).

A GQRA uses published criteria to screen the site-specific contamination testing data and identify potential hazards to specific receptors. Generic criteria are typically conservative in derivation and exceedance does not indicate that a site is statutorily contaminated and/or unsuitable for use in the planning context. These criteria are used to identify situations where further assessment and/or action may be required. This document is divided into general introductory text and sections on soils, waters and gases.

2 GENERAL NOTES

This document should be read in conjunction with another entitled "Stantec Methodology for Assessment of Land Contamination" which summarises the legislative regime and our approach to ground contamination and risk assessment.

Any Stantec interpretation of contamination test results is based on a scientific and engineering appraisal. The perceptions of, for example, banks, insurers, lay people etc are not taken into account.

Any tables included in this document are produced for ease of reference to the criteria, they do not in any way replace the documents of origin (which are fully referenced) and which should be read to ensure appropriate use and interpretation of the data.

Generic criteria provide an aid to decision-making, but they do not replace the need for sound professional judgement in risk assessment (EA, 2006). The criteria are based on numerous and complex assumptions. The appropriateness of these assumptions in a site-specific context requires confirmation on a project by project basis. Our interpretative report will comment on the appropriateness of the routine criteria for project objectives or ground conditions. In some cases the published criteria whilst typically conservative may in some circumstances not be suitable for the site being assessed, either because they do not address the identified pollutant linkages or because they may not be sufficiently precautionary in the context of the site. Under these circumstances it may be necessary to recommend deriving site-specific assessment criteria. Any deviation from the routine criteria and/or selection of criteria for parameters not covered in this document will be described in the report text.

3 CRITERIA FOR EVALUATING SOIL RESULTS

3.1 Potential Harm to Human Health

The criteria used by Stantec UK Ltd to assess the potential for harm to human health are:-

- Category 4 Screening Levels (C4SLs) (DEFRA, 2014).
- Suitable 4 Use Levels (S4ULs) (Nathanail *et al*, 2015).
- CL:AIRE/EIC/AGS Generic Assessment Criteria (GAC) (CL:AIRE, 2010).
- Soil Guideline Values (SGVs) (EA, 2009a).

These criteria have been generated using the Contaminated Land Exposure Assessment model (CLEA) and supporting technical guidance (EA, 2009b, 2009c, 2009d, 2009e). The CLEA model uses generic assumptions about the fate and transport of chemicals in the environment and a generic conceptual model for site conditions and human behaviour to estimate child and adult exposures to soil contaminants for those potentially living, working, and/or playing on contaminated sites over long time periods (EA, 2009c).

The S4ULs, SGVs and GACs are all based on use of minimal/tolerable risk Health Criteria Values (HCVs) as the toxicological benchmark whereas the C4SL are based on use of a "low level of toxicological concern" (LLTC) as the toxicological benchmark. The LLTC represents a slightly higher level of risk than the HCV.

An update to the software (1.071) was published on 04/09/2015 (the handbook (EA 2009f) referring to version 1.05 is still valid). The update includes the library data sets from the DEFRA research project SP1010 (Development of Category 4 Screening Levels for assessment of land affected by contamination).

The CLEA model uses ten exposure pathways (Ingestion (outdoor soil, indoor dust, homegrown vegetables and soil attached to homegrown vegetables), Dermal Contact (outdoor soil and indoor dust) and Inhalation (outdoor dust, indoor dust, outdoor vapours and indoor vapours)). There are exposure pathways not included in the CLEA model such as the permeation of organics into plastic water supply pipes.

The presence and/or significance of each of the potential exposure pathways is dependent on the land use being considered. The model uses standard land use scenarios as follows:-

Residential – habitation of a dwelling up to two storeys high with various default material and design parameters, access to either private or nearby community open space with soil track back

to form indoor dust. Assumes ingestion of homegrown produce.

Allotments – the model has default parameters for use and consumption of vegetables but not animals or their products (eggs).

Industrial/Commercial – assumes office or light physical work in a permanent three storey structure with breaks taken outside and that the site is NOT covered in hardstanding.

Public Open Space – two public open space (POS) scenarios are considered: POS_{resi} is shared communal space within a residential development where tracking back of soil into the home is assumed to occur. POS_{park} is intended for a public park sufficiently distant from housing (i.e. not adjacent to housing) such that tracking back of soil into the home is negligible. Note that the POS assessment criteria may not be appropriate for assessing sports fields.

The assessment criteria generated using CLEA can be used as a conservative starting point for evaluating long-term risks to human health from chemicals in soil.

It is important to note that the model does not assess all the potential exposure scenarios, for example risk to workers in excavations (short term exposure) or diffusion of contaminants through drinking water pipes.

Recent guidance (DEFRA 2012) introduces a four stage classification system where Category 1 sites are clearly contaminated land and Category 4 sites are definitely not contaminated land as defined by EPA 1990. Outside of these categories further specific risk assessment is required to determine if the site should fall into Category 2 (contaminated land) or Category 3 (not contaminated land). Category 4 screening values are considered to be more pragmatic than the current published SGV/GAC criteria but still strongly precautionary with the aim of allowing rapid identification of sites where the risk is above minimal but still low/acceptable.

Category 4 Screening Levels (C4SLs)

At the end of 2013, technical guidance in support of DEFRA's revised Statutory Guidance (SG) was published and then revised in 2014 (CL:AIRE 2014) which provided:

- A methodology for deriving C4SLs for the standard land-uses and two new public open space scenarios using the updated assumptions relating to the modelling of human exposure to soil contaminants; and
- A demonstration of the methodology, via the derivation of C4SLs for six substances – arsenic, benzene, benzo(a)pyrene, cadmium, chromium (VI) and lead.

Following issue of an Erratum in December 2014, a Policy Companion Document was published (DEFRA 2014).

A letter from Lord de Mauley dated 3rd September 2014 provides more explicit direction to local authorities on the use of the C4SL in a planning context. The letter identifies four key points:

1) that the screening values were developed expressly with the planning regime in mind

2) their use is recommended in DCLG's planning guidance

3) soil concentrations below a C4SL limit are considered to be 'definitely not contaminated' under Part IIA of the 1990 Environmental Protection Act and pose at most a 'low level of toxicological concern' and,

4) exceedance of a C4SL screening value does not mean that land is definitely contaminated land, just that further investigation may be warranted.

Stantec use the C4SLs as the Tier 2 soil screening criteria protective of human health for substances with C4SL available. Table 1 summarises the C4SL (DEFRA 2014) for each of the six substances.

Note that, with the exception of benzene, the DEFRA published C4SL are not dependent on soil organic matter content (SOM) ("*Given that BaP is non volatile and that empirical soil to plant concentration factors have been used, soil organic matter content has a negligible influence on the C4SLs for this chemical"*). The DEFRA published C4SL for benzene is based on an SOM of 6%. Stantec have used the CLEA model (v1.071) to derive C4SL for benzene for 1% and 2.5% SOM which are also shown in Table 1.

Note that an industry led project to derive C4SL for a further 20 substances has commenced (CL:AIRE, 2018). The project is being project managed by CL:AIRE and is funded by the Soil and Groundwater Technology Association (SAGTA), the Society of Brownfield Briefing (SoBRA) and others. A dedicated steering group, made up of representatives from SAGTA, DEFRA, Welsh Government, Public Health England, Environment Agency, Natural Resources Wales, Food Standards Agency, Homes England and further Land Forum representatives, has been set up to oversee the project. The new C4SL will be added to this document as they are published.

Suitable 4 Use Levels (S4ULs)

In July 2009, Generic Assessment Criteria (GACs) for 82 substances were published (LQM and CIEH, 2009) using the then current version of the CLEA software v1.04 and replaced those generated in

2006 using the original version of the model CLEA UK *beta*. In 2015 S4ULs were published by LQM/CIEH (Nathanail *et al*, 2015) to replace the second edition GACs. Table 2 summarises the S4ULs which are reproduced with permission; Publication Number S4UL3202.

Soil Guideline Values (SGVs) and Generic Assessment Criteria (GAC)

In 2009, Soil Guideline Values (SGVs) were published by the Environment Agency for arsenic, cadmium, mercury, nickel, selenium, benzene, toluene, ethyl benzene, xylenes, phenol and dioxins, furans and dioxin-like PCBs. These were derived using the CLEA model for residential, allotments and commercial land-uses.

These SGVs have now largely been superseded by the C4SLs and the S4ULs, with the exception of the SGVs for dioxins, furans and dioxin-like PCBs which are shown in Table 3.

In January 2010, Generic Assessment Criteria (GAC) derived using CLEA were published by CL:AIRE for 35 substances. These GAC are listed in Table 4.

Note that the SGVs for dioxins, furans and dioxin like PCBs and CL:AIRE GAC were derived using an older version of CLEA (v1.06) than used to derive the S4UL and C4SL (v1.07). This older version used slightly more conservative values for some exposure parameters and therefore the derived SGVs/GAC are still considered suitably precautionary for use as screening criteria.

Note on Mercury, Chromium and Arsenic

The analytical testing routinely undertaken by Stantec determines total concentration, however, the toxicity depends on the form of the contaminant.

If a source of Mercury, Chromium or Arsenic is identified or the total concentration exceeds the relevant worst case speciated criteria it will be desirable/necessary to undertake additional speciated testing and further assessment.

Note on Polycyclic Aromatic Hydrocarbons

Polycyclic Aromatic Hydrocarbons (PAHs) are a family of hundreds of different congeners whose chemical structures contain two or more fused aromatic rings. Whilst it is recognised that there is an ongoing debate on the most appropriate method to assess health effects of PAH mixtures, in 2010 the Health Protection Agency recommended the use of benzo[a]pyrene (BaP) as a surrogate marker approach in the assessment of carcinogenic risks posed by PAHs in soils (HPA, 2010).

In most cases, BaP is chosen as the surrogate marker (SM) due to its ubiquitous nature and the vast amount of data available and has been used by various authoritative bodies to assess the carcinogenic risk of PAHs in food. The SM approach estimates the carcinogenic toxicity of a mixture of PAHs in an environmental matrix by using toxicity data for a PAH mixture for which the composition is known.

Exposure to the SM is assumed to represent exposure to all PAHs in that matrix therefore the toxicity of the SM represents the toxicity of the mixture. The SM approach relies on a number of assumptions (HPA, 2010).

- The SM (BaP) must be present in all the samples.
- The profile of the different PAH relative to BaP should be similar in all samples.
- The PAH profile in the soil samples should be sufficiently similar to that used in the pivotal toxicity study on which HBGV was based i.e. the Culp study (Culp et al. (1998)).

In order to justify the use of a surrogate marker assessment criterion (C4SL for benzo(a)pyrene and S4UL coal tar) the LQM PAH Profiling Tool is used by Stantec to assess the similarity of the PAH profile in a soil sample to that of the toxicity study. The spreadsheet calculates the relative proportions of the genotoxic PAHs and plots them relative to the composition of the two coal mixtures used by Culp et al. Provided that the relative proportions are within an order of magnitude of those from the Culp Study (as suggested by HPA) Stantec will use the C4SL for benzo(a)pyrene as a surrogate marker for the carcinogenic PAHs, i.e. benzo(a)pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(ah)anthracene, indeno(123-cd)pyrene and benzo(ghi)perylene. For projects where this approach is appropriate the results will be assessed using the Coal Tar criterion (BAP C4SL) and the criteria for non-carcinogenic PAHs (S4ULs), i.e. naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene and pyrene.

Note on Total Petroleum Hydrocarbons

The S4UL for Total Petroleum Hydrocarbon (TPH) fractions are based on 'threshold' health effects. In accordance with Environment Agency guidance (EA, 2005) and the S4UL report (Nathanail *et al*, 2015) the potential for additivity of toxicological effects between fractions should be considered. Practically, to address this issue the hazard quotient (HQ) for each fraction should be calculated by dividing the measured concentration of the fraction by the GAC. The HQs are then added to form a hazard index (HI) for that sample. An HI greater than 1 indicates an exceedance.

Note on Dioxins, Furans and Dioxin-like PCBs

The SGVs for dioxins, furans and dioxin-like PCBs

are based on an assumed congener profile for urban soils. The total measured concentration of dioxin, furan and dioxin-like PCB congeners listed in the SGV report (EA, 2009a) should be compared with the SGVs to make an initial assessment of risk. A more accurate assessment can be made using the Environment Agency's site specific worksheet for dioxins, furans and dioxin like PCBs available from [redacted]

Note on Asbestos

Asbestos in soil and made ground is currently under review by a number of bodies. There are no current published guidance values for asbestos in soil other than the waste classification values given in the EA's Technical Guidance WM3, Hazardous Waste – Interpretation of the definition and classification of hazard waste (EA, 2015). This guidance is only appropriate for soils that are being discarded as waste.

Testing for asbestos will be carried out on selected samples of made ground encountered during investigation, initially samples will be subjected to an asbestos screen and, if asbestos is found to be present, subjected to quantification depending on the project specific requirements. The reader is directed to the report text for guidance on the approach adopted in respect to any asbestos found to be present.

Further guidance is also available in publication C733, Asbestos in soil and made ground: a guide to understanding and managing risks (CIRIA 2014).

Note on Soil Saturation Concentration

The soil saturation concentration is the concentration of an organic constituent in soil at which either the pore water or soil vapour has theoretically become saturated with the substance, i.e. the substance concentration has reached its maximum aqueous solubility or vapour pressure. The soil saturation concentration is related to the properties of the substance as well as the properties of the soil (including soil organic matter content).

The soil saturation concentrations are shown in Table 2 in brackets where exceeded by the assessment criteria and in Table 4 for all substances. Measured concentrations in excess of the soil saturation concentration have various potential implications as discussed below.

Firstly, where measured concentrations exceed the soil saturation concentration, the risk from vapour inhalation and/or consumption of produce may be limited. The CLEA model calculates the soil saturation concentration but it does not limit exposure where this concentration is exceeded. This adds an additional level of conservatism for CLEA derived assessment criteria where these exceed the calculated soil saturation concentration. Secondly, the soil saturation concentration is sometimes used to flag the potential presence of non-aqueous phase liquid (NAPL, a.k.a. free phase) in soil. The presence of NAPL is an important consideration in the Tier 2 assessment because, where present, the risks from NAPL may need to be considered separately. Theoretically, where a measured concentration exceeds the soil saturation concentration NAPL could be present. However, using theoretical saturation values is not always reliable for the following reasons: The soil saturation concentration is based on the aqueous solubility and vapour pressure of a pure substance and not a mixture, of which NAPLs are often comprised; and

The soil saturation concentration does not account for the sorption capacity of the soil. As a result, exceedance of the soil saturation concentration does not necessarily imply that NAPL is present. This is particularly the case for longer chain hydrocarbons such as PAHs which have low solubility and vapour pressure and hence a low soil saturation concentration but that are strongly sorbed to soil.

The measured concentrations will be compared to the soil saturation concentrations shown in Tables 2 and 4. Where exceeded Stantec will use additional lines of evidence (such as visual evidence and concentration of total TPH) to determine whether or not NAPL is likely to be present. If the presence of NAPL is deemed plausible the implications will be considered in the risk assessment.

3.2 Potential Harm to the Built Environment

Land contamination can pose risks to buildings, building materials and services (BBM&S) in a number of ways. Volatile contaminants and gases can accumulate and cause explosion or fire. Foundations and buried services can be damaged by corrosive substances and contaminants such as steel slags can create unstable ground conditions through expansion causing structural damage.

Stantec use the following primary guidance to assess the significance of soil chemistry with respect to its potential to harm the built environment.

i) Approved Document C - Site Preparation and Resistance to Contaminants and Moisture. (DCLG, 2013);
ii) Concrete in aggressive ground SD1 (BRE 2005);
iii) Guidance for the selection of water supply pipes to be used in brownfield sites (UK WIR 2011);
iv) Protocols published by agreement between Water UK and the Home Builders Federation providing supplementary guidance which

includes the Risk Assessment for Water Pipes (the 'RA') (Water UK 2014).
v) Performance of Building Materials in Contaminated Land report BR255 (BRE 1994).
vi) Risks of Contaminated Land to Buildings, Building Materials and Services. A Literature Review - Technical Report P331 (EA, 2000).
vii) Guidance on assessing and managing risks to buildings from land contamination - Technical Report P5 035/TR/01 (EA, 2001).

3.3 Potential to Harm Ecosystems, Animals, Crops etc

The criteria routinely used by Stantec as Tier 2 screening values to assess the potential of soil chemistry to harm ecosystems are taken from the following guidance and are summarised in Table 5.

i) Derivation and Use of Soil Screening Values for assessing ecological risks (EA, 2017a);
ii) The Restoration and Aftercare of Metalliferous Mining Sites for Pasture and Grazing (ICRCL 70/90, 1990);
iii) Sewage sludge on farmland: code of practice for England, Wales and Northern Ireland (DEFRA, 2018); and
iv) BS 3882:2015 Specification for topsoil and requirements for use (BSI, 2015).

Unless stated in the report the assessment is solely for phytotoxic parameters and additional assessment is required to determine suitability as a growing medium.

4 CRITERIA FOR EVALUATING LIQUID RESULTS

4.1 Potential Harm to Human Health via Ingestion

The Tier 2 water screening values routinely adopted by Stantec for assessing the potential for harm to human health via ingestion (presented as Table 6) are taken from The Water Supply (Water Quality) Regulations (S.I. 2018/647) unless otherwise indicated.

It should be noted that some of the prescribed concentrations listed in the Water Supply Regulations have been set for reasons other than their potential to cause harm to human health. The concentrations of iron and manganese are controlled because they may taint potable water with an undesirable taste, odour or colour or may potentially deposit precipitates in water supply pipes.

4.2 Potential Harm to Human Health via Inhalation of Vapours

The Tier 2 water screening values adopted by Stantec for assessing the potential for chronic human health risk from the inhalation of vapours from volatile contaminants in groundwater are presented in Table 7. These generic assessment criteria have been taken from a report published by the Society of Brownfield Risk Assessment (SoBRA) (SoBRA, 2017). The methodology adopted in their generation is considered compatible with the UK approach to deriving GAC and adopts a precautionary approach. As with all published GAC the suitability for use on the site being assessed has to be decided by the assessor based on a thorough understanding of the methodology and assumptions used in their derivation. Note, that the SoBRA groundwater vapour GAC are not intended for assessing risks to ground workers from short-term exposure.

Note that Table 7 shows the theoretical maximum aqueous solubility for each contaminant and indicates the GAC that exceed solubility. Measured concentrations in excess of solubility may be an indication that NAPL is present. As for the assessment of soils, if the presence of NAPL is deemed plausible the implications will be considered in the risk assessment.

4.3 Potential to Harm Controlled Waters

When assessing ground condition data and the potential to harm Controlled Waters Stantec uses the approach presented in the groundwater protection position statements published 14.03.17 (EA, 2017b) which describe the Environment Agency's approach to managing and protecting groundwater. They update and replace Groundwater Protection: principles and practice (GP3). Controlled Waters are rivers, estuaries, coastal waters, lakes and groundwaters. Water in the unsaturated zone is not groundwater but does come within the scope of the term "ground waters" as used and defined in the Water Resources Act 1991. It will continue to be a technical decision for the Environment Agency to determine what is groundwater in certain circumstances for the purposes of the Regulations. As discussed in our Methodology for Assessment of Land Contamination perched water is not considered a receptor in Stantec assessments.

The EU Water Framework Directive (WFD) 2000/60/EC provides for the protection of sub-surface, surface, coastal and territorial waters through a framework of river basin management.

The EU Updated Water Framework Standards Directive 2014/101/EU amended the EU WFD to update the international standards therein; it entered into force on 20 November 2014 with the requirement for its provisions to be transposed in Member State law by 20 May 2016.
Member States are required under the EU WFD to update their river basin management plans every six years. The first river basin management plans for England and Wales, Scotland and Northern

Ireland were published in December 2009, and these were updated in 2015.

Other EU Directives in the European water management framework include:

- the EU Priority Substances Directive 2013/39/EU;
- EU Groundwater Pollutants Threshold Values Directive 2014/80/EU amending the EU Groundwater Daughter Directive (GWDD) 2006/118/EC; and
- the EU Biological Monitoring Directive 2014/101/EU.

The Priority Substances Directive set environmental quality standards (EQS) for the substances in surface waters (river, lake, transitional and coastal) and confirmed their designation as priority or priority hazardous substances (PS), the latter being a subset of particular concern. Environmental Quality Standards for PS are determined at the European level and apply to all Member States. Member States identify and develop standards for 'Specific Pollutants'. Specific Pollutants (SP) are defined as substances that can have a harmful effect on biological quality.

The Water Framework Directive (Standards and Classification) Directions (England and Wales) (DEFRA, 2015) were issued to the Environment Agency as an associated document of the Water Environment (WFD) (England and Wales) Regulations 2015 (S.I. 2015/1623) and provide directions for the classification of surface water and groundwater bodies. Schedule 3 parts 2 and 3 relate to surface water standards for specific pollutants in fresh or salt water bodies and priority substances in inland (rivers, lakes and related modified/artificial bodies) or other surface waters respectively. Although Schedule 5 presents threshold values for groundwater the Direction specifically excludes their use as part of site-specific investigations.

Table 6 presents the criteria routinely used by Stantec as Tier 2 screening values. This table only presents a selection of the more commonly analysed parameters and the source documents should be consulted for other chemicals. For screening groundwater the criteria selected are the standards for surface water and/or human consumption as appropriate together with the following:-

For a **hazardous substance** Stantec adopts the approach that, if the concentration in a discharge to groundwater is less than the Minimum Reporting Value (MRV), the input is regarded as automatically meeting the Article 2 (b) 'de-minimus' requirement of exemption 6 (3) (b) of the GWDD. Stantec has selected hazardous substances from the latest list published by the Joint Agencies Groundwater Directive Advisory Group (JAGDAG, 2018). MRV is the lowest concentration of a substance that can be routinely determined with a known degree of confidence, and may not be equivalent to limit of detection. MRVs have been identified from DEFRA's guidance on Hazardous Substances to Groundwater: Minimum Reporting Values (DEFRA, 2017), and are shown in Table 6.

Note that for land contamination assessments, where hazardous substances have already entered groundwater, remediation targets would typically be based on achieving appropriate water quality standards (e.g. drinking water standard or EQS) at a compliance point rather than an MRV. For this reason, when assessing measured groundwater or soil leachate concentrations, the values for human consumption, fresh water and salt water shown in Table 6 (whichever is appropriate for the context of the site) will be used as the Tier 2 assessment criteria rather than MRV. For hazardous substances with no water quality standard the laboratory method detection limit will be used as the assessment criteria.

For **non-hazardous substances** the GWDD requires that inputs be limited to avoid deterioration. UKTAG guidance equates deterioration with pollution. Non-hazardous substances are all substances not classified as hazardous. For Stantec assessments the values for human consumption, fresh water and salt water shown in Table 6 (whichever is appropriate for the context of the site) are used as the assessment criteria for non-hazardous substances.

Note on Copper, Lead, Manganese, Nickel and Zinc

$EQS_{bioavailable}$ have been developed for UK Specific Pollutants copper, zinc and manganese and the EU priority substances lead and nickel. An EQS is the concentration of a chemical in the environment below which there is not expected to be an adverse effect on the specific endpoint being considered, e.g. the protection of aquatic life.

It is very difficult to measure the bioavailable concentration of a metal directly. The UK has developed simplified Metal Bioavailability Assessment Tool (M-BAT) for copper, zinc, nickel and manganese which uses local water chemistry data, specifically pH, dissolved organic carbon (DOC) (mg/L) and Calcium (Ca) (mg/L).

Where the recorded total dissolved concentration exceeds the screening criteria for these parameters ($EQS_{bioavailable}$) further assessment will be undertaken using the tools downloaded from [redacted]

The models calculate a risk characterisation ratio (RCR) and where this is greater than 1 this indicates the bioavailable concentration is above the EQS and the parameter is then identified as a potential hazard. The report will discuss this identified

hazard noting that the pH, calcium and, in particular, the dissolved organic carbon (DOC) in groundwater may be quite different to the receiving water (e.g. due to the presence to leaf litter or organic sediments dissolving in the water).

5 CRITERIA FOR EVALUATING GAS RESULTS

Stantec use the following primary guidance on gas monitoring methods and investigation, the assessment of risk posed by soil gases (including Volatile Organic Compounds (VOCs)) and mitigation measures/risk reduction during site development.

i) BS 8576:2013 – Guidance on Ground Gas Investigations: Permanent gases and Volatile Organic Compounds (VOCs) (BSI, 2013);
ii) TB18 Continuous Ground-Gas Monitoring and the Lines of Evidence Approach to Risk Assessment CL:AIRE Technical Bulletin TB18 (CL:AIRE 2019)
iii) RB17 A pragmatic approach to Ground Gas Risk Assessment. CL:AIRE Research Bulletin RB17 (Card et al, 2012);
iv) The VOCs Handbook. C682 (CIRIA, 2009).
v) Assessing risks posed by hazardous gases to buildings C665 (CIRIA, 2007);
vi) Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present. (NHBC, 2007); and
vii) BS 8485:2015+A1:2019- Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings (BSI, 2019).

Gas and borehole flow data are used to obtain the gas screening value (GSV) for methane and carbon dioxide. The GSV is used to establish the characteristic situation and to make recommendations for gas protection measures for buildings if required.

Radon

Stantec use the following primary guidance to assess the significance of the radon content of soil gas.

i) Radon: guidance on protective measures for new dwellings. Report BR211 (BRE, 2015); and
ii) Indicative Atlas of Radon in England and Wales (HPA & BGS, 2007).

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Table 1: Category 4 Screening Levels (C4SL)

	Allotments	Residential (with home-grown produce)	Residential (without home-grown produce)	Commercial	Public Open Space 1	Public Open Space 2
Arsenic	49	37	40	640	79	170
Benzene - 1% SOM* - 2.5% SOM* - 6% SOM	 0.039 0.081 0.18	 0.20 0.41 0.87	 0.89 1.6 3.3	 27 50 98	 140 140 140	 190 210 230
Benzo(a)pyrene (as a surrogate marker for carcinogenic PAHs)	5.7	5.0	5.3	77	10	21
Cadmium	3.9	22	150	410	220	880
Chromium VI	170	21	21	49	21	250
Lead	80	200	310	2300	630	1300

Units mg/kg dry weight

Values taken from SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document (Department for Environment, Food and Rural Affairs December 2014), unless stated otherwise
Public Open Space 1 – for grassed area adjacent to residential housing
Public Open Space 2 - Park Type Public Open Space Scenario
Based on a sandy loam as defined in SR3 (Environment Agency, 2009b)
Note that, with the exception of benzene, these C4SL are not SOM dependent
* - Stantec derived C4SL using CLEA v1.071

Table 2: Suitable 4 Use Levels (S4UL)

Determinand	Allotment	$R_{W}HP$	$R_{WO}HP$	Commercial/ Industrial	POSresi	POSpark
Metals						
Arsenic (**Inorganic**)[a, b, c]	43	37	40	640	79	170
Beryllium [a, b, d, e]	35	1.7	1.7	12	2.2	63
Boron [a, b, d]	45	290	11000	240000	21000	46000
Cadmium (**pH6-8**) [a, b, d, f]	1.9	11	85	190	120	560
Chromium (trivalent) [a, b, d, g]	18000	910	910	8600	1500	33000
Chromium (hexavalent) [a, b, c]	1.8[h]	6[i]	6[i]	33[i]	7.7[i]	220[i]
Copper [a, b, c]	520	2400	7100	68000	12000	44000
Mercury (elemental) [a, b, c, j]	21	1.2	1.2	58[vap] (25.8)	16	30[vap] (25.8)
Mercury (inorganic) [a, b, c]	19	40	56	1100	120	240
Methylmercury [a, b, c]	6	11	15	320	40	68
Nickel [a, b, c]	53[k]	130[e]	180[e]	980[e]	230[e]	800[k]
Selenium [a, b, c]	88	250	430	12000	1100	1800
Vanadium [a, b, c, i, j]	91	410	1200	9000	2000	5000
Zinc [a, b, c]	620	3700	40000	730000	81000	170000
BTEX Compounds (SOM 1%/ 2.5%/ 6%)						
Benzene [a, b, l, m]	0.017/0.034/ 0.075	0.087/0.17/ 0.37	0.38/0.7/1.4	27 / 47 / 90	72 / 72 / 73	90 / 100 / 110
Toluene [a, b, l, m]	22 / 51 / 120	130 / 290 / 660	880[vap] (869) /1900/3900	56000[vap] (869) / 110000[vap] (1920)/ 180000[vap] (4360)	56000 / 56000 / 56000	87000[vap](869)/ 95000[vap](1920)/ 100000[vap](4360)
Ethylbenzene [a, b, l, m]	16 / 39 / 91	47 / 110 / 260	83 / 190 / 440	5700[vap] (518) / 13000[vap] (1220) / 27000[vap] (2840)	24000 / 24000 / 25000	17000[vap] (518) / 22000[vap](1220) / 27000[vap] (2840)
O – Xylene [a, b, l, m, n]	28 / 67 / 160	60 / 140 / 330	88 / 210 / 480	6600[sol] (478) / 15000[sol] (1120) / 33000[sol] (2620)	41000 / 42000 / 43000	17000[sol] (478) / 24000[sol] (1120) / 33000[sol] (2620)
M – Xylene [a, b, l, m, n]	31 / 74 / 170	59 / 140 / 320	82 / 190 / 450	6200[vap] (625) / 14000[vap] (1470) / 31000[vap] (3460)	41000 / 42000 / 43000	17000[vap] (625) / 24000[vap](1470) / 32000[vap] (3460)
P – Xylene [a, b, l, m, n]	29 / 69 / 160	56 / 130 / 310	79 / 180 / 430	5900[sol] (576) / 14000[sol] (1350) / 30000[sol] (3170)	41000 / 42000 / 43000	17000[sol] (576) / 23000[sol] (1350) / 31000[sol] (3170)
Total xylenes [t]	28 / 67 / 160	56 / 130 / 310	79 / 180 / 430	5900[sol] (576) / 14000[sol] (1350) / 30000[sol] (3170)	41000 / 42000 / 43000	17000[sol] (576) / 23000[sol] (1350) / 31000[sol] (3170)
Polycyclic Aromatic Hydrocarbons (SOM 1%/ 2.5%/ 6%) [a, b, l, p]						
Acenaphthene	34 / 85 / 200	210 / 510 / 1100	3000[sol](57.0)/ 4700[sol] (141)/ 6000[sol] (336)	84000[sol] (57.0)/ 97000[sol] (141)/ 100000	15000 / 15000 / 15000	29000/ 30000/ 30000
Acenaphthylene	28 / 69 / 160	170 / 420 / 920	2900[sol](86.1)/ 4600[sol] (212)/ 6000[sol] (506)	83000[sol] (86.1)/ 97000[sol] (212)/ 100000	15000 / 15000 / 15000	29000 / 30000 / 30000
Anthracene	380 / 950 / 2200	2400 / 5400 / 11000	31000[sol](1.17) /35000/ 37000	520000/ 540000/ 540000	74000 / 74000 / 74000	150000 / 150000 / 150000
Benzo(a)anthracene	2.9 / 6.5 / 13	7.2 / 11 / 13	11 / 14 / 15	170 / 170 / 180	29 / 29 / 29	49 / 56 / 62
Benzo(a)pyrene (Bap) [u]	0.97 / 2.0 / 3.5	2.2 / 2.7 / 3.0	3.2 / 3.2 / 3.2	35 / 35 / 36	5.7 / 5.7 / 5.7	11 / 12 / 13
Benzo(b)fluoranthene	0.99 / 2.1 / 3.9	2.6 / 3.3 / 3.7	3.9 / 4.0 / 4.0	44 / 44 / 45	7.1 / 7.2 / 7.2	13 / 15 / 16

Determinand	Allotment	R_WHP	$R_{WO}HP$	Commercial/ Industrial	POSresi	POSpark
Benzo(g,h,i)perylene	290 / 470 / 640	320 / 340 / 350	360 / 360 / 360	3900 / 4000 / 4000	640 / 640 / 640	1400 / 1500 / 1600
Benzo(k)fluoranthene	37 / 75 / 130	77 / 93 / 100	110 / 110 / 110	1200 / 1200 /1200	190 / 190 / 190	370 / 410 / 440
Chrysene	4.1 / 9.4 / 19	15 / 22 / 27	30 / 31 / 32	350 / 350 / 350	57 / 57 / 57	93 / 110 / 120
Dibenzo(ah)anthracene	0.14 / 0.27 / 0.43	0.24 / 0.28 / 0.3	0.31 / 0.32 / 0.32	3.5 / 3.6 / 3.6	0.57 / 0.57 / 0.58	1.1 / 1.3 / 1.4
Fluoranthene	52 / 130 / 290	280 / 560 / 890	1500 / 1600 / 1600	23000 / 23000 / 23000	3100 / 3100 / 3100	6300 / 6300 / 6400
Fluorene	27 / 67 / 160	170 / 400 / 860	2800[sol] (30.9) /3800[sol] (76.5) /4500[sol] (183)	63000[sol] (30.9) / 68000 / 71000	9900 / 9900 / 9900	20000 / 20000 / 20000
Indeno(1,2,3-cd)pyrene	9.5 / 21 / 39	27 / 36 / 41	45 / 46 / 46	500 / 510 / 510	82 / 82 / 82	150 / 170 / 180
Naphthalene [q]	4.1 / 10 / 24	2.3 / 5.6 / 13	2.3 / 5.6 / 13	190[sol] (76.4) / 460[sol] (183) / 1100[sol] (432)	4900/ 4900/ 4900	1200[sol] (76.4) / 1900[sol] (183) / 3000
Phenanthrene	15 / 38 / 90	95 / 220 / 440	1300[sol](36.0) / 1500 / 1500	22000 / 22000 / 23000	3100 / 3100 / 3100	6200 / 6200 / 6300
Pyrene	110 / 270 / 620	620 / 1200 / 2000	3700 / 3800 / 3800	54000 / 54000 / 54000	7400 / 7400 / 7400	15000 / 15000 / 15000
Coal Tar (Bap as surrogate marker) [u]	0.32 / 0.67 / 1.2	0.79 / 0.98 / 1.1	1.2 / 1.2 / 1.2	15 / 15 / 15	2.2 / 2.2 / 2.2	4.4 / 4.7 / 4.8
Explosives [a, b, l, p]						
2, 4, 6 Trinitrotoluene	0.24 / 0.58 / 1.40	1.6 / 3.7 / 8.0	65 / 66 / 66	1000 / 1000 / 1000	130 / 130 / 130	260 / 270 / 270
RDX (Royal Demolition Explosive $C_3H_6N_6O_6$)	17 / 38 / 85	120 / 250 / 540	13000 / 13000 / 13000	210000 / 210000 / 210000	26000 / 26000 / 27000	49000[sol] (18.7) / 51000 / 53000
HMX (High Melting Explosive $C_4H_8N_8O_8$)	0.86 / 1.9 / 3.9	5.7 / 13 / 26	6700 / 6700 / 6700	110000 / 110000 / 110000	13000 / 13000 / 13000	23000[vap] (0.35) /23000[vap] (0.39) /24000[vap] (0.48)
Petroleum Hydrocarbons (SOM 1%/ 2.5%/ 6%) [a, b, l, m]						
Aliphatic EC 5-6	730 / 1700 / 3900	42 / 78 / 160	42 / 78 / 160	3200[sol] (304) / 5900[sol] (558) / 12000[sol] (1150)	570000[sol](304) 590000 / 600000	95000[sol] (304) / 130000[sol] (558)/ 180000[sol](1150)
Aliphatic EC >6-8	2300 / 5600 / 13000	100 / 230 / 530	100 / 230 / 530	7800[sol] (144) / 17000[sol] (322) / 40000[sol] (736)	600000 / 610000 / 620000	150000[sol] (144) 220000[sol] (322)/ 320000[sol] (736)
Aliphatic EC >8-10	320 / 770 / 1700	27 / 65 / 150	27 / 65 / 150	2000[sol] (78) / 4800[vap] (190) / 11000[vap] (451)	13000 / 13000 / 13000	14000[sol] (78) / 18000[vap] (190) / 21000[vap] (451)
Aliphatic EC >10-12	2200 / 4400 / 7300	130v[ap] (48) / 330[vap] (118) / 760[vap] (283)	130v[ap] (48) / 330[vap] (118) / 770[vap] (283)	9700[sol] (48) / 23000[vap] (118) / 47000[vap] (283)	13000 / 13000 / 13000	21000[sol] (48) / 23000[vap] (118) / 24000[vap] (283)
Aliphatic EC >12-16	11000 / 13000 / 13000	1100[sol] (24) / 2400[sol] (59) / 4300[sol] (142)	1100[sol] (24) / 2400[sol] (59) / 4400[sol] (142)	59000[sol] (24) / 82000[sol] (59) / 90000[sol] (142)	13000 / 13000 / 13000	25000[sol] (24) / 25000[sol] (59) / 26000[sol] (142)
Aliphatic EC >16-35 °	260000 / 270000 / 270000	65000[sol](8.48 92000[sol] (21) 110000	65000[sol] (8.48 92000[sol] (21) 110000	1600000 / 1700000 / 1800000	250000 / 250000 / 250000	450000 / 480000 / 490000
Aliphatic EC >35-44 °	260000 / 270000 / 270000	65000[sol](8.48 92000[sol] (21) / 110000	65000[sol](8.48 92000[sol] (21) 110000	1600000 / 1700000 / 1800000	250000 / 250000 / 250000	450000 / 480000 / 490000
Aromatic EC 5-7 (benzene)	13 / 27 / 57	70 / 140 / 300	370 / 690 / 1400	26000[sol] (1220) / 46000[sol] (2260) / 86000[sol] (4710)	56000 / 56000 / 56000	76000[sol] (1220) /84000[sol](2260)/ 92000[sol] (4710)
Aromatic EC >7-8 (toluene)	22 / 51 / 120	130 / 290 / 660	860 / 1800 / 3900	56000[vap] (869)/ 110000[sol] (1920)/ 180000[vap] (4360)	56000 / 56000 / 56000	87000[vap](869) / 95000[sol] (1920)/ 100000[vap](4360)
Aromatic EC >8-10	8.6 / 21 / 51	34 / 83 / 190	47 / 110 / 270	3500[vap] (613) / 8100[vap] (1500) / 17000[vap] (3580)	5000 / 5000 / 5000	7200[vap](613) / 8500[vap] (1500) / 9300[vap] (3580)
Aromatic EC >10-12	13 / 31 / 74	74 / 180 / 380	250 / 590 / 1200	16000[sol] (364) / 28000[sol] (899) / 34000[sol] (2150)	5000 / 5000 / 5000	9200[sol] (364) / 9700[sol] (899) / 10000
Aromatic EC >12-16	23 / 57 / 130	140 / 330 / 660	1800 / 2300[sol] (419) / 2500	36000[sol] (169) / 37000 / 38000	5100 / 5100 / 5000	10000 / 10000 / 10000
Aromatic EC >16-21 °	46 / 110 / 260	260 / 540 / 930	1900 / 1900 / 1900	28000 / 28000 / 28000	3800 / 3800 / 3800	7600 / 7700 / 7800
Aromatic EC >21-35 °	370 / 820 / 1600	1100 / 1500 / 1700	1900 / 1900 / 1900	28000 / 28000 / 28000	3800 / 3800 / 3800	7800 / 7800 / 7900
Aromatic EC >35-44 °	370 / 820 / 1600	1100 / 1500 / 1700	1900 / 1900 / 1900	28000 / 28000 / 28000	3800 / 3800 / 3800	7800 / 7800 / 7900
Aliphatic+Aromatic EC >44-70 °	1200 / 2100 / 3000	1600 / 1800 / 1900	1900 / 1900 / 1900	28000 / 28000 / 28000	3800 / 3800 / 3800	7800 / 7800 / 7900
Chloroalkanes & Chloroalkenes (SOM 1%/ 2.5%/ 6%) [a, b, l, p]						
1,2-Dichloroethane	0.0046 / 0.0083 / 0.016	0.0071 / 0.011 / 0.019	0.0092 / 0.013 / 0.023	0.67 / 0.97 / 1.7	29 / 29 / 29	21 / 24 / 28

Determinand	Allotment	R_WHP	$R_{WO}HP$	Commercial/ Industrial	POSresi	POSpark
1,1,1 Trichloroethane (TCA)	48 / 110 / 240	8.8 / 18 / 39	9.0 / 18 / 40	660 / 1300 / 3000	140000 / 140000 / 140000	57000[vap](1425) 76000[vap](2915)/ 100000[vap](6392)
1,1,1,2 Tetrachloroethane	0.79 / 1.9 / 4.4	1.2 / 2.8 / 6.4	1.5 / 3.5 / 8.2	110 / 250 / 560	1400 / 1400 / 1400	1500 / 1800 / 2100
1,1,2,2 Tetrachloroethane	0.41 / 0.89 / 2.0	1.6 / 3.4 / 7.5	3.9 / 8.0 / 17	270 / 550 / 1100	1400 / 1400 / 1400	1800 / 2100 / 2300
Tetrachloroethene (PCE)	0.65 / 1.5 / 3.6	0.18 / 0.39 / 0.90	0.18 / 0.4 / 0.92	19 / 42 / 95	1400 / 1400 / 1400	810[sol](424)/1100[s ol] (951)/1500
Tetrachloromethane (Carbon Tetrachloride)	0.45 / 1.0 / 2.4	0.026 / 0.056 / 0.13	0.026 / 0.056 / 0.13	2.9 / 6.3 / 14	890 / 920 / 950	190 / 270 / 400
Trichloroethene (TCE)	0.041 / 0.091 / 0.21	0.016 / 0.034 / 0.075	0.017 / 0.036 / 0.080	1.2 / 2.6 / 5.7	120 / 120 / 120	70 / 91 / 120
Trichloromethane (Chloroform)	0.42 / 0.83 / 1.7	0.91 / 1.7 / 3.4	1.2 / 2.1 / 4.2	99 / 170 / 350	2500 / 2500 / 2500	2600 / 2800 / 3100
Chloroethene (Vinyl Chloride)	0.00055/ 0.001/ 0.0018	0.00064 / 0.00087/ 0.0014	0.00077 / 0.001 / 0.0015	0.059 / 0.077 / 0.12	3.5 / 3.5 / 3.5	4.8 / 5.0 / 5.4
Phenol & Chlorophenols [a, b, l, p]						
Phenol	23 / 42 / 83	120 / 200 / 380	440 / 690 / 1200	440[dir] (26000) / 690[dir] (30000) / 1300[dir] (34000)	440[dir] (10000)/ 690[dir](10000) 1300[dir](10000)	440[dir] (7600) / 690[dir] (8300) / 1300[dir] (93000)
Chlorophenols (excluding PCP) [r]	0.13[s] / 0.3 / 0.7	0.87[s] / 2.0 / 4.5	94 / 150 / 210	3500 / 4000 / 4300	620 / 620 / 620	1100 / 1100 / 1100
Pentachlorophenol (PCP)	0.03 / 0.08 / 0.19	0.22/ 0.52 / 1.2	27[vap] (16.4) / 29 / 31	400 / 400 / 400	60 / 60 / 60	110 / 120 / 120
Other [a, b, l, p]						
Carbon Disulphide	4.8 / 10 / 23	0.14 / 0.29 / 0.62	0.14 / 0.29 / 0.62	11 / 22 / 47	11000 / 11000 / 12000	1300 / 1900 / 2700
Hexachlorobutadiene (HCBD)	0.25 / 0.61 / 1.4	0.29 / 0.7 / 1.6	0.32 / 0.78 / 1.8	31 / 66 / 120	25 / 25 / 25	48 / 50 / 51
Pesticides (SOM 1%/ 2.5%/ 6%) [a, b, l, p]						
Aldrin	3.2 / 6.1 / 9.6	5.7/ 6.6 /7.1	7.3 / 7.4 / 7.5	170 / 170 / 170	18 / 18 / 18	30 / 31 / 31
Atrazine	0.5 / 1.2 / 2.7	3.3 / 7.6 / 17.4	610 / 620 / 620	9300 / 9400 / 9400	1200 / 1200 / 1200	2300 / 2400 / 2400
Dichlorvos	0.0049 / 0.010 / 0.022	0.032 / 0.066 / 0.14	6.4 / 6.5 / 6.6	140 / 140 / 140	16 / 16 / 16	26 / 26 / 27
Dieldrin	0.17/0.41/0.96	0.97/ 2 / 3.5	7.0 / 7.3 / 7.4	170 / 170 / 170	18 / 18 / 18	30 / 30 / 31
Alpha - Endosulfan	1.2 / 2.9 / 6.8	7.4 / 18 / 41	160[vap] (0.003)/ 280[vap] (0.007)/ 410[vap] (0.016)	5600[vap] (0.003) / 7400[vap] (0.007) / 8400[vap] (0.016)	1200 / 1200 / 1200	2400 / 2400 / 2500
Beta - Endosulfan	1.1 / 2.7 / 6.4	7.0 / 17 / 39	190[vap](0.00007) /320[vap](0.0002) /440[vap](0.0004)	6300[vap](0.00007) /7800[vap](0.0002) / 8700	1200 / 1200 / 1200	2400 / 2400 / 2500
Alpha-Hexachlorocyclohexane	0.035/0.087/ 0.21	0.23/0.55 / 1.2	6.9 / 9.2 / 11	170 / 180 / 180	24 / 24 / 24	47 / 48 / 48
Beta - Hexachlorocyclohexane	0.013 / 0.032 / 0.077	0.085 / 0.2 / 0.46	3.7 / 3.8 / 3.8	65 / 65 / 65	8.1 / 8.1 / 8.1	15 / 15 / 16
Gamma – Hexachlorocyclohexane	0.0092 / 0.023 / 0.054	0.06 / 0.14 / 0.33	2.9 / 3.3 / 3.5	67 / 69 / 70	8.2 / 8.2 / 8.2	14 / 15 / 15
Chlorobenzenes [a, b, l, p]						
Chlorobenzene	5.9 / 14 / 32	0.46 / 1.0 / 2.4	0.46 / 1.0 / 2.4	56 / 130 / 290	11000 / 13000 / 14000	1300[sol](675)/ 2000[sol](1520)/ 2900
1,2-dichlorobenzene (1,2-DCB)	94 / 230 / 540	23 / 55 / 130	24 / 57 / 130	2000[sol] (571) / 4800[sol] (1370) / 11000[sol] (3240)	90000 / 95000 / 98000	24000[sol] (571) / 36000[sol] (1370) /51000[sol] (3240)
1,3-dichlorobenzene (1,3-DCB)	0.25 / 0.6 / 1.5	0.4 / 1.0 / 2.3	0.44 /1.1 / 2.5	30 / 73 / 170	300 / 300 / 300	390 / 440 / 470
1-4-dichlorobenzene (1,4-DCB)	15[i] / 37[i] / 88 [i]	61[q] / 150[q] /350 [q]	61[q] / 150[q] / 350[q]	4400[vap,q] (224) / 10000[vap,q] (540) / 25000[vap,q] (1280)	17000[i] / 17000[i] / 17000[i]	36000[vap,i] (224) 36000[vap, i](540)/ 36000[vap,i](1280)
1,2,3-Trichlorobenzene	4.7 / 12 / 28	1.5 / 3.6 / 8.6	1.5 / 3.7 / 8.8	102 / 250 / 590	1800 / 1800 / 1800	770[vap] (134) / 1100[vap] (330) / 1600[vap] (789)
1,2,4- Trichlorobenzene	55 / 140 / 320	2.6 / 6.4 / 15	2.6 / 6.4 / 15	220 / 530 / 1300	15000 / 17000 / 19000	1700[vap] (318) / 2600[vap] (786) / 4000[vap] (1880)
1,3,5- Trichlorobenzene	4.7 / 12 / 28	0.33 / 0.81 / 1.9	0.33 / 0.81 / 1.9	23 / 55 / 130	1700 / 1700 / 1800	380[vap] (36.7) / 580[vap] (90.8) / 860[vap] (217)
1,2,3,4-Tetrachlorobenzene	4.4 / 11 / 26	15 / 36 / 78	24 / 56 / 120	1700[vap] (122) / 3080[vap] (304) / 4400[vap] (728)	830 / 830 / 830	1500[vap] (122) / 1600 / 1600
1,2,3,5- Tetrachlorobenzene	0.38 / 0.90 / 2.2	0.66 / 1.6 / 3.7	0.75 / 1.9 / 4.3	49[vap] (39.4) / 120[vap] (98.1) / 240[vap] (235)	78 / 79 / 79	110[vap] (39.4) / 120 / 130
1,2,4,5- Tetrachlorobenzene	0.06 / 0.16 / 0.37	0.33 / 0.77 / 1.6	0.73 / 1.7 / 3.5	42[sol] (19.7) / 72[sol] (49.1) / 96	13 / 13 / 13	25 / 26 / 26

Determinand	Allotment	R_WHP	$R_{WO}HP$	Commercial/ Industrial	POSresi	POSpark
Pentachlorobenzene (P_ECB)	1.2 / 3.1 / 7.0	5.8 / 12 / 22	19 / 30 / 38	640^{sol} (43.0) / 770^{sol} (107) / 830	100 / 100 / 100	190 / 190 / 190
Hexachlorobenzene (HCB)	0.47 / 1.1 / 2.5	1.8^{vap} (0.20) / 3.3^{vap} (0.5) / 4.9	4.1^{vap} (0.20) / 5.7^{vap} (0.5) / 6.7^{vap} (1.2)	110^{vap} (0.20) / 120 / 120	16 / 16 / 16	30 / 30 / 30

Units are mg/kg Dry Weight

R_WHP Residential with homegrown produce
$R_{WO}HP$ Residential without homegrown produce
POSresi public open spaces near residential housing
POSpark public open space for recreational use but not dedicated sports pitches
SOM Soil Organic Matter – ***the S4UL for all organic compounds will vary according to SOM***

a Based on a sandy loam soil as defined in SR3 (Environment Agency, 2009b) and 6% soil organic matter (SOM)
b Figures rounded to two significant figures
c Based only on a comparison of oral and dermal soil exposure with oral Index Dose
d The background ADE is limited to being no larger than the contribution from the relevant soil ADE
e Based on comparison of inhalation exposure with inhalation TDI only
f Based on a lifetime exposure via the oral, dermal and inhalation pathways
g Based on localised effects comparing inhalation exposure with inhalation ID only
h Based on comparison of inhalation exposure with inhalation ID
i Based on comparison of oral and dermal exposure with oral TDI
j Based on comparison of oral, dermal and inhalation exposure with inhalation TDI
k Based on comparison of all exposure pathways with oral TDI
l S4ULs assume that free phase contamination is not present
m S4ULs based on a sub-surface soil to indoor air correction factor of 10
n The HCV applied is based on the intake of total Xylene and therefore exposure should not consider an isomer in isolation
o Oral, dermal and inhalation exposure compared with oral HCV
p S4ULs based on a sub-surface soil to indoor air correction factor of 1
q Based on a comparison of inhalation exposure with the inhalation TDI for localised effects
r Based on 2,4-dichlorophenol unless otherwise stated
s Based on 2,3,4,6-tetrachlorophenol
t Based on lowest GAC for all three xylene isomers
u Measured concentrations of benzo(a)pyrene should be compared to the S4UL for benzo(a)pyrene as a single compound and to the S4UL for benzo(a)pyrene as a surrogate marker of genotoxic PAHs.
vap S4UL presented exceeded the vapour saturation limit, which is presented in brackets
sol S4UL presented exceeds the solubility saturation limit, which is presented in brackets
dir S4ULs based on a threshold protective of direct skin contact, guideline in brackets based on the health effects following long term exposure provided for illustration only

Table 3: Soil Guideline Values (SGVs) for dioxins, furans and dioxin like PCBs

Determinand	Allotments	Residential with consumption of homegrown produce	Residential without consumption of homegrown produce	Commercial
Sum of PCDDs, PCDFs and dioxin-like PCBs	0.008	0.008	0.008	0.24

Units are mg/kg Dry Weight

Table 4: EIC/AGS/CL:AIRE Generic Assessment Criteria (GAC)

	Allotments	Residential with consumption of homegrown produce	Residential without consumption of homegrown produce	Commercial	Soil Saturation Concentration
Metals					
Antimony	ND	ND	550	7500	NA
Barium	ND	ND	1300	22000	NA
Molybdenum	ND	ND	670	17000	NA
Organics (SOM 1%/ 2.5%/ 6%)					
1,1,2 Trichloroethane	0.28 / 0.61 / 1.4	0.6 / 1.2 / 2.7	0.88 / 1.8 / 3.9	94 / 190 / 400	4030 / 8210 / 18000
1,1-Dichloroethane	9.2 / 17 / 35	2.4 / 3.9 / 7.4	2.5 / 4.1 / 7.7	280 / 450 / 850	1830 / 2960 / 5600
1,1-Dichloroethene	2.8 / 5.6 / 12	0.23 / 0.4 / 0.82	0.23 / 0.41 / 0.82	26 / 46 / 92	2230 / 3940 / 7940
1,2,4-Trimethylbenzene	0.38 / 0.93 / 2.2	0.35 / 0.85 / 2	0.41 / 0.99 / 2.3	42 / 99 / 220	557 / 1360 / 3250
1,2-Dichloropropane	0.62 / 1.2 / 2.6	0.024 / 0.042 / 0.084	0.024 / 0.042 / 0.085	3.3 / 5.9 / 12	1190 / 2110 / 4240
2,4-Dimethylphenol	3.1 / 7.2 / 17	19 / 43 / 97	210 / 410 / 730	16000 / 24000 / 30000	1380 / 3140 / 7240
2,4-Dinitrotoluene	0.22 / 0.49 / 1.1	1.5 / 3.2 / 7.2	170 / 170 / 170	3700 / 3700 / 3800	141 / 299 / 669
2,6-Dinitrotoluene	0.12 / 0.27 / 0.61	0.78 / 1.7 / 3.9	78 / 84 / 87	1900 / 1900 / 1900	287 / 622 / 1400
2-Chloronaphthalene	40 / 98 / 230	3.7 / 9.2 / 22	3.8 / 9.3 / 22	390 / 960 / 2200	114 / 280 / 669
Biphenyl	14 / 35 / 83	66 / 160 / 360	220 / 500 / 980	18000 / 33000 / 48000	34.4 / 84.3 / 201
Bis (2-ethylhexyl) phthalate	47 / 120 / 280	280 / 610 / 1100	2700 / 2800 / 2800	85000 / 86000 / 86000	8.68 / 21.6 / 51.7

	Allotments	Residential with consumption of homegrown produce	Residential without consumption of homegrown produce	Commercial	Soil Saturation Concentration
Bromobenzene	3.2 / 7.6 / 18	0.87 / 2 / 4.7	0.91 / 2.1 / 4.9	97 / 220 / 520	853 / 1970 / 4580
Bromodichloromethane	0.016 / 0.032 / 0.068	0.016 / 0.03 / 0.061	0.019 / 0.034 / 0.07	2.1 / 3.7 / 7.6	1790 / 3220 / 6570
Bromoform	0.95 / 2.1 / 4.6	2.8 / 5.9 / 13	5.2 / 11 / 23	760 / 1500 / 3100	2690 / 5480 / 12000
Butyl benzyl phthalate	220 / 550 / 1300	1400 / 3300 / 7200	42000 / 44000 / 44000	940000 / 940000 / 950000	26.3 / 64.7 / 154
Chloroethane	110 / 200 / 380	8.3 / 11 / 18	8.4 / 11 / 18	960 / 1300 / 2100	2610 / 3540 / 5710
Chloromethane	0.066 / 0.13 / 0.23	0.0083 / 0.0098 / 0.013	0.0085 / 0.0099 / 0.013	1 / 1.2 / 1.6	1910 / 2240 / 2990
Cis 1,2 Dichloroethene	0.26 / 0.5 / 1	0.11 / 0.19 / 0.37	0.12 / 0.2 / 0.39	14 / 24 / 47	3940 / 6610 / 12900
Dichloromethane	0.1 / 0.19 / 0.34	0.58 / 0.98 / 1.7	2.1 / 2.8 / 4.5	270 / 360 / 560	7270 / 9680 / 15300
Diethyl Phthalate	19 / 41 / 94	120 / 260 / 570	1800 / 3500 / 6300	150000 / 220000 / 290000	13.7 / 29.1 / 65
Di-n-butyl phthalate	2 / 5 / 12	13 / 31 / 67	450 / 450 / 450	15000 / 15000 / 15000	4.65 / 11.4 / 27.3
Di-n-octyl phthalate	940 / 2100 / 3900	2300 / 2800 / 3100	3400 / 3400 / 3400	89000 / 89000 / 89000	32.6 / 81.5 / 196
Hexachloroethane	0.27 / 0.67 / 1.6	0.2 / 0.48 / 1.1	0.22 / 0.54 / 1.3	22 / 53 / 120	8.17 / 20.1 / 48.1
Isopropylbenzene	32 / 79 / 190	11 / 27 / 64	12 / 28 / 67	1400 / 3300 / 7700	390 / 950 / 2250
Methyl tert-butyl ether (MTBE)	23 / 44 / 90	49 / 84 / 160	73 / 120 / 220	7900 / 13000 / 24000	20400 / 33100 / 62700
Propylbenzene	34 / 83 / 200	34 / 82 / 190	40 / 97 / 230	4100 / 9700 / 21000	402 / 981 / 2330
Styrene	1.6 / 3.7 / 8.7	8.1 / 19 / 43	35 / 78 / 170	3300 / 6500 / 11000	626 / 1440 / 3350
Total Cresols (2-, 3- and 4-methylphenol)	12 / 27 / 63	80 / 180 / 400	3700 / 5400 / 6900	160000 / 180000 / 180000	15000 / 32500 / 73300
Trans 1,2 Dichloroethene	0.93 / 1.9 / 4	0.19 / 0.34 / 0.7	0.19 / 0.35 / 0.71	22 / 40 / 81	3420 / 6170 / 12600
Tributyl tin oxide	0.042 / 0.1 / 0.24	0.25 / 0.59 / 1.3	1.4 / 3.1 / 5.7	130 / 180 / 200	41.3 / 101 / 241

Units are mg/kg Dry Weight

Table 5: Tier 2 Criteria for the Assessment of Soils – Protection of Flora and Fauna

Parameter	ICRCL 70/90 [a]		SSVs [b]	Code of Practice for Agricultural Use of Sewage Sludge [c]	BS 3882:2015 Specification for topsoil and requirements for use
	Maximum				Phytotoxic contaminants
	Livestock	Crop Growth			
	mg/kgDW	mg/kgDW	mg/kgDW	mg/kgDW	mg/kgDW
Antimony			37		
Arsenic	500	1000		50	
Cadmium	30	50	0.6	3	
Chromium				400	
Cobalt			4.2		
Copper	500	250	35.1	80/ 100/ 135/ 200 [d]	<100/<135/<200 [e]
Fluoride	1000			500	
Lead	1000			300	
Mercury				1	
Molybdenum			5.1	4	
Nickel			28.2	50/ 60/ 75/ 110 [d]	<60/<75/<110 [e]
Selenium				3	
Silver			0.3		
Vanadium			2.0		
Zinc	3000	1000	35.6	200/200/200/300 [d]	<200/<200/<300 [e]
Benzo(a)pyrene			0.15		
Bis(2-ethylhexyl) phthalate			13		
Hexachlorobenzene			0.002		
Pentachlorobenzene					
Pentachlorophenol			0.6		
Perfluorooctanoic acid			0.022		
Perfluorooctane sulfonate			0.014		
Polychlorinated alkanes medium chain			11.9		
Tetrachloroethene					
Toluene					
Triclosan			0.13		

Parameter	ICRCL 70/90 [a]		SSVs [b]	Code of Practice for Agricultural Use of Sewage Sludge [c]	BS 3882:2015 Specification for topsoil and requirements for use
	Maximum				Phytotoxic contaminants
	Livestock	Crop Growth			
	mg/kgDW	mg/kgDW	mg/kgDW	mg/kgDW	mg/kgDW
Tris(2-chloroethyl)phosphate			1.1		
Tris(2-chloro-1-methylethyl) phosphate			1.8		

a. Interdepartmental Committee on the Redevelopment of Contaminated Land (ICRCL) 70/90 Restoration and Aftercare of Metalliferous Mining Sites for Pasture and Grazing 1st edition 1990.
b. Soil screening values for assessing ecological risks, EA 2017a Report – ShARE id26
c. Maximum permissible concentration of potentially toxic elements for Arable land from the Sewage sludge in agriculture: code of practice.. There are also criteria for Grassland which are higher than for Arable.
d. Where four values are presented, concentrations are for soils with pH values 5.0-5.5/ 5.5-6.0/ 6.0-7.0/ >7.0 (and the soils contain more than 5% calcium carbonate)
e. Where three values are presented, concentrations are for soils with pH values <6.0/ 6.0-7.0/ >7.0

Table 6: Tier 2 Criteria for Screening Liquids

	Screening Concentration (mg/l)			
	Minimum Reporting Value	Human Consumption	Fresh Water/Inland	Salt Water/Other
Arsenic SP	-	0.01	0.05 (2)	0.025 (2)
Boron	-	1	-	-
Cadmium PS	0.0001	0.005	≤0.00008, 0.00008, 0.00009, 0.00015, 0.00025 (14)	0.0002
Chromium (total)	-	0.05	-	-
Chromium (III) SP	-	-	0.0047	-
Chromium (VI) SP	-	-	0.0034	0.0006
Copper SP	-	2	0.001 bioavailable	0.00376 bioavailable
Iron SP	-	0.2	1	1
Lead PS	-	0.01	0.0012 bioavailable	0.0013 bioavailable
Mercury compounds PS	0.00001	0.001	0.00007 max	0.00007 max
Manganese SP	-	0.05	0.123 bioavailable	-
Nickel PS	-	0.02	0.004 bioavailable	0.0086 bioavailable
Selenium	-	0.01	-	-
Zinc SP	-	5(3)	0.0109bioavailable(13)	0.0068bioavailable (13)
Chlorinated Compounds				
C10-13 chloroalkanes PS short chain chlorinated paraffins	-	-	0.0004	0.0004
Dichloromethane PS	-	-	0.02	0.02
1,2-Dichloroethane PS	0.001	0.003	0.01	0.01
Trichloroethene PS	0.0001	0.01(5)	0.01	0.01
1,1,1-Trichloroethane	0.0001	-	-	-
1,1,2-Trichloroethane	0.0001	-	-	-
Trichloromethanes PS	-	0.1(1)	0.0025	0.0025
1, 2, 4-Trichlorobenzene	0.00001			
Tetrachloroethene PS	0.0001	0.01(5)	0.01	0.01
Tetrachloromethane PS	0.0001	0.003	0.012	0.012
Tetrachloroethane SP	-		0.140	
Vinyl chloride	-	0.0005	-	-
Trichlorobenzene (TCB) PS	-	-	0.0004	0.0004
Chloroform	0.0001			
Chloronitrotoluenes(CNT)(11)	0.001	-	-	-
Hexachlorobutadiene PS	0.000005	-	0.0006 max	0.0006 max
Hexachlorocyclohexanes (HCH) PS	0.000001	-	0.00002	0.000002
Polycyclic Aromatic Hydrocarbons				
Acenaphthene	-	-	-	-

	Screening Concentration (mg/l)			
	Minimum Reporting Value	**Human Consumption**	**Fresh Water/Inland**	**Salt Water/Other**
Acenaphthylene	-	-	-	-
Anthracene PS	-	-	0.0001	0.0001
Benzo(a)anthracene	-	-	-	-
Benzo(b)fluoranthene PS	-	0.0001 (10)	0.000017 max (12)	0.000017 max (12)
Benzo(a)pyrene PS	-	0.00001	0.00000017	0.00000017
Benzo(k)fluoranthene PS	-	0.0001 (10)	0.000017 max (12)	0.000017 max (12)
Benzo(g,h,i)perylene PS	-	0.0001 (10)	0.0000082 max (12)	0.00000082 max (12)
Indeno(1,2,3-cd)pyrene PS	-	0.0001 (10)	- (12)	- (12)
Chrysene		-	-	-
Dibenzo(a,h)anthracene		-	-	-
Fluoranthene PS	-	-	0.0000063	0.0000063
Fluorene	-	-	-	-
Phenanthrene	-	-	-	-
Pyrene	-	-	-	-
Naphthalene PS	-	-	0.002	0.002
Polycyclic Aromatic Hydrocarbons		0.0001(10)		
Petroleum hydrocarbons				
Total petroleum hydrocarbons	-	0.01(3)	-	-
Benzene PS	0.001	0.001	0.01	0.008
Toluene SP	0.004	0.7(9)	0.074	0.074
Ethylbenzene	-	0.3(9)	-	-
Xylenes	0.003(4)	0.5(9)		
Methyl tert-butyl ether (MTBE)	-	0.015(7)	-	-
Pesticides and Herbicides				
Alachlor PS	-	-	0.0003	0.0003
Aldrin PS	0.000003	0.00003	0.00001(8)	0.000005(8)
Dieldrin PS	0.000003	0.00003		
Endrin PS	0.000003	0.0006(9)		
Isodrin	0.000003	-	-	-
2,4 dichlorophenol SP	0.0001	-	0.0042	0.00042
2,4 D ester SP	0.0001	-	0.0003	0.0003
op and pp DDT (each) PS		0.001(6)	0.000025 (6)	0.000025 (6)
op and pp DDE (each)				
op and pp TDE (each)				
Dimethoate SP	0.00001	-	0.00048	0.00048
Endosulfan PS	0.000005	-	0.000005	0.0000005
Hexachlorobenzene PS	0.000001		0.00005 max	0.00005 max
Permethrin SP		-	0.000001	0.0000002
Atrazine PS	0.00003	-	0.0006	0.0006
Simazine PS	0.00003	-	0.001	0.001
Linuron SP		-	0.0005	0.0005
Mecoprop SP		-	0.018	0.018
Trifluralin PS	0.00001	-	0.00003	0.00003
Total pesticides		0.0005		
Miscellaneous				
Ammoniacal nitrogen (as NH4+)	-	0.5	0.26 16 0.39 17	-
Ammoniacal nitrogen (as N)	-	0.39	0.2 16 0.3 17	-
Unionised Ammonia (NH3) SP	-	-	-	0.021
Chloride	-	250		
Chlorine SP			0.002	0.01 max
Cyanide SP (hydrogen cyanide)	-	0.05	0.001	0.001
Nitrate (as NO_3)	-	50	-	-
Nitrite (as NO_2)	-	0.1	-	-
Phenol SP	-	0.005 (3)	0.0077	0.0077
Pentachlorophenol PS	0.0001	-	0.0004	0.0004
PCBs (individual congeners)	0.000001	-	-	-
Sodium	-	200	-	-
Sulphate	-	250		-

	Screening Concentration (mg/l)			
	Minimum Reporting Value	Human Consumption	Fresh Water/Inland	Salt Water/Other
Tributyl and triphenyl tin compounds (each) PS	0.000001	-	0.0000002	0.0000002
Di(2-ethylhexyl)-phthalate PS	-	-	0.0013	0.0013

Substances highlighted in yellow are hazardous substances, PS = Priority Substances, SP = Specific Pollutants, '-' screening concentration is not available, 'max' – maximum allowable concentration used where no annual average provided

Notes:

1. Concentration for trihalomethanes is the sum of chloroform, bromoform, dibromochloromethane and bromodichloromethane.
2. Concentration is the dissolved fraction of a water sample obtained by filtration through a 0.45um filter.
3. Concentration is taken from Statutory Instrument 1989 No. 1147. The Water Supply (Water Quality) Regulations 1989, as amended.
4. Concentration for xylenes is 0.003mg/l each for o-xylene and m/p xylene.
5. Concentration is the Sum of TCE and PCE.
6. Concentration is for Total DDT. Para DDT on its own has a target concentration of 0.00001mg/l.
7. Concentration for MTBE is taken from Environment Agency guidance, dated 2006.
8. Concentration is the sum of aldrin, dieldrin, endrin.
9. Concentration is taken from WHO (2004) guidelines for drinking-water quality.
10. Sum of benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(1,2,3-cd)pyrene
11. Concentration is for 2,6-CNT, 4,2-CNT, 4,3-CNT, 2,4-CNT, 2,5-CNT
12. BAP can be considered as a marker of the other PAHs for comparison with the annual average
13. Concentration plus ambient background concentration (dissolved)
14. For cadmium and its compounds the EQS depends on the hardness of the water (Class 1: < 40 mg CaCO3/l, Class 2: 40 to < 50 mg CaCO3/l, Class 3: 50 to < 100 mg CaCO3/l, Class 4: 100 to < 200 mg CaCO3/l and Class 5: ≥ 200 mg CaCO3/l).
15. Manufactured and used in industrial applications, such as flame retardants and plasticisers, as additives in metal working fluids, in sealants, paints, adhesives, textiles, leather fat and coatings. Persistent, bioaccumulate and toxic to aquatic life (carcinogen in rat studies). Candidate Persistent Organic Pollutant (POP).
16. Acceptable 90th percentile concentration for a freshwater lake/river with "High" chemical quality standard and alkalinity (as mg/l CaCO3) < 50 mg/L or alkalinity < 200 mg/L where river elevation > 80 m above Ordnance Datum (mAOD). See the Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 for further details.
17. Acceptable 90th percentile concentration for a freshwater lake/river with "High" chemical quality standard and alkalinity (as mg/l CaCO3) ≥ 50 mg/L where river elevation < 80 m mAOD or > 200 mg/l where river elevation > 80 mAOD. See the Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 for further details.

Table 7: Tier 2 Criteria for Screening Groundwater Vapour Generation Hazard

Chemical	CAS	GAC_{gwvap}(µg/l)[1,2]		Aqueous Solubility (µg/l)
		Residential	Commercial	
Petroleum Hydrocarbons				
1,2,4-Trimethylbenzene	95-63-6	24	2,200	559,000
Benzene [3]	71-43-2	210	20,000	1,780,000
Ethylbenzene [3]	100-41-4	10,000	*960,000 (sol)*	180,000
Isopropylbenzene	98-82-8	850	*86,000 (sol)*	56,000
Propylbenzene	103-65-1	2,700	*240,000 (sol)*	54,100
Styrene	100-42-5	8,800	*810,000 (sol)*	290,000
Toluene [3]	108-88-3	230,000	*21,000,000 (sol)*	590,000
TPH Aliphatic EC5-EC6 [3]		1,900	*190,000 (sol)*	35,900
TPH Aliphatic >EC6-EC8 [3]		1,500	*150,000 (sol)*	5,370
TPH Aliphatic >EC8-EC10 [3]		57	*5,700 (sol)*	427
TPH Aliphatic >EC10-EC12 [3]		37	*3,600 (sol)*	34
TPH Aromatic >EC5-EC7 [2,3]		210,000	*20,000,000 (sol)*	1,780,000
TPH Aromatic >EC7-EC8 [3]		220,000	*21,000,000 (sol)*	590,000
TPH Aromatic >EC8-EC10 [3]		1,900	*190,000 (sol)*	64,600
TPH Aromatic >EC10-EC12 [3]		6,800	*660,000 (sol)*	24,500
TPH Aromatic >EC12-EC16 [3]		39,000	*3,700,000 (sol)*	5,750
meta-Xylene [3,5]	108-38-3	9,500	*940,000 (sol)*	200,000
ortho-Xylene [3,5]	95-47-6	12,000	*1,100,000 (sol)*	173,000
para-Xylene [3,5]	106-42-3	9,900	*980,000 (sol)*	200,000
Polycyclic Aromatic Hydrocarbons (PAH)				
Acenaphthene	83-32-9	*170,000 (sol)*	*15,000,000 (sol)*	4,110

Chemical	CAS	GAC_{gwvap}(µg/l)[1,2]		Aqueous Solubility (µg/l)
		Residential	Commercial	
Acenaphthylene	208-96-8	*220,000 (sol)*	*20,000,000 (sol)*	7,950
Fluorene	86-73-7	*210,000 (sol)*	*18,000,000 (sol)*	1,860
Naphthalene	91-20-3	220	*23,000 (sol)*	19,000
Pesticides				
Aldrin	309-00-2	*47 (sol)*	*3,700 (sol)*	20
alpha-Endosulfan	959-98-8	*7,400 (sol)*	*590,000 (sol)*	530
beta-Endosulfan	33213-65-9	*7,500 (sol)*	*600,000 (sol)*	280
Halogenated Organics				
1,1,1,2-Tetrachloroethane	79-34-5	240	22,000	1,110,000
1,1,1-Trichloroethane	71-55-6	3,000	290,000	1,300,000
1,1,2,2-Tetrachloroethane	79-35-4	1,600	150,000	2,930,000
1,1,2-Trichloroethane	79-00-5	520	49,000	4,491,000
1,1-Dichloroethane	75-34-3	2,700	260,000	3,666,000
1,1-Dichloroethene	75-35-4	160	1,6000	3,100,000
1,2,3,4-Tetrachlorobenzene	634-66-2	240	*31,000 (sol)*	7,800
1,2,3,5-Tetrachlorobenzene	634-90-2	7.0	*600*	3,500
1,2,3-Trichlorobenzene	87-61-7	35	3,100	21,000
1,2,4,5-Tetrachlorobenzene	95-94-3	8.1	*700 (sol)*	600
1,2,4-Trichlorobenzene	120-82-1	68	7,200	41,400
1,2-Dichlorobenzene	95-50-1	2,000	*220,000 (sol)*	133,000
1,2-Dichloroethane	107-06-2	8.9	850	8,680,000
1,2-Dichloropropane	78-87-5	22	2,600	2,050,000
1,3,5-Trichlorobenzene	108-70-3	7.4	660	6,000
1,3-Dichlorobenzene	541-73-1	31	2,800	103,000
1,4-Dichlorobenzene	106-46-7	5,000	*460,000 (sol)*	51,200
Bromobenzene	108-86-1	220	20,000	388,040
Bromodichloromethane	75-27-4	17	1,600	3,000,000
Bromoform (Tribromomethane)	75-25-2	3,100	400,000	3,000,000
Chlorobenzene	108-90-7	98	15,000	387,000
Chloroethane	75-00-3	10,000	1,000,000	5,742,000
Chloroethene (Vinyl Chloride)	75-01-4	0.62	63	2,760,000
Chloromethane	74-87-3	14	1,400	5,350,000
cis-1,2-Dichloroethene	156-59-2	130	13,000	7,550,000
Dichloromethane	75-09-2	3,300	370,000	20,080,000
Hexachlorobenzene	118-74-1	*16 (sol)*	*1,400 (sol)*	10
Hexachlorobutadiene	87-68-3	1.7	230	4,800
Hexachloroethane	67-72-1	8.5	740	49,900
Pentachlorobenzene	608-93-5	140	*12,000 (sol)*	500
Tetrachloroethene	127-18-4	34	4,600	225,000
Tetrachloromethane (Carbon Tetrachloride)	56-23-5	5.3	770	846,000
trans-1,2-Dichloroethene	156-60-5	160	16,000	5,250,000
Trichloroethene	79-01-6	5.7	530	1,370,000
Trichloromethane (Chloroform)	67-66-3	790	85,000	8,950,000
Others (organic and inorganic)				
2-Chloronaphthalene	91-58-7	160	*14,000 (sol)*	11,700
Biphenyl (Lemonene)	92-52-4	*15,000 (sol)*	*1,300,000 (sol)*	4,060
Carbon Disulphide	75-15-0	56	5,600	2,100,000
Mercury, elemental	7439-97-6	1.1	*95 (sol)*	56
Methyl tertiary butyl ether (MTBE)	1634-04-4	83,000	7,800,000	48,000,000

Notes

1. GAC in *italics* with (sol) exceed aqueous solubility.
2. GAC rounded to two significant figures.
3. The GAC for these petroleum hydrocarbon contaminants have been calculated using a sub-surface soil to indoor air correction factor of 10 in line with the physical-chemical data sources.
4. The GAC for TPH fractions do not account for genotoxic mutagenic effects. Concentrations of TPH Aromatic >EC5-EC7 should therefore also be compared with the GAC for benzene to ensure that such effects are also assessed.
5. The Health Criteria Value used for each xylene isomer was for total xylene. If site specific additivity assessments are not completed, as a conservative measure the sum of isomer concentrations should be compared to the lowest xylene GAC (as is the case for soil GAC).

Appendix C Geoenvironmental Soils Assessment

TABLE SUMMARISING SOIL RESULTS AND HIGHLIGHTING EXCEEDANCES ABOVE SOIL ASSESSMENT CRITERIA
M3 JUNCTION 9 IMPROVEMENTS

SOM 6%			Assessment Criteria		Strata				No. of Exceedances			MG	ALVc	ALVc	TS	ALVc	SECK	MG	HDD	HDD	HDD	SECK	TS	SECK	SECK	SECK	SECK	MG	MG	SECK
												DS101	DS101	DS101	DS103	DS103	DS103	DS104	DS104	DS105	DS105	DS105	DS107	DS107	DS107	DS108	DS108	DS109	DS109A	DS109A
Analyte	Units	LOD	POSresi	POSpark	Commercial	No. of Tests	Min	Max	POSresi	POSpark	Commercial	0.5	2.8	7.8	0.25	2.6	6.9	0.25	1.5	0.25	1	7	0.25	5.2	6.85	0.25	6	0.25	0.25	3.4
Stones Content	%		-	-	-																									
Arsenic*	mg/kg	2	79	170	640	126	2	37				*2*	5	*2*	7	*2*	*2*	8	3	7	5	*2*	6	37	*2*	10	*2*	6	6	*2*
Cadmium*	mg/kg	0.2	220	880	410	126	0.2	1.3				*0.2*	0.3	0.3	0.9	0.3	*0.2*	0.9	0.4	1.2	0.4	*0.2*	0.8	0.9	*0.2*	0.5	*0.2*	0.8	0.8	0.4
Chromium Trivalent	mg/kg		1500	33000	8600																									
Chromium Hexavalent*	mg/kg	2	21	250	49	126	2	2				*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
Copper	mg/kg	4	12000	44000	68000	126	4	93				8	10	7	14	9	8	16	10	16	9	9	17	93	9	42	8	20	20	9
Lead*	mg/kg	3	630	1300	2300	126	3	470				9	9	*3*	23	*3*	*3*	37	5	49	9	*3*	37	470	*3*	30	*3*	51	55	*3*
Mercury	mg/kg	1	120	240	1100	126	1	3.1				*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	3.1	*1*	*1*	*1*	*1*	*1*	*1*
Nickel	mg/kg	3	230	800	980	126	3	47				*3*	13	5	14	5	*3*	15	7	11	8	*3*	6	47	*3*	18	*3*	10	12	*3*
Selenium	mg/kg	3	1100	1800	12000	126	3	13.6				*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
Zinc	mg/kg	3	81000	170000	730000	126	3	190				18	37	12	63	16	9	64	18	68	24	8	46	9	9	81	10	65	73	8
Beryllium	mg/kg	0.5	2.2	63	12	126	0.5	2.3	1			*0.5*	0.6	*0.5*	0.8	*0.5*	*0.5*	0.8	*0.5*	0.7	*0.5*	*0.5*	*0.5*	2.3	*0.5*	0.9	*0.5*	0.6	0.6	*0.5*
Boron	mg/kg	1	21000	46000	240000	126	1	4				*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	3.1	*1*	*1*	*1*	*1*	*1*	*1*
Vanadium	mg/kg	2	2000	5000	9000	126	2	52				4	22	6	30	8	*2*	32	11	24	14	*2*	15	52	*2*	26	*2*	20	23	*2*
Cyanide (Total)	mg/kg	2	-	-	-	126	2	2				*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
Organic matter	mg/kg		-	-	-																									
Phenol, Total	mg/kg		1300	1300	1300																									
Sulphate (Total) as SO4	mg/l	0.02	-	-	-	126	0.02	0.46				0.04	0.05	0.04	0.1	0.05	0.04	0.1	0.04	0.23	0.06	0.04	0.1	0.17	0.04	0.09	0.05	0.1	0.11	0.04
pH	pH Units		-	-	-	126	6.5	11				8.1	8.6	8.2	7.7	8.1	8.1	6.8	7.1	8.5	8.1	8.2	6.7	8.2	7.3	7.7	7.7	7.1	6.5	6.9
>C5 to C6 Aliphatic	mg/kg	0.01	600000	180000	12000	126	0.01	0.01				*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*
>C6 to C8 Aliphatic	mg/kg	0.05	620000	320000	40000	126	0.05	0.05				*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
>C8 to C10 Aliphatic	mg/kg	2	13000	21000	11000	126	2	2				*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C10 to C12 Aliphatic	mg/kg	2	13000	24000	47000	126	2	2				*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C12 to C16 Aliphatic	mg/kg	3	13000	26000	90000	126	3	62				*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
>C16 to C21 Aliphatic	mg/kg	3	-	-	-	126	3	282				*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	5	*3*	*3*	*3*	*3*
>C21 to C35 Aliphatic	mg/kg	10	-	-	-	126	10	202				*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	202	*10*	*10*	*10*	*10*
>C16 to C35 Aliphatic	mg/kg	13	250000	490000	1800000	126		292				*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	207	*13*	*13*	*13*	*13*
>C35 to C44 Aliphatic	mg/kg		250000	490000	1800000																									
Total Aliphatic C5-C35	mg/kg	21	-	-	-	126	21	343				*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	207	*21*	*21*	*21*	*21*
>C5 to C7 Aromatic	mg/kg		56000	92000	86000																									
>C7 to C8 Aromatic	mg/kg	0.05	56000	100000	180000	126	0.05	0.05				*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
>C8 to C10 Aromatic	mg/kg	2	5000	9300	17000	126	2	2				*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C10 to C12 Aromatic	mg/kg	2	5000	10000	34000	126	2	5				*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C12 to C16 Aromatic	mg/kg	2	5000	10000	38000	126	2	13				*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C16 to C21 Aromatic	mg/kg	3	3800	7800	28000	126	3	16				*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
>C21 to C35 Aromatic	mg/kg	10	3800	7900	28000	126	10	246				*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	246	*10*	*10*	*10*	*10*
>C35 to C44 Aromatic	mg/kg		3800	7900	28000																									
Total Aromatic C5-C35	mg/kg	21	-	-	-	126	21	249				*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	249	*21*	*21*	*21*	*21*
TPH Ali/Aro	mg/kg	42	-	-	-	126	42	457				*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	457	*42*	*42*	*42*	*42*
EPH (C10-C40)	mg/kg		-	-	-																									
Hazard Index - POSresi	-	-	-	-	-	126	0.005	0.068				0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0681	0.0052	0.0052	0.0052	0.0052
Hazard Index - POSpark	-	-	-	-	-	126	0.003	0.033				0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0329	0.0026	0.0026	0.0026	0.0026
Hazard Index - Commercial	-	-	-	-	-	126	0.001	0.009				0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0095	0.0010	0.0010	0.0010	0.0010
Benzene*	mg/kg	0.002	140	230	98	126	0.002	0.002				*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Ethylbenzene	mg/kg	0.002	25000	27000	27000	126	0.002	0.002				*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Toluene	mg/kg	0.005	56000	100000	180000	126	0.005	0.01				*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
Xylene	mg/kg		43000	33000	33000																									
M- & P- Xylene	mg/kg	0.002	-	-	-	126	0.002	0.002				*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
O-Xylene	mg/kg	0.002	-	-	-	126	0.002	0.002				*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Total Xylene (M, P & O)	mg/kg	0.004	43000	33000	33000	126		0.004				*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*
MTBE	mg/kg		-	-	-																									
naphthalene	mg/kg	0.1	4900	3000	1100	126	0.1	0.1				*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
acenaphthylene	mg/kg	0.1	15000	30000	100000	126	0.1	0.1				*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
acenaphthene	mg/kg	0.1	15000	30000	100000	126	0.1	0.1				*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
fluorene	mg/kg	0.1	9900	20000	71000	126	0.1	0.1				*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
phenanthrene	mg/kg	0.1	3100	6300	23000	126	0.1	1.08				*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.15	*0.1*	*0.1*	0.15	*0.1*
anthracene	mg/kg	0.1	74000	150000	540000	126	0.1	0.29				*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
fluoranthene	mg/kg	0.1	3100	6400	23000	126	0.1	1.75				*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.18	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.21	*0.1*	0.3	0.35	*0.1*
pyrene	mg/kg	0.1	7400	15000	54000	126	0.1	1.44				*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.14	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.22	*0.1*	0.23	0.28	*0.1*
benzo(a)anthracene	mg/kg	0.1	29	62	180	126	0.1	0.58				*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.36	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.13	*0.1*	0.44	0.47	*0.1*
chrysene	mg/kg	0.1	57	120	350	126	0.1	0.55				*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.16	*0.1*	*0.1*	0.13	*0.1*
benzo(b)fluoranthene	mg/kg	0.1	7.2	16	45	126	0.1	0.62				*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.16	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.16	*0.1*	0.21	0.54	*0.1*
benzo(k)fluoranthene	mg/kg	0.1	190	440	1200	126	0.1	0.19				*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.13	*0.1*	*0.1*
benzo(a)pyrene	mg/kg	0.1	5.7	13	36	126	0.1	0.48				*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.16	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.11	*0.1*	0.21	0.21	*0.1*
indeno(1,2,3-c,d)pyrene	mg/kg	0.1	82	180	510	126	0.1	0.46				*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
dibenzo(ah)anthracene	mg/kg	0.1	0.58	1.4	3.6	126	0.1	0.1				*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(g,h,i)perylene	mg/kg	0.1	640	1600	4000	126	0.1	0.41				*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Total PAH	mg/kg		-	-	-																									
Coal Tar (Bap as surrogate)*	mg/kg	0.1	10	21	77	126	0.1	0.48				*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.16	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.11	*0.1*	0.21	0.21	*0.1*
PCB (as Aroclors)	mg/kg	0.1	-	-	-	65	0.1	0.1				*0.1*	*0.1*		*0.1*		*0.1*	*0.1*	*0.1*	*0.1*		*0.1*				*0.1*	*0.1*	*0.1*		
1,2 Dichloroethane	mg/kg		1400	2300	1100																									
1,1,1 Trichloroethane (TCA)	mg/kg		140000	100000	3000																									
1,1,1,2 Tetrachloroethane	mg/kg		1400	2100	560																									
1,1,2,2 Tetrachloroethane	mg/kg		1400	2300	1100																									
Tetrachloroethene (PCE)	mg/kg		1400	1500	95																									
Carbon Tetrachloride	mg/kg		950	400	14																									
Trichloroethene (TCE)	mg/kg		120	120	5.7																									
Trichloromethane (Chloroform)	mg/kg		2500	3100	350																									
Vinyl Chloride (Chloroethene)	mg/kg		3.5	5.4	0.12																									
Asbestos (Presence of)	TEXT		-	-	-	126						Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
Asbestos Analysts Comments	TEXT		-	-	-																									
Asbestos Fibre Count	%																													

* Category 4 Screening Value @ 6% SOM

TABLE SUMMARISING SOIL RESULTS AND HIGHLIGHTING EXCEEDANCES ABOVE SOIL ASSESSMENT CRITERIA
M3 JUNCTION 9 IMPROVEMENTS

SOM 6%			Assessment Criteria		Strata	SECK	MG	SECK	SECK	MG	PEAT	SECK	ALVg	SECK	SECK	SECK	SECK	SECK	SECK	SECK	SECK	TS	SECK	ALVc	HDD	HDD	SECK	SECK
						DS109A	DS110	DS110	DS110	DS111	DS111	DS111	DS112	DS112	DS114	DS114	DS115	DS115	DS115	DS115	DS115	DS203	DS203	DS204	DS204	DS205	DS205	DS205
Analyte	**Units**	**LOD**	**POSresi**	**POSpark**	**Commercial**	9.1	0.25	1.7	8.3	1	4.5	10.3	0.5	6.6	0.5	4	0.25	0.5	3.8	5.1	8.8	0.25	2.2	0.5	5.75	0.25	0.5	4.95
Stones Content	%		-	-	-																							
Arsenic*	mg/kg	2	79	170	640	*2*	5	*2*	*2*	*2*	5	*2*	7	*2*	*2*	*2*	3	*2*	*2*	*2*	*2*	4	*2*	5	*2*	4	*2*	*2*
Cadmium*	mg/kg	0.2	220	880	410	0.4	0.8	0.4	0.4	*0.2*	0.9	*0.2*	0.7	*0.2*	*0.2*	*0.2*	0.6	0.4	0.4	0.3	0.3	0.9	0.3	0.4	*0.2*	0.8	0.4	0.4
Chromium Trivalent	mg/kg		1500	33000	8600																							
Chromium Hexavalent*	mg/kg	2	21	250	49	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
Copper	mg/kg	4	12000	44000	68000	8	18	9	10	14	29	7	11	9	7	8	15	11	8	8	8	12	8	9	*4*	12	9	9
Lead*	mg/kg	3	630	1300	2300	*3*	41	*3*	*3*	18	22	*3*	15	*3*	*3*	*3*	16	*3*	*3*	*3*	*3*	15	*3*	6	*3*	11	*3*	*3*
Mercury	mg/kg	1	120	240	1100	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
Nickel	mg/kg	3	230	800	980	*3*	8	*3*	*3*	4	25	*3*	17	*3*	*3*	*3*	5	*3*	*3*	*3*	*3*	5	*3*	11	*3*	7	*3*	*3*
Selenium	mg/kg	3	1100	1800	12000	*3*	*3*	*3*	*3*	*3*	6.3	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
Zinc	mg/kg	3	81000	170000	730000	9	54	9	11	34	108	9	54	7	8	10	29	11	10	9	11	38	9	26	7	36	8	9
Beryllium	mg/kg	0.5	2.2	63	12	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	0.7	*0.5*	0.9	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*
Boron	mg/kg	1	21000	46000	240000	*1*	*1*	*1*	*1*	*1*	1.1	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
Vanadium	mg/kg	2	2000	5000	9000	*2*	16	3	*2*	5	19	*2*	32	*2*	*2*	*2*	9	*2*	*2*	*2*	*2*	14	*2*	18	3	13	*2*	*2*
Cyanide (Total)	mg/kg	2	-	-	-	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
Organic matter	mg/kg		-	-	-																							
Phenol, Total	mg/kg		1300	1300	1300																							
Sulphate (Total) as SO4	mg/l	0.02	-	-	-	0.04	0.1	0.04	0.04	0.05	0.15	0.03	0.09	0.05	0.05	0.04	0.07	0.05	0.04	0.04	0.05	0.11	0.04	0.04	0.02	0.09	0.05	0.04
pH	pH Units		-	-	-	6.9	6.9	7	7.1	7.7	7.3	7.3	7	7	7.6	7.6	7.4	7.6	7.2	7.4	8	7.6	8.1	7.4	7.4	7.2	7.3	7.5
>C5 to C6 Aliphatic	mg/kg	0.01	600000	180000	12000	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*
>C6 to C8 Aliphatic	mg/kg	0.05	620000	320000	40000	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
>C8 to C10 Aliphatic	mg/kg	2	13000	21000	11000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C10 to C12 Aliphatic	mg/kg	2	13000	24000	47000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C12 to C16 Aliphatic	mg/kg	3	13000	26000	90000	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
>C16 to C21 Aliphatic	mg/kg	3	-	-	-	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
>C21 to C35 Aliphatic	mg/kg	10	-	-	-	*10*	*10*	*10*	35	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
>C16 to C35 Aliphatic	mg/kg	13	250000	490000	1800000	*13*	*13*	*13*	38	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*
>C35 to C44 Aliphatic	mg/kg		250000	490000	1800000																							
Total Aliphatic C5-C35	mg/kg	21	-	-	-	*21*	*21*	*21*	35	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*
>C5 to C7 Aromatic	mg/kg		56000	92000	86000																							
>C7 to C8 Aromatic	mg/kg	0.05	56000	100000	180000	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
>C8 to C10 Aromatic	mg/kg	2	5000	9300	17000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C10 to C12 Aromatic	mg/kg	2	5000	10000	34000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C12 to C16 Aromatic	mg/kg	2	5000	10000	38000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C16 to C21 Aromatic	mg/kg	3	3800	7800	28000	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
>C21 to C35 Aromatic	mg/kg	10	3800	7900	28000	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
>C35 to C44 Aromatic	mg/kg		3800	7900	28000																							
Total Aromatic C5-C35	mg/kg	21	-	-	-	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*
TPH Ali/Aro	mg/kg	42	-	-	-	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*
EPH (C10-C40)	mg/kg		-	-	-																							
Hazard Index - POSresi	-	-	-	-	-	0.0052	0.0052	0.0052	0.0053	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052
Hazard Index - POSpark	-	-	-	-	-	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026
Hazard Index - Commercial	-	-	-	-	-	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Benzene*	mg/kg	0.002	140	230	98	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Ethylbenzene	mg/kg	0.002	25000	27000	27000	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Toluene	mg/kg	0.005	56000	100000	180000	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	0.01	*0.005*	*0.005*	*0.005*
Xylene	mg/kg		43000	33000	33000																							
M- & P- Xylene	mg/kg	0.002	-	-	-	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
O-Xylene	mg/kg	0.002	-	-	-	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Total Xylene (M, P & O)	mg/kg	0.004	43000	33000	33000	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*
MTBE	mg/kg		-	-	-																							
naphthalene	mg/kg	0.1	4900	3000	1100	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
acenaphthylene	mg/kg	0.1	15000	30000	100000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
acenaphthene	mg/kg	0.1	15000	30000	100000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
fluorene	mg/kg	0.1	9900	20000	71000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
phenanthrene	mg/kg	0.1	3100	6300	23000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
anthracene	mg/kg	0.1	74000	150000	540000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
fluoranthene	mg/kg	0.1	3100	6400	23000	*0.1*	0.23	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
pyrene	mg/kg	0.1	7400	15000	54000	*0.1*	0.21	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(a)anthracene	mg/kg	0.1	29	62	180	*0.1*	0.16	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
chrysene	mg/kg	0.1	57	120	350	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(b)fluoranthene	mg/kg	0.1	7.2	16	45	*0.1*	0.22	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(k)fluoranthene	mg/kg	0.1	190	440	1200	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(a)pyrene	mg/kg	0.1	5.7	13	36	*0.1*	0.13	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
indeno(1,2,3-c,d)pyrene	mg/kg	0.1	82	180	510	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
dibenzo(ah)anthracene	mg/kg	0.1	0.58	1.4	3.6	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(g,h,i)perylene	mg/kg	0.1	640	1600	4000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Total PAH	mg/kg		-	-	-																							
Coal Tar (Bap as surrogate)*	mg/kg	0.1	10	21	77	*0.1*	0.13	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
PCB (as Aroclors)	mg/kg	0.1	-	-	-	*0.1*	*0.1*		*0.1*	*0.1*	*0.1*							*0.1*				*0.1*	*0.1*					
1,2 Dichloroethane	mg/kg		1400	2300	1100																							
1,1,1 Trichloroethane (TCA)	mg/kg		140000	100000	3000																							
1,1,1,2 Tetrachloroethane	mg/kg		1400	2100	560																							
1,1,2,2 Tetrachloroethane	mg/kg		1400	2300	1100																							
Tetrachloroethene (PCE)	mg/kg		1400	1500	95																							
Carbon Tetrachloride	mg/kg		950	400	14																							
Trichloroethene (TCE)	mg/kg		120	120	5.7																							
Trichloromethane (Chloroform)	mg/kg		2500	3100	350																							
Vinyl Chloride (Chloroethene)	mg/kg		3.5	5.4	0.12																							
Asbestos (Presence of)	TEXT		-	-	-	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
Asbestos Analysts Comments	TEXT		-	-	-																							
Asbestos Fibre Count	%																											

* Category 4 Screening Value @ 6% SOM

TABLE SUMMARISING SOIL RESULTS AND HIGHLIGHTING EXCEEDANCES ABOVE SOIL ASSESSMENT CRITERIA
M3 JUNCTION 9 IMPROVEMENTS

SOM 6%			Assessment Criteria		Strata	SECK	SECK	SECK	HDD	SECK	SECK	SECK	TS	SECK	SECK	SECK	SECK	TS	SECK	SECK	SECK	SECK	TS	SECK	TS	SECK	SECK	MG
						DS206	DS206	DS206	DS207	DS207	DS207	DS207	DS208	DS208	DS208	DS209	DS209	DS210	DS210	DS210	DS211	DS211	DS212	DS212	DS213	DS213	DS213	DS214A
Analyte	**Units**	**LOD**	**POSresi**	**POSpark**	**Commercial**	**0.5**	**1**	**4**	**0.25**	**0.5**	**2.4**	**3.6**	**0.25**	**0.5**	**5.5**	**0.5**	**3.8**	**0.25**	**0.5**	**5.1**	**0.5**	**4.4**	**0.25**	**4**	**0.25**	**0.5**	**5**	**0.25**
Stones Content	%		-	-	-																							
Arsenic*	mg/kg	2	79	170	640	*2*	*2*	*2*	4	*2*	*2*	*2*	*2*	4	*2*	*2*	*2*	7	*2*	*2*	*2*	*2*	6	*2*	5	*2*	*2*	5
Cadmium*	mg/kg	0.2	220	880	410	0.6	0.4	0.3	0.9	0.5	0.5	0.4	0.4	0.8	0.3	0.4	0.3	0.8	0.5	0.3	0.3	0.3	0.8	0.4	0.9	0.4	0.3	0.9
Chromium Trivalent	mg/kg		1500	33000	8600																							
Chromium Hexavalent*	mg/kg	2	21	250	49	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
Copper	mg/kg	4	12000	44000	68000	9	13	12	16	10	9	9	9	14	9	6	7	20	10	8	10	7	18	8	15	8	10	20
Lead*	mg/kg	3	630	1300	2300	4	*3*	*3*	15	*3*	*3*	*3*	4	25	*3*	*3*	*3*	50	16	*3*	9	5	45	*3*	26	*3*	*3*	48
Mercury	mg/kg	1	120	240	1100	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
Nickel	mg/kg	3	230	800	980	*3*	*3*	*3*	*7*	*3*	*3*	*3*	*3*	5	*3*	*3*	*3*	10	*3*	*3*	*3*	10	9	*3*	8	*3*	*3*	10
Selenium	mg/kg	3	1100	1800	12000	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
Zinc	mg/kg	3	81000	170000	730000	14	12	9	48	14	13	9	11	37	9	11	10	56	15	11	20	24	70	9	50	11	12	64
Beryllium	mg/kg	0.5	2.2	63	12	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	0.6
Boron	mg/kg	1	21000	46000	240000	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
Vanadium	mg/kg	2	2000	5000	9000	3	*2*	*2*	14	3	*2*	*2*	*2*	11	*2*	*2*	*2*	19	3	*2*	5	15	18	*2*	17	*2*	*2*	20
Cyanide (Total)	mg/kg	2	-	-	-	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
Organic matter	mg/kg		-	-	-																							
Phenol, Total	mg/kg		1300	1300	1300																							
Sulphate (Total) as SO4	mg/l	0.02	-	-	-	0.06	0.05	0.05	0.09	0.05	0.05	0.04	0.05	0.09	0.05	0.03	0.03	0.11	0.05	0.05	0.04	0.04	0.09	0.04	0.09	0.04	0.04	0.08
pH	pH Units		-	-	-	7	7.1	7.2	7.3	7.4	7.4	7.4	7.4	7.3	7.7	8.5	8.5	7.3	7.5	8	8.4	8.3	7.3	7.1	6.8	7.2	8	6.7
>C5 to C6 Aliphatic	mg/kg	0.01	600000	180000	12000	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*
>C6 to C8 Aliphatic	mg/kg	0.05	620000	320000	40000	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
>C8 to C10 Aliphatic	mg/kg	2	13000	21000	11000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C10 to C12 Aliphatic	mg/kg	2	13000	24000	47000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C12 to C16 Aliphatic	mg/kg	3	13000	26000	90000	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	11
>C16 to C21 Aliphatic	mg/kg	3	-	-	-	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
>C21 to C35 Aliphatic	mg/kg	10	-	-	-	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
>C16 to C35 Aliphatic	mg/kg	13	250000	490000	1800000	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*
>C35 to C44 Aliphatic	mg/kg		250000	490000	1800000																							
Total Aliphatic C5-C35	mg/kg	21	-	-	-	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*
>C5 to C7 Aromatic	mg/kg		56000	92000	86000																							
>C7 to C8 Aromatic	mg/kg	0.05	56000	100000	180000	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
>C8 to C10 Aromatic	mg/kg	2	5000	9300	17000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C10 to C12 Aromatic	mg/kg	2	5000	10000	34000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C12 to C16 Aromatic	mg/kg	2	5000	10000	38000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	13
>C16 to C21 Aromatic	mg/kg	3	3800	7800	28000	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	5
>C21 to C35 Aromatic	mg/kg	10	3800	7900	28000	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
>C35 to C44 Aromatic	mg/kg		3800	7900	28000																							
Total Aromatic C5-C35	mg/kg	21	-	-	-	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*
TPH Ali/Aro	mg/kg	42	-	-	-	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*
EPH (C10-C40)	mg/kg		-	-	-																							
Hazard Index - POSresi	-	-	-	-	-	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0086
Hazard Index - POSpark	-	-	-	-	-	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0043
Hazard Index - Commercial	-	-	-	-	-	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0014
Benzene*	mg/kg	0.002	140	230	98	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Ethylbenzene	mg/kg	0.002	25000	27000	27000	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Toluene	mg/kg	0.005	56000	100000	180000	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
Xylene	mg/kg		43000	33000	33000																							
M- & P- Xylene	mg/kg	0.002	-	-	-	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
O-Xylene	mg/kg	0.002	-	-	-	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Total Xylene (M, P & O)	mg/kg	0.004	43000	33000	33000	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*
MTBE	mg/kg		-	-	-																							
naphthalene	mg/kg	0.1	4900	3000	1100	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
acenaphthylene	mg/kg	0.1	15000	30000	100000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
acenaphthene	mg/kg	0.1	15000	30000	100000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
fluorene	mg/kg	0.1	9900	20000	71000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
phenanthrene	mg/kg	0.1	3100	6300	23000	*0.1*	*0.1*	*0.1*	0.14	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	1.08	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
anthracene	mg/kg	0.1	74000	150000	540000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.29	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
fluoranthene	mg/kg	0.1	3100	6400	23000	*0.1*	*0.1*	*0.1*	0.32	*0.1*	*0.1*	*0.1*	0.55	*0.1*	*0.1*	*0.1*	*0.1*	1.75	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.15	*0.1*	*0.1*	0.15
pyrene	mg/kg	0.1	7400	15000	54000	*0.1*	*0.1*	*0.1*	0.26	*0.1*	*0.1*	*0.1*	0.44	*0.1*	*0.1*	*0.1*	*0.1*	1.44	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.15	*0.1*	*0.1*	0.15
benzo(a)anthracene	mg/kg	0.1	29	62	180	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.13	*0.1*	*0.1*	*0.1*	*0.1*	0.58	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
chrysene	mg/kg	0.1	57	120	350	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.5	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(b)fluoranthene	mg/kg	0.1	7.2	16	45	*0.1*	*0.1*	*0.1*	0.23	*0.1*	*0.1*	*0.1*	0.28	*0.1*	*0.1*	*0.1*	*0.1*	0.58	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(k)fluoranthene	mg/kg	0.1	190	440	1200	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.15	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(a)pyrene	mg/kg	0.1	5.7	13	36	*0.1*	*0.1*	*0.1*	0.15	*0.1*	*0.1*	*0.1*	0.18	*0.1*	*0.1*	*0.1*	*0.1*	0.44	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
indeno(1,2,3-c,d)pyrene	mg/kg	0.1	82	180	510	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.34	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
dibenzo(ah)anthracene	mg/kg	0.1	0.58	1.4	3.6	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(g,h,i)perylene	mg/kg	0.1	640	1600	4000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.14	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Total PAH	mg/kg		-	-	-																							
Coal Tar (Bap as surrogate)*	mg/kg	0.1	10	21	77	*0.1*	*0.1*	*0.1*	0.15	*0.1*	*0.1*	*0.1*	0.18	*0.1*	*0.1*	*0.1*	*0.1*	0.44	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
PCB (as Aroclors)	mg/kg	0.1	-	-	-	*0.1*		*0.1*		*0.1*				*0.1*		*0.1*	*0.1*		*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
1,2 Dichloroethane	mg/kg		1400	2300	1100																							
1,1,1 Trichloroethane (TCA)	mg/kg		140000	100000	3000																							
1,1,1,2 Tetrachloroethane	mg/kg		1400	2100	560																							
1,1,2,2 Tetrachloroethane	mg/kg		1400	2300	1100																							
Tetrachloroethene (PCE)	mg/kg		1400	1500	95																							
Carbon Tetrachloride	mg/kg		950	400	14																							
Trichloroethene (TCE)	mg/kg		120	120	5.7																							
Trichloromethane (Chloroform)	mg/kg		2500	3100	350																							
Vinyl Chloride (Chloroethene)	mg/kg		3.5	5.4	0.12																							
Asbestos (Presence of)	TEXT		-	-	-	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
Asbestos Analysts Comments	TEXT		-	-	-																							
Asbestos Fibre Count	%																											

* Category 4 Screening Value @ 6% SOM

TABLE SUMMARISING SOIL RESULTS AND HIGHLIGHTING EXCEEDANCES ABOVE SOIL ASSESSMENT CRITERIA
M3 JUNCTION 9 IMPROVEMENTS

SOM 6%			Assessment Criteria			Strata	SECK	MG	SECK	SECK	SECK	MG	MG	MG	MG	MG	SECK	SECK	SECK	SECK	SECK	SECK	SECK	SECK	SECK	SECK	SECK	TS
							DS214A	DS215	DS215	DS216	DS216	DS217	DS217	DS218	DS218	DS218	DS219	DS219	DS220	DS220	DS301	DS301	DS301	DS302	DS302	DS302	TP03	TP03	TP04
Analyte	**Units**	**LOD**	**POSresi**	**POSpark**	**Commercial**		**1**	**0.25**	**2.5**	**2.9**	**7**	**0.5**	**4.1**	**0.65**	**2**	**5.7**	**1**	**8.7**	**0.5**	**5.5**	**0.5**	**5.3**	**8.9**	**0.5**	**4.95**	**10.05**	**1**	**3**	**0.25**
Stones Content	%		-	-	-																								
Arsenic*	mg/kg	2	79	170	640		*2*	7	*2*	*2*	*2*	4	*2*	*2*	*2*	*2*	*2*	*2*	4	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	4
Cadmium*	mg/kg	0.2	220	880	410		0.5	0.3	0.4	*0.2*	*0.2*	0.4	0.3	*0.2*	0.3	0.3	0.4	0.3	0.8	0.3	0.4	*0.2*	*0.2*	0.4	*0.2*	*0.2*	0.4	0.4	0.8
Chromium Trivalent	mg/kg		1500	33000	8600																								
Chromium Hexavalent*	mg/kg	2	21	250	49		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
Copper	mg/kg	4	12000	44000	68000		8	10	9	9	8	35	7	*4*	6	7	7	8	10	7	9	9	7	10	9	10	9	8	13
Lead*	mg/kg	3	630	1300	2300		*3*	21	*3*	*3*	*3*	13	*3*	*3*	*3*	*3*	*3*	*3*	42	*3*	6	*3*	*3*	5	*3*	*3*	*3*	*3*	13
Mercury	mg/kg	1	120	240	1100		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
Nickel	mg/kg	3	230	800	980		*3*	10	*3*	*3*	*3*	6	*3*	*3*	*3*	*3*	*3*	*3*	4	*3*	*3*	*3*	*3*	4	*3*	*3*	*3*	*3*	6
Selenium	mg/kg	3	1100	1800	12000		*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
Zinc	mg/kg	3	81000	170000	730000		12	33	10	11	8	76	8	6	8	9	13	9	190	10	13	9	8	18	8	9	8	7	39
Beryllium	mg/kg	0.5	2.2	63	12		*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*
Boron	mg/kg	1	21000	46000	240000		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
Vanadium	mg/kg	2	2000	5000	9000		*2*	19	*2*	*2*	*2*	6	*2*	*2*	*2*	3	*2*	*2*	6	*2*	3	*2*	*2*	6	3	*2*	3	*2*	12
Cyanide (Total)	mg/kg	2	-	-	-		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
Organic matter	mg/kg		-	-	-																								
Phenol, Total	mg/kg		1300	1300	1300																								
Sulphate (Total) as SO4	mg/l	0.02	-	-	-		0.05	0.46	0.04	0.05	0.05	0.06	0.03	0.02	0.04	0.04	0.04	0.04	0.06	0.04	0.06	0.06	0.04	0.06	0.05	0.05	0.05	0.04	0.08
pH	pH Units		-	-	-		7.2	11	8.3	7.6	7.6	9.6	7.3	8	8.5	8.5	8.6	8.5	7.9	7.5	7.2	7.4	7.4	7.9	7.9	7.9	8	8	7.8
>C5 to C6 Aliphatic	mg/kg	0.01	600000	180000	12000		*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*
>C6 to C8 Aliphatic	mg/kg	0.05	620000	320000	40000		*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
>C8 to C10 Aliphatic	mg/kg	2	13000	21000	11000		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C10 to C12 Aliphatic	mg/kg	2	13000	24000	47000		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C12 to C16 Aliphatic	mg/kg	3	13000	26000	90000		*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	62	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
>C16 to C21 Aliphatic	mg/kg	3	-	-	-		*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	282	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
>C21 to C35 Aliphatic	mg/kg	10	-	-	-		*10*	48	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
>C16 to C35 Aliphatic	mg/kg	13	250000	490000	1800000		*13*	51	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	292	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*
>C35 to C44 Aliphatic	mg/kg		250000	490000	1800000																								
Total Aliphatic C5-C35	mg/kg	21	-	-	-		*21*	48	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	343	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*
>C5 to C7 Aromatic	mg/kg		56000	92000	86000																								
>C7 to C8 Aromatic	mg/kg	0.05	56000	100000	180000		*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
>C8 to C10 Aromatic	mg/kg	2	5000	9300	17000		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C10 to C12 Aromatic	mg/kg	2	5000	10000	34000		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C12 to C16 Aromatic	mg/kg	2	5000	10000	38000		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C16 to C21 Aromatic	mg/kg	3	3800	7800	28000		*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	6	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
>C21 to C35 Aromatic	mg/kg	10	3800	7900	28000		*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
>C35 to C44 Aromatic	mg/kg		3800	7900	28000																								
Total Aromatic C5-C35	mg/kg	21	-	-	-		*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*
TPH Ali/Aro	mg/kg	42	-	-	-		*42*	48	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	349	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*
EPH (C10-C40)	mg/kg		-	-	-																								
Hazard Index - POSresi	-	-	-	-	-		0.0052	0.0054	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0117	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052
Hazard Index - POSpark	-	-	-	-	-		0.0026	0.0027	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0058	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026
Hazard Index - Commercial	-	-	-	-	-		0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0019	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Benzene*	mg/kg	0.002	140	230	98		*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Ethylbenzene	mg/kg	0.002	25000	27000	27000		*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Toluene	mg/kg	0.005	56000	100000	180000		*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
Xylene	mg/kg		43000	33000	33000																								
M- & P- Xylene	mg/kg	0.002	-	-	-		*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
O-Xylene	mg/kg	0.002	-	-	-		*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Total Xylene (M, P & O)	mg/kg	0.004	43000	33000	33000		*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*
MTBE	mg/kg		-	-	-																								
naphthalene	mg/kg	0.1	4900	3000	1100		*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
acenaphthylene	mg/kg	0.1	15000	30000	100000		*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
acenaphthene	mg/kg	0.1	15000	30000	100000		*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
fluorene	mg/kg	0.1	9900	20000	71000		*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
phenanthrene	mg/kg	0.1	3100	6300	23000		*0.1*	0.46	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
anthracene	mg/kg	0.1	74000	150000	540000		*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
fluoranthene	mg/kg	0.1	3100	6400	23000		*0.1*	0.62	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.22	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
pyrene	mg/kg	0.1	7400	15000	54000		*0.1*	0.46	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.17	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(a)anthracene	mg/kg	0.1	29	62	180		*0.1*	0.45	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
chrysene	mg/kg	0.1	57	120	350		*0.1*	0.16	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(b)fluoranthene	mg/kg	0.1	7.2	16	45		*0.1*	0.46	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.21	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(k)fluoranthene	mg/kg	0.1	190	440	1200		*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(a)pyrene	mg/kg	0.1	5.7	13	36		*0.1*	0.18	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.13	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
indeno(1,2,3-c,d)pyrene	mg/kg	0.1	82	180	510		*0.1*	0.25	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
dibenzo(ah)anthracene	mg/kg	0.1	0.58	1.4	3.6		*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(g,h,i)perylene	mg/kg	0.1	640	1600	4000		*0.1*	0.15	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Total PAH	mg/kg		-	-	-																								
Coal Tar (Bap as surrogate)*	mg/kg	0.1	10	21	77		*0.1*	0.18	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.13	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
PCB (as Aroclors)	mg/kg	0.1	-	-	-		*0.1*	*0.1*	*0.1*	*0.1*		*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*									
1,2 Dichloroethane	mg/kg		1400	2300	1100																								
1,1,1 Trichloroethane (TCA)	mg/kg		140000	100000	3000																								
1,1,1,2 Tetrachloroethane	mg/kg		1400	2100	560																								
1,1,2,2 Tetrachloroethane	mg/kg		1400	2300	1100																								
Tetrachloroethene (PCE)	mg/kg		1400	1500	95																								
Carbon Tetrachloride	mg/kg		950	400	14																								
Trichloroethene (TCE)	mg/kg		120	120	5.7																								
Trichloromethane (Chloroform)	mg/kg		2500	3100	350																								
Vinyl Chloride (Chloroethene)	mg/kg		3.5	5.4	0.12																								
Asbestos (Presence of)	TEXT		-	-	-		Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
Asbestos Analysts Comments	TEXT		-	-	-																								
Asbestos Fibre Count	%																												

* Category 4 Screening Value @ 6% SOM

TABLE SUMMARISING SOIL RESULTS AND HIGHLIGHTING EXCEEDANCES ABOVE SOIL ASSESSMENT CRITERIA
M3 JUNCTION 9 IMPROVEMENTS

SOM 6%			Assessment Criteria		Strata	SECK	SECK	SECK	MG	SECK	MG	SECK	HDD	SECK	SECK	SECK	HDD	SECK	SECK	SECK	SECK	SECK	MG	MG	MG	MG	ALVg	ALVg
						TP04	TP05	TP05	TP06	TP06	TP07	TP07	TP08	TP08	TP08	TP09	TP10	TP10	TP11	TP11	TP12	TP12	WS01	WS01	WS01	WS02	WS02	WS02
Analyte	**Units**	**LOD**	**POSresi**	**POSpark**	**Commercial**	1	0.5	2	0.25	3	0.25	1	0.3	1	3	3	0.5	3	0.3	3	1	4	0.25	0.5	4.7	0.5	2.55	4.8
Stones Content	%		-	-	-																							
Arsenic*	mg/kg	2	79	170	640	*2*	*2*	*2*	4	*2*	*2*	*2*	4	*2*	*2*	*2*	4	*2*	3	*2*	*2*	*2*	6	*2*	*2*	3	7	3
Cadmium*	mg/kg	0.2	220	880	410	0.4	0.4	0.3	0.8	0.3	*0.2*	0.3	0.9	0.4	*0.2*	*0.2*	0.5	*0.2*	0.5	*0.2*	*0.2*	0.3	0.5	*0.2*	*0.2*	*0.2*	*0.2*	1.3
Chromium Trivalent	mg/kg		1500	33000	8600																							
Chromium Hexavalent*	mg/kg	2	21	250	49	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
Copper	mg/kg	4	12000	44000	68000	10	7	6	12	8	*4*	8	13	9	*4*	10	11	8	9	8	11	8	17	9	9	10	*4*	*4*
Lead*	mg/kg	3	630	1300	2300	*3*	*3*	*3*	19	*3*	*3*	*3*	15	*3*	*3*	*3*	13	*3*	5	*3*	*3*	*3*	53	8	11	4	8	*3*
Mercury	mg/kg	1	120	240	1100	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
Nickel	mg/kg	3	230	800	980	*3*	*3*	*3*	5	*3*	*3*	*3*	8	*3*	*3*	*3*	7	*3*	5	*3*	*3*	*3*	6	*3*	*3*	4	*3*	9
Selenium	mg/kg	3	1100	1800	12000	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
Zinc	mg/kg	3	81000	170000	730000	11	11	10	34	8	*3*	9	48	12	7	10	29	8	19	9	11	10	52	15	15	16	8	11
Beryllium	mg/kg	0.5	2.2	63	12	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*
Boron	mg/kg	1	21000	46000	240000	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
Vanadium	mg/kg	2	2000	5000	9000	3	*2*	3	12	*2*	*2*	*2*	15	3	*2*	3	12	*2*	8	*2*	*2*	*2*	10	3	*2*	6	9	6
Cyanide (Total)	mg/kg	2	-	-	-	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
Organic matter	mg/kg		-	-	-																							
Phenol, Total	mg/kg		1300	1300	1300																							
Sulphate (Total) as SO4	mg/l	0.02	-	-	-	0.05	0.04	0.05	0.1	0.04	0.12	0.04	0.16	0.05	0.02	0.05	0.07	0.05	0.06	0.05	0.06	0.04	0.06	0.04	0.06	0.04	0.02	0.03
pH	pH Units		-	-	-	8	8.3	8.2	6.8	7.4	7.3	7.5	7.4	7.3	7.3	7.3	7.3	7.4	7.3	7.4	7.3	7.3	8.1	8.5	8.6	7.1	7.2	8
>C5 to C6 Aliphatic	mg/kg	0.01	600000	180000	12000	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*
>C6 to C8 Aliphatic	mg/kg	0.05	620000	320000	40000	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
>C8 to C10 Aliphatic	mg/kg	2	13000	21000	11000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C10 to C12 Aliphatic	mg/kg	2	13000	24000	47000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C12 to C16 Aliphatic	mg/kg	3	13000	26000	90000	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*7*	*3*	*3*	*3*	*3*	*3*
>C16 to C21 Aliphatic	mg/kg	3	-	-	-	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
>C21 to C35 Aliphatic	mg/kg	10	-	-	-	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	57	*10*	*10*	*10*	*10*	*10*
>C16 to C35 Aliphatic	mg/kg	13	250000	490000	1800000	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	60	*13*	*13*	*13*	*13*	*13*
>C35 to C44 Aliphatic	mg/kg		250000	490000	1800000																							
Total Aliphatic C5-C35	mg/kg	21	-	-	-	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	63	*21*	*21*	*21*	*21*	*21*
>C5 to C7 Aromatic	mg/kg		56000	92000	86000																							
>C7 to C8 Aromatic	mg/kg	0.05	56000	100000	180000	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
>C8 to C10 Aromatic	mg/kg	2	5000	9300	17000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C10 to C12 Aromatic	mg/kg	2	5000	10000	34000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C12 to C16 Aromatic	mg/kg	2	5000	10000	38000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	8	*2*	*2*	*2*	*2*	*2*
>C16 to C21 Aromatic	mg/kg	3	3800	7800	28000	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	14	*3*	*3*	*3*	*3*	*3*
>C21 to C35 Aromatic	mg/kg	10	3800	7900	28000	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	141	*10*	*10*	*10*	*10*	*10*
>C35 to C44 Aromatic	mg/kg		3800	7900	28000																							
Total Aromatic C5-C35	mg/kg	21	-	-	-	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	163	*21*	*21*	*21*	*21*	*21*
TPH Ali/Aro	mg/kg	42	-	-	-	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	226	*42*	*42*	*42*	*42*	*42*
EPH (C10-C40)	mg/kg		-	-	-																							
Hazard Index - POSresi	-	-	-	-	-	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0443	0.0052	0.0052	0.0052	0.0052	0.0052
Hazard Index - POSpark	-	-	-	-	-	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0214	0.0026	0.0026	0.0026	0.0026	0.0026
Hazard Index - Commercial	-	-	-	-	-	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0063	0.0010	0.0010	0.0010	0.0010	0.0010
Benzene*	mg/kg	0.002	140	230	98	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Ethylbenzene	mg/kg	0.002	25000	27000	27000	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Toluene	mg/kg	0.005	56000	100000	180000	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
Xylene	mg/kg		43000	33000	33000																							
M- & P- Xylene	mg/kg	0.002	-	-	-	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
O-Xylene	mg/kg	0.002	-	-	-	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Total Xylene (M, P & O)	mg/kg	0.004	43000	33000	33000	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*
MTBE	mg/kg		-	-	-																							
naphthalene	mg/kg	0.1	4900	3000	1100	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
acenaphthylene	mg/kg	0.1	15000	30000	100000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
acenaphthene	mg/kg	0.1	15000	30000	100000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
fluorene	mg/kg	0.1	9900	20000	71000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
phenanthrene	mg/kg	0.1	3100	6300	23000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.27	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
anthracene	mg/kg	0.1	74000	150000	540000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
fluoranthene	mg/kg	0.1	3100	6400	23000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.12	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.85	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
pyrene	mg/kg	0.1	7400	15000	54000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.84	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(a)anthracene	mg/kg	0.1	29	62	180	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.58	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
chrysene	mg/kg	0.1	57	120	350	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.55	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(b)fluoranthene	mg/kg	0.1	7.2	16	45	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.21	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.62	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(k)fluoranthene	mg/kg	0.1	190	440	1200	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.19	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(a)pyrene	mg/kg	0.1	5.7	13	36	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.48	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
indeno(1,2,3-c,d)pyrene	mg/kg	0.1	82	180	510	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.29	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
dibenzo(ah)anthracene	mg/kg	0.1	0.58	1.4	3.6	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(g,h,i)perylene	mg/kg	0.1	640	1600	4000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.41	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Total PAH	mg/kg		-	-	-																							
Coal Tar (Bap as surrogate)*	mg/kg	0.1	10	21	77	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.48	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
PCB (as Aroclors)	mg/kg	0.1	-	-	-	*0.1*	*0.1*				*0.1*	*0.1*				*0.1*							*0.1*	*0.1*		*0.1*		
1,2 Dichloroethane	mg/kg		1400	2300	1100																							
1,1,1 Trichloroethane (TCA)	mg/kg		140000	100000	3000																							
1,1,1,2 Tetrachloroethane	mg/kg		1400	2100	560																							
1,1,2,2 Tetrachloroethane	mg/kg		1400	2300	1100																							
Tetrachloroethene (PCE)	mg/kg		1400	1500	95																							
Carbon Tetrachloride	mg/kg		950	400	14																							
Trichloroethene (TCE)	mg/kg		120	120	5.7																							
Trichloromethane (Chloroform)	mg/kg		2500	3100	350																							
Vinyl Chloride (Chloroethene)	mg/kg		3.5	5.4	0.12																							
Asbestos (Presence of)	TEXT		-	-	-	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
Asbestos Analysts Comments	TEXT		-	-	-																							
Asbestos Fibre Count	%																											

* Category 4 Screening Value @ 6% SOM

TABLE SUMMARISING SOIL RESULTS AND HIGHLIGHTING EXCEEDANCES ABOVE SOIL ASSESSMENT CRITERIA
M3 JUNCTION 9 IMPROVEMENTS

SOM 6%			Assessment Criteria		Strata	MG	PEAT	TS	SECK	SECK	HDD	SECK	MG	SECK	SECK	MG	SECK	MG	MG	HDD
						WS03	WS03	WS04	WS04	WS04	WS05	WS05	WS06	WS06	WS06	WS07	WS07	WS08	WS08	WS08
Analyte	**Units**	**LOD**	**POSresi**	**POSpark**	**Commercial**	**3.92**	**4.76**	**0.25**	**1.8**	**6.7**	**0.25**	**3**	**0.25**	**2**	**6**	**0.25**	**1**	**0.5**	**1.7**	**5.9**
Stones Content	%		-	-	-															
Arsenic*	mg/kg	2	79	170	640	5	5	6	*2*	*2*	6	*2*	5	*2*	*2*	3	*2*	7	*2*	4
Cadmium*	mg/kg	0.2	220	880	410	0.4	0.4	0.9	0.4	0.3	0.8	0.4	0.8	0.4	0.3	0.6	0.5	0.5	*0.2*	0.4
Chromium Trivalent	mg/kg		1500	33000	8600															
Chromium Hexavalent*	mg/kg	2	21	250	49	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
Copper	mg/kg	4	12000	44000	68000	11	24	17	8	8	20	8	14	9	8	15	8	20	10	8
Lead*	mg/kg	3	630	1300	2300	21	*3*	47	*3*	*3*	49	*3*	29	*3*	*3*	26	6	61	*3*	4
Mercury	mg/kg	1	120	240	1100	1.2	2.9	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
Nickel	mg/kg	3	230	800	980	7	34	9	*3*	*3*	8	*3*	7	*3*	*3*	4	*3*	8	*3*	6
Selenium	mg/kg	3	1100	1800	12000	*3*	13.6	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
Zinc	mg/kg	3	81000	170000	730000	31	29	59	10	9	57	10	48	10	9	52	17	60	12	15
Beryllium	mg/kg	0.5	2.2	63	12	*0.5*	*0.5*	0.6	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*
Boron	mg/kg	1	21000	46000	240000	4	1.5	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
Vanadium	mg/kg	2	2000	5000	9000	8	17	20	*2*	*2*	18	*2*	16	*2*	*2*	8	*2*	3	4	10
Cyanide (Total)	mg/kg	2	-	-	-	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
Organic matter	mg/kg		-	-	-															
Phenol, Total	mg/kg		1300	1300	1300															
Sulphate (Total) as SO4	mg/l	0.02	-	-	-	0.18	0.22	0.09	0.05	0.04	0.1	0.05	0.09	0.04	0.04	0.06	0.05	0.06	0.05	0.05
pH	pH Units		-	-	-	7.4	7.1	7.4	7.8	7.8	7.8	7.9	7.5	7.7	7.7	8	8.2	8	7.8	8
>C5 to C6 Aliphatic	mg/kg	0.01	600000	180000	12000	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*
>C6 to C8 Aliphatic	mg/kg	0.05	620000	320000	40000	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
>C8 to C10 Aliphatic	mg/kg	2	13000	21000	11000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C10 to C12 Aliphatic	mg/kg	2	13000	24000	47000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C12 to C16 Aliphatic	mg/kg	3	13000	26000	90000	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
>C16 to C21 Aliphatic	mg/kg	3	-	-	-	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
>C21 to C35 Aliphatic	mg/kg	10	-	-	-	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
>C16 to C35 Aliphatic	mg/kg	13	250000	490000	1800000	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*	*13*
>C35 to C44 Aliphatic	mg/kg		250000	490000	1800000															
Total Aliphatic C5-C35	mg/kg	21	-	-	-	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*
>C5 to C7 Aromatic	mg/kg		56000	92000	86000															
>C7 to C8 Aromatic	mg/kg	0.05	56000	100000	180000	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
>C8 to C10 Aromatic	mg/kg	2	5000	9300	17000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
>C10 to C12 Aromatic	mg/kg	2	5000	10000	34000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	5	*2*	*2*	*2*	*2*	*2*
>C12 to C16 Aromatic	mg/kg	2	5000	10000	38000	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	9	*2*	*2*	*2*	*2*	*2*
>C16 to C21 Aromatic	mg/kg	3	3800	7800	28000	16	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
>C21 to C35 Aromatic	mg/kg	10	3800	7900	28000	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
>C35 to C44 Aromatic	mg/kg		3800	7900	28000															
Total Aromatic C5-C35	mg/kg	21	-	-	-	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*
TPH Ali/Aro	mg/kg	42	-	-	-	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*	*42*
EPH (C10-C40)	mg/kg		-	-	-															
Hazard Index - POSresi	-	-	-	-	-	0.0086	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0072	0.0052	0.0052	0.0052	0.0052	0.0052
Hazard Index - POSpark	-	-	-	-	-	0.0043	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0036	0.0026	0.0026	0.0026	0.0026	0.0026
Hazard Index - Commercial	-	-	-	-	-	0.0014	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0012	0.0010	0.0010	0.0010	0.0010	0.0010
Benzene*	mg/kg	0.002	140	230	98	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Ethylbenzene	mg/kg	0.002	25000	27000	27000	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Toluene	mg/kg	0.005	56000	100000	180000	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
Xylene	mg/kg		43000	33000	33000															
M- & P- Xylene	mg/kg	0.002	-	-	-	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
O-Xylene	mg/kg	0.002	-	-	-	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Total Xylene (M, P & O)	mg/kg	0.004	43000	33000	33000	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*
MTBE	mg/kg		-	-	-															
naphthalene	mg/kg	0.1	4900	3000	1100	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
acenaphthylene	mg/kg	0.1	15000	30000	100000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
acenaphthene	mg/kg	0.1	15000	30000	100000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
fluorene	mg/kg	0.1	9900	20000	71000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
phenanthrene	mg/kg	0.1	3100	6300	23000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.2	*0.1*	*0.1*
anthracene	mg/kg	0.1	74000	150000	540000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
fluoranthene	mg/kg	0.1	3100	6400	23000	0.33	*0.1*	0.36	*0.1*	*0.1*	0.28	*0.1*	0.16	*0.1*	*0.1*	*0.1*	*0.1*	0.58	*0.1*	*0.1*
pyrene	mg/kg	0.1	7400	15000	54000	0.29	*0.1*	0.31	*0.1*	*0.1*	0.24	*0.1*	0.14	*0.1*	*0.1*	*0.1*	*0.1*	0.5	*0.1*	*0.1*
benzo(a)anthracene	mg/kg	0.1	29	62	180	0.4	*0.1*	0.42	*0.1*	*0.1*	0.44	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.48	*0.1*	*0.1*
chrysene	mg/kg	0.1	57	120	350	*0.1*	*0.1*	0.12	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.28	*0.1*	*0.1*
benzo(b)fluoranthene	mg/kg	0.1	7.2	16	45	0.32	*0.1*	0.49	*0.1*	*0.1*	0.5	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.52	*0.1*	*0.1*
benzo(k)fluoranthene	mg/kg	0.1	190	440	1200	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.18	*0.1*	*0.1*
benzo(a)pyrene	mg/kg	0.1	5.7	13	36	*0.1*	*0.1*	0.19	*0.1*	*0.1*	0.24	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.38	*0.1*	*0.1*
indeno(1,2,3-c,d)pyrene	mg/kg	0.1	82	180	510	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.3	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.46	*0.1*	*0.1*
dibenzo(ah)anthracene	mg/kg	0.1	0.58	1.4	3.6	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
benzo(g,h,i)perylene	mg/kg	0.1	640	1600	4000	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.17	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.33	*0.1*	*0.1*
Total PAH	mg/kg		-	-	-															
Coal Tar (Bap as surrogate)*	mg/kg	0.1	10	21	77	*0.1*	*0.1*	0.19	*0.1*	*0.1*	0.24	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.38	*0.1*	*0.1*
PCB (as Aroclors)	mg/kg	0.1	-	-	-	*0.1*			*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*			*0.1*		
1,2 Dichloroethane	mg/kg		1400	2300	1100															
1,1,1 Trichloroethane (TCA)	mg/kg		140000	100000	3000															
1,1,1,2 Tetrachloroethane	mg/kg		1400	2100	560															
1,1,2,2 Tetrachloroethane	mg/kg		1400	2300	1100															
Tetrachloroethene (PCE)	mg/kg		1400	1500	95															
Carbon Tetrachloride	mg/kg		950	400	14															
Trichloroethene (TCE)	mg/kg		120	120	5.7															
Trichloromethane (Chloroform)	mg/kg		2500	3100	350															
Vinyl Chloride (Chloroethene)	mg/kg		3.5	5.4	0.12															
Asbestos (Presence of)	TEXT		-	-	-	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
Asbestos Analysts Comments	TEXT		-	-	-															
Asbestos Fibre Count	%																			

* Category 4 Screening Value @ 6% SOM

Appendix D Controlled Water Risk Assessment

TECHNICAL NOTE

Job Name: M3 Junction 9 Improvements

Job No: 48176/3501

Doc Ref: HE551511-VFK-EGT-X_XXXX_XX-TN-GE-003

Date: December 2020

Prepared By: Natasha Caton

Reviewed By: Kate Riley

Subject: **Controlled Waters Risk Assessment**

1 Introduction

1.1 Preamble

1.1.1 Stantec UK Limited (Stantec) has been commissioned by VolkerFitzpatrick Limited and Highways England (the Client) to undertake a Controlled Waters Risk Assessment for the M3 Junction 9 Improvement Site, Winchester, based on the factual findings of the Factual Ground Investigation Report (HE551511-HEX-EGT-ZZ-RP-CE-0001) (Soils Limited, August 2019, amended July 2020)

1.1.2 This Technical Note has been written to accompany the Phase 2 Ground Investigation Report undertaken by Stantec (December 2020b) which contains information on the ground conditions. The Ground Investigation specification was prepared by Jacobs and the field data and laboratory analysis was undertaken by the Principal Contractor, Geoffrey Osborne Limited, who employed the ground investigation contractor Soils Limited.

1.1.3 This Technical Note presents a Stage 1, Tier 2 Generic Qualitative Risk Assessment (GQRA) in respect to Controlled Waters receptors and has also been prepared to support the Development Consent Order (DCO) application. An explanation of the staged risk management approach is presented in Section 4 of this Technical Note.

1.2 Sources of Information

1.2.1 The following sources of information were used in the preparation of this technical note and should be read in conjunction with this technical note:

- Factual Ground Investigation Report (HE551511-HEX-EGT-ZZ-RP-CE-0001) (Soils Limited, August 2019, amended July 2020)
- PCF Stage 2 – Preliminary Sources Study Report (HE551511-WSP-HGT-ZZ-RP-CE-0001) (WSP, September 2017)
- Preliminary Environmental Information Report (PEIR) (GFD19_0101_M3 Junction 9) (Jacobs, June 2019)
- Project Control Framework (PCF) Stage 2 – Preliminary Sources Study Report (HE551511-WSP-HGT-ZZ-RP-CE-0001) (WSP, September 2017)
- PCF Stage 3B: Phase 1 Ground Condition Assessment (Contamination and Stability for Proposed Deposition and Compound Areas (HE551511-VFK-EGT-X_XXXX_XX-RP-GE-0001) (Stantec, December 2020a)
- PCF Stage 3B: Ground Investigation Report (HE552988-VFK-HGT-X_XXXX_XX-RP-CE-0001) (Stantec, December 2020b)

2 Site Setting

2.1 Geology & Ground Conditions

2.1.1 The anticipated ground conditions within the M3 J9 Improvement Site have been determined through review of the published geological mapping and intrusive information contained within both the Factual Ground Investigation Report (Soils Limited, 2020) and the Ground Investigation Report (Stantec, 2020b).

Published Geology

2.1.2 The published BGS geological mapping indicates that the majority of the M3 J9 Improvement Site is underlain by solid geology comprising the Seaford Chalk formation, with the overlying Newhaven Chalk only present in the area to the east of the M3, in the northern part of the study area. The Seaford Chalk formation is underlain by the Lewes Nodular Chalk formation, and in the southern extent of the Site, the Lewes Nodular Chalk is indicated to outcrop at the ground surface.

2.1.3 Along the route of the River Itchen, which traverses the northern part of the M3 J9 Improvement Site, the solid geology is overlain by superficial deposits comprising Alluvium. There are also smaller transects of superficial deposits, comprising Head, overlying the solid geology, located to the north and to the south of the existing junction, and in the northern parts of the Site.

2.1.4 In the area to the east of the M3 and to the south of the River Itchen, the geological mapping also indicates there may be an area of Clay with Flints and Head deposits overlying the Newhaven Chalk Formation (which overlies the Seaford Chalk Formation where present).

Encountered Ground Conditions

2.1.5 A Phase 2 geotechnical and geo-environmental ground investigation was undertaken across parts of the M3 J9 Improvement Site between March 2019 and June 2019. The information from the investigation generally confirms the anticipated/published ground conditions. Further details can be found within the Ground Investigation Report (Stantec, 2020b).

2.1.6 In addition to the published geology described above, made ground and engineered fill is also present within the Site, associated with the construction of the M3, A34, A33 and other infrastructure. The made ground and engineering fill material predominantly comprises reworked natural strata with lenses of organic soil and extends to a maximum of 11.35m below ground level.

2.1.7 The Ground Investigation Report did not identify any evidence of contamination or exceedances of the relevant assessment criteria within the soil results.

2.2 Historical Land Use

2.2.1 The historical land use (relevant to the potential for contamination) has previously been determined and presented in the Preliminary Sources Study Report (PSSR) (WSP, 2017), and Phase 1 Desk Study (Stantec, 2020a) respectively. These are based on historical Ordnance Survey maps obtained as part of an Envirocheck Report. In summary, the area of the current M3 J9 roundabout and its immediate surroundings remained undeveloped until the construction of the A33 in the late 1930's and later, in the early 1980's, when J9 of the M3 is shown to have been constructed. The Didcot, Newbury and Southampton railway line is indicated to have been constructed in the late 1890's 200m to the west of the Site, along the eastern bank of the River Itchen, crossing the northern section of the Site. The railway line remained until the 1960's when it was dismantled. In the wider area there have been various industrial uses such as iron and gas works, although these sites have since been redeveloped and are outside of the proposed works.

2.2.2 A review of available other published information has identified records for three historical landfills or close to the Site. These are located beneath the existing M3 J9 roundabout (Spitfire Link), on the western side of the A34 at the northern tip of Wykeham Industrial Estate (land between Old Newbury Railway and A33) and between the A34/A33 and M3 carriageways, south of the River Itchen (land adjacent to Winchester Bypass). Further commentary is given below:

- The 'Spitfire Link, Easton Lane' landfill was investigated in part by Soils Limited (2020) with six exploratory holes undertaken within or immediately adjacent to the mapped extents of the landfill. No evidence of waste or Made Ground was indicated on those exploratory hole records. It is considered unlikely that the landfill therefore represents a source of significant contamination.

- The 'Land Adjacent to Winchester Bypass, Abbots Worth, Hampshire' landfill is recorded as accepting inert waste from 1967 through to 1968. The licence holder is listed as D Hewestson-Brown. The recorded operational period broadly corresponds with the widening of the Winchester Bypass and construction of a gantry crossing the River Itchen. It is considered that the landfill may therefore have been used to accept earthworks arisings from that scheme and is therefore unlikely to represent a source of significant contamination.

- The third landfill 'Land Between Old Newbury Railway and A33' is located to the west of Winchester bypass and is very small therefore unlikely to have operated commercially and therefore unlikely to represent a significant risk.

2.2.3 Based on the information above the risk from the historical landfills to the M3 J9 Improvement Site is considered to be Low.

2.2.4 Contrary to the 'published information' outlined above, a review of the available historical OS mapping and investigations to date have not specifically identified the presence of infilled workings/landfills.

2.3 Current Land Use

2.3.1 The majority of the M3 J9 Improvement Site comprises the carriageways of the M3, A33 and A34. In the area to the east of the M3, the land use is predominantly agricultural.

2.3.2 In the areas to the west of the A34, the land use is predominantly highway land or undeveloped land adjacent to the highway. However, in the wider Site, the land use is varied including flood plain, residential and mixed use industrial.

2.3.3 In the northern part of the M3 J9 Improvement Site, the predominant current land use is mixed, comprising residential, agricultural and flood plain.

3 Hydrological and Hydrogeological Conceptual Site Model

3.1 Introduction

3.1.1 The conceptual site model (CSM) describes the types and locations of potential contamination sources, the identification of potential receptors and the identification of potential transport/migration pathways.

3.1.2 For a pollutant linkage to be identified a connection between all three elements (source-pathway-receptor) is required. An assessment of the hydrogeological conceptual site model (CSM) has been undertaken and draws on the information from a ground investigation by Soils Limited which took place between March and June 2019.

3.1.3 It should be noted that this CSM only addresses risks to controlled waters; assessment of risks to human health and other receptors is presented within the Phase 2 Ground Investigation Report (Stantec, 2020b). A full description of the environmental setting of the M3 J9 Improvement Site, including the geology, hydrology and hydrogeology is contained within the Phase 1 Ground Condition Assessment (Stantec, 2020a) and Ground Investigation Report (Stantec, 2020b), together with supporting documents.

3.2 Sources

3.2.1 The potentially contaminative land uses and contaminants of concern based on the current and historical land uses are presented in **Table 3.1**.

Table 3-1 Potentially Contaminative Land Uses and Contaminants of Concern

Land Use	Potential Contaminants of Concern
Motorway/'A' Road	Metals and metalloids, chloride, polycyclic aromatic hydrocarbons (PAHs), oil/fuel hydrocarbons, sulphates, asbestos.
Historical Landfill	Metals and metalloids, PAHs), oil/fuel hydrocarbons, sulphates, asbestos, landfill gas, leachate, acids, ammonia.
Historical Railway Line	Metals and metalloids, PAHs, oil/fuel hydrocarbons, lubricating oils, creosotes, sulphates.
Agricultural Land	Hydrocarbons and lubricating oils associated with machinery and nitrates from fertilisers. Potential pesticides and herbicides.
Gas Works	Metals and metalloids, inorganic compounds, coal tars, PAHs, oil/fuel hydrocarbons, acids, alkalis.
Iron Works	Metals and metalloids, inorganic compounds, Polychlorinated Biphenyls (PCBs)
Mixed Industrial Use	Metals and organo-metals, PAHs, oil/fuel hydrocarbons, sulphates, asbestos, PFAS.

3.3 Receptors

3.3.1 The nearest surface water receptor is the River Itchen, which is present across the north and along the west of the M3 J9 Improvement Site. The River Itchen flows to the south towards Southampton and is designated a Site of Special Scientific Interest (SSSI) and a Special Area of Conservation (SAC). A further surface water feature and receptor, 'Nun's Walk Stream' flows in a channel approximately parallel to the River Itchen and is classified by the EA as a Main River.

3.3.2 The Seaford Chalk Formation which is beneath the entire M3 J9 Improvement Site is designated as a Principal Aquifer, and the overlying superficial deposits are designated as Secondary Aquifers, the Alluvium as a Secondary A Aquifer, and the Head as a Secondary (undifferentiated) Aquifer which are beneath only parts of the Site. It is also considered that the aquifers are in hydraulic continuity. These designations reflect the importance of the aquifers in terms of groundwater as a resource (drinking water supply) but also their role in supporting surface water flows and wetland ecosystems.

3.3.3 Parts of the study area in the north are covered by both Zones 1 and 2 groundwater Source Protection Zones (SPZs) which are associated with two abstraction points for potable drinking

supply located in the north of the Site. These drinking water supplies are both abstracted from the Chalk. The Secondary A aquifer is also believed to be in continuity with the Principal aquifer.

3.3.4 The sensitivity of the receptors is detailed in **Table 3.2** below:

Table 3-3 Controlled Water Receptor Sensitivity

Receptor	Sensitivity
Groundwater	Very High
Surface Waters	Very High

3.4 Pathways

3.4.1 The leaching and vertical and lateral migration of dissolved phase contaminants to the surrounding and underlying Principal aquifer and River Itchen is considered a viable pathway. Infill material and superficial deposits across the M3 J9 Improvement Site may dependant on their precise nature and form also act as a preferential pathway to the Principal Aquifer and hence groundwater.

3.4.2 There is also the potential for runoff from roads and agricultural land to affect the River Itchen and groundwater, via either permeation into the underlying soils, and runoff, or as a result of surface water drainage discharges to water bodies.

3.5 Potential Pollutant Linkages

3.5.1 The preliminary Conceptual Model, as discussed above and also presented within the Ground Investigation Report (Stantec, 2020b) identified potential impacts to controlled waters receptors, including the underlying Secondary A aquifer within superficial deposits and Principal aquifer within the Seaford Chalk Formation and nearby surface water courses.

4 Generic Qualitative Risk Assessment (GQRA)

4.1 Introduction

4.1.1 Online guidance entitled Land Contamination: Risk Management (LC:RM) from GOV.UK states that to manage existing (historical) contamination it is necessary to identify and assess the level of risk, decide if that risk is unacceptable to identified receptor(s) and decide how to manage any unacceptable risks. Further information on the assessment of land contamination is given in the Stantec guide presented in **Appendix CWRA 1.**

4.1.2 LC:RM presents three stages of risk management (1) Stage 1: Risk assessment (2) Stage 2: Options appraisal and (3) Stage 3: Remediation and each stage has three tiers.

4.1.3 The progressive tiers of a Stage 1 Risk Assessment are:

- Tier 1 Preliminary (qualitative) Risk Assessment (PRA): containing generic factual information with the assessed risks informed by professional judgement.
- Tier 2 Generic Quantitative Risk Assessment (GQRA): which uses site specific factual data from intrusive investigations with the assessed risks stated with reasonable certainty, through to.
- Tier 3 Detailed Quantitative Risk Assessment (DQRA). providing numerical analysis of modelling of the aquifer properties and groundwater quality.

4.1.4 This technical note presents a Stage 1 Risk Assessment - Tier 2 GQRA and the evaluation of site-specific contamination data compared to published Generic Assessment Criteria (GAC).

4.1.5 Where the recorded concentration of a contaminant is below the GAC for the specified end use it is not deemed to be a hazard. Exceedance of the criterion indicates that the parameter is a potential hazard and the identified pollutant linkage may represent an unacceptable risk. The GQRA also determines whether further detailed assessment is required. In doing so, it confirms whether the potential contaminant linkages identified in the preliminary risk assessment are of concern or not.

4.2 Generic Assessment Criteria

4.2.1 The GAC that have been selected as appropriate to this Tier 2 controlled waters risk assessment are the UK Drinking Water Standards (DWS) (DETR,2000) on the basis that the groundwater is abstracted for potable supply, and also the Environmental Quality Standards (EQS) in accordance with the Water Framework Directive (WFD) (DEFRA,2010) for the protection of surface waters and ecological systems that could be affected by baseflow from potentially contaminated groundwater.

4.2.2 Full details of the assessment criteria are given in the guidance note included in **Appendix CWRA 2.**

4.3 Assessment of Groundwater Results

4.3.1 Groundwater samples were recovered from eight boreholes DS110, DS112, DS114, DS203, DS213, DS216, DS301 and DS302 on two occasions as part of the ground investigation undertaken in 2019. A total of nine samples were submitted for each round for geoenvironmental laboratory testing, including two samples obtained within DS110 at 12m and 29.5m below ground level (bgl). At the current time, the results from only one of the monitoring rounds has been made available to Stantec. All of the monitoring installations were installed within the Seaford Chalk Formation.

4.3.2 Two of the sampling locations (DS110 and DS213) are located within the Junction 9 roundabout, a further four locations (DS216, DS302, DS114 and DS203) are located within the vicinity of the north bound on-slip and south bound off-slip roads of the M3 J9 with the final two locations (DS112 and DS301) positioned approximately 950m north of Junction 9. All of the locations are on the southern side of the River Itchen which flows towards the south.

4.3.3 Surface water samples were not taken during the ground investigation or in the subsequent sampling/monitoring.

4.3.4 The results of the analysis have been compared against the Environmental Quality Standards (EQS) for Freshwater to assess the potential to affect controlled waters as an ecological receptor and also compared with the Drinking Water Standard (DWS) assessment criteria. Summary tables of the results are presented in **Appendix CWRA 3**.

Potential to Affect Controlled Waters as an Ecological Receptor

4.3.5 Comparison of the geoenvironmental laboratory testing groundwater results with the EQS indicates the following exceedances:

- One exceedance of Copper in DS103 (9ug/l compared to an assessment criterion of 1ug/l)
- Two exceedances of Mercury within DS110 and DS203 respectively (0.24ug/l and 18.3ug/l compared to an assessment criterion of 0.07ug/l)

- One exceedance of Nickel within DS203 (68ug/l compared to an assessment criterion of 4ug/l)
- One exceedance of Zinc within DS203 (27ug/l compared to an assessment criterion of 10.9ug/l)

4.3.6 The laboratory limit of detection (LOD) for some metals is higher than the assessment criteria, and the following results were all recorded below the LOD.

- All of the groundwater samples tested for Cadmium, were below the LOD of 0.4ug/l, however this exceeds the GAC of 0.08ug/l.
- All the groundwater samples tested for Hexavalent Chromium were below the LOD of 20ug/l, however this exceeds the GAC of 3.4ug/l,
- Eight out of the nine samples tested for Copper were below the LOD of 5ug/l, however this exceeds the GAC of 1ug/l.
- All of the groundwater samples tested for Lead were below the LOD of 5ug/l, however this exceeds the GAC of 1.2ug/l.
- All of the groundwater samples tested for Cyanide were below the LOD of 5ug/l however this exceeds the GAC of 1ug/l.

4.3.7 The recorded exceedances of the EQS for Copper, Mercury, Nickel, Zinc, and the LOD exceedances of the EQS for Cadmium, Hexavalent Chromium, Lead and Cyanide are taken forward as potential hazards to controlled waters and discussed further in **Section 4.4**.

4.3.8 All recorded concentrations of TPHs and PAHs were below the laboratory LOD. The laboratory LOD was higher than the GAC for several of the PAHs (fluoranthene, benzo(a)pyrene and benzo(g,h,i)perylene) and therefore these are taken forward as a potential hazard to controlled waters and discussed further in **Section 4.4**.

4.3.9 It should be noted that taking forward the parameters where the concentrations were below the LOD but the LOD is above the GAC is a conservative approach.

Potential to Affect Controlled Waters as a Drinking Water Resource

4.3.10 Comparison of the geoenvironmental laboratory testing groundwater results with the Drinking Water Standards (DWS) indicates the following exceedances:

- One exceedance of Mercury within DS203 (18.3ug/l compared to a GAC of 1ug/l)
- One exceedance of Nickel within DS203 (68ug/l compared to a GAC of 20ug/l)
- Two exceedances of Nitrate as NO_3 within DS110 and DS216 respectively (56,000ug/l and 54,600ug/l compared to a GAC of 50,000ug/l)

4.3.11 Mercury, Nickel and Nitrate as NO_3 are taken forward as potential Controlled Waters hazards in the context of the groundwater as a drinking water resource and discussed further in **Section 4.4**.

4.4 Interpretation of Controlled Waters GQRA

Potential to Affect Controlled Waters as an Ecological Receptor

4.4.1 Where the laboratory limit of detection (LOD) for some parameters was above the assessment criteria in the previous monitoring, further sampling and testing could be undertaken in

laboratories able to achieve LODs below the specific assessment criteria. In this instance this would include testing for cadmium, hexavalent chromium, copper, lead and cyanide.

4.4.2 In some cases, the EQS is extremely low and the LOD of these compounds cannot be routinely achieved by commercial laboratories, therefore it is not pragmatic to recommend further testing for these compounds. These include fluoranthene, benzo(a)pyrene and benzo(g,h,i)perylene. Without a positive detection of any Polyaromatic Hydrocarbons or Total Petroleum Hydrocarbons within the groundwater results and evidence of only marginal exceedances of the LOD for these chemicals within soil results, (which are contained within the Ground Investigation Report (Stantec, 2020b)), it is considered that the ground conditions at the Site are not significantly adversely affecting the groundwater quality and PAHs as a potential controlled water hazard are not therefore considered further.

4.4.3 The EQS used as the GAC in the above assessment are not site-specific and consider a conservative scenario of high bioavailability, which is not applicable to all sites and depends on the local water quality. In order to consider the effect of site-specific conditions on metal bioavailability, the UK-TAG Metal Bioavailability Assessment tool (M-BAT) has been used.

4.4.4 The M-BAT tool uses water quality parameters to predict the potential risk posed by metals in the aquatic environment. It does this by calculating a 'predicted no effect concentration' (PNEC) which is considered to be a site-specific EQS, and the bioavailable fraction. Where measured concentrations of metals are used, the bioavailable concentration, (which is a comparison between the dissolved metal concentration and the bioavailable factor of the metal) and the Risk Characterisation ratio, (which indicates if the bioavailable concentration is above the EQS), are calculated.

4.4.5 The toxicity of metals is dependent on a range of water quality parameters such as pH, Calcium and Dissolved Organic Carbon (DOC). Where possible, these should be taken from the receiving water, in this case the River Itchen, but in the absence of surface water sampling data - the groundwater data has been used. The tool has been used to determine a PNEC for Copper, Zinc, Nickel and Lead.

4.4.6 The PNEC can be considered as a location specific EQS, to which the measured metal concentration can be compared. The calculated PNEC for each sample exceeding the EQS were:

- Copper in DS203 (9ug/l) the calculated PNEC for this location is 42.87ug/l with a bioavailable fraction of 2% and a bioavailable concentration of 0.12ug/l.
- Zinc in DS203 (27ug/l) the calculated PNEC for this location is 59.79ug/l with a bioavailable fraction of 18% and a bioavailable concentration of 4.94ug/l.
- Nickel in DS203 (68ug/l) the calculated PNEC for this location is 27.72ug/l with a bioavailable fraction of 14% and a bioavailable concentration of 9.81ug/l.

4.4.7 This indicates that the Zinc and Copper results that exceed the EQS do not exceed the location specific PNEC and therefore theses metals are not considered to be a risk to controlled waters as an ecological receptor in these circumstances. However, the single Nickel concentration in DS203 exceeds the location specific PNEC and therefore remains a potential risk to controlled waters.

4.4.8 The locations where Zinc, Copper, Nickel and Lead are below the LOD but exceed the EQS assessment criteria are not considered to pose a significant risk as the LODs, which were used in the calculation, are below the location specific PNECs calculated. The tables detailing the location specific PNECs are detailed within **Appendix CWRA 4**.

4.4.9 Exceedances of Mercury have also been detected within DS110 and DS203 along with the exceedance of the PNEC for Nickel within DS203 discussed above. These locations are within

or close to two of the historical landfills identified on or close to the Site. Whilst the historical landfills are not considered to represent a significant potential source of contamination, and the limited exceedances of the GACs are also not considered to represent a significant risk to controlled waters, further sampling and analysis is recommended to confirm this preliminary assessment.

Potential to Affect Controlled Waters as a Drinking Water Resource

4.4.10 The samples of groundwater were all obtained from within the Seaford Chalk Formation and therefore the samples are considered to be representative of the groundwater aquifer receptor which is abstracted as a potable source. Within the samples obtained, a number of exceedances of the Drinking Water Standards (DWS) were recorded within DS110, DS203 and DS216 for Mercury, Nickel and Nitrate as NO3 and therefore were taken forward as a potential hazard to controlled waters as a drinking water resource.

4.4.11 The locations of the boreholes where elevated Nitrate concentrations were recorded are on the east side of the Site within or adjacent to areas of agricultural land use and therefore the nitrate source is considered to be the agricultural use within the area.

4.4.12 The elevated concentrations of Mercury and Nickel were encountered in boreholes within or close to historical landfills and as described above (see 4.4.9), although a significant potential source of contamination or risk to controlled waters has not been identified. Furthermore, the results of the Mercury and Nickel within DS203 are vastly different from the results of the surrounding groundwater monitoring locations and it is considered that this could also be due to a sampling or laboratory error. which could be determined through additional sampling and testing. Further sampling and analysis is recommended to confirm this preliminary assessment.

5 Conclusions

5.1 Assessed Geoenvironmental Risk

5.1.1 This Tier 2 risk assessment builds on the information available from the Preliminary Tier 1 assessments. The methodology and criteria adopted by Stantec for the geoenvironmental risk assessment is presented in **Appendix CWRA 1.**

Controlled Waters as an Ecological Receptor

5.1.2 The data reviewed indicates that at the majority of locations, concentrations of the potential contaminants tested, are below the relevant assessment criteria. However, some laboratory limits of detection (LOD) were above the assessment criteria for cadmium, hexavalent chromium and cyanide. It is not considered that this represents a significant risk to controlled waters, and this preliminary assessment could be further supported through additional sampling and analysis – using LODs below the assessment criteria where commercially available, and the use of the UK-TAG Metal Bioavailability Assessment tool.

5.1.3 Nickel and Mercury were also identified above the assessment criteria in two specific locations; and whilst this is also not considered to represent a significant risk to controlled waters, further sampling and analysis is recommended to confirm this preliminary assessment and rule out previous sampling/testing errors. .

5.1.4 Based on the information available, the potential for significant contamination to be present is considered to be **Low.** The estimated risks to the sensitive receptors are summarised below:

Table 5-1 Estimated Risk to Sensitive Ecological Receptors

Receptor	Assessed Sensitivity	Estimated Risk
Groundwater	Very High	Low
Surface Water	Very High	Low

Controlled Waters as a Drinking Water Resource

5.1.5 The majority of the groundwater samples did not record any exceedances of the Drinking Water Standards (DWS), however exceedances were recorded within DS110, DS203 and DS216 for Mercury, Nickel and Nitrate as NO_3. The source of the Nitrate is likely to be off site agriculture and therefore unrelated to the Site. As described above (Section 5.1.3), whilst the Mercury and Nickel concentrations at these limited locations are not considered to represent a significant risk to controlled waters, further sampling and analysis is recommended.

5.1.6 Based on the information available, the potential for significant contamination to be present is considered to be **Low.** The estimated risks to the sensitive receptors are summarised below:

Table 5-2 Estimated Risk to Sensitive Receptors as a Drinking Water Resource

Receptor	Assessed Sensitivity	Estimated Risk
Groundwater	Very High	Low

5.2 Protection of Controlled Waters

5.2.1 Whilst it is acknowledged that the groundwater below the Site shows limited marginal exceedances of the relevant assessment criteria, a specific / significant source for these concentrations has not been recorded. The concentrations recorded represent background/baseline concentrations at the Site and therefore specific remediation/mitigation measures are not necessary.

5.2.2 It is not considered that the Site represents a significant risk to controlled waters however further sampling and analysis is recommended to augment the baseline.

5.3 Recommendations

5.3.1 On the basis of this Tier 2 Risk Assessment, it is not currently considered that a Tier 3 Detailed Risk Assessment is required, although further supplementary Tier 2 Risk Assessment is recommended following additional ground investigation and both groundwater and surface water sampling and laboratory analysis.

5.3.2 It is recommended that further monitoring wells are installed, and groundwater sampling is undertaken within the areas of suspected landfill, deeper Made Ground and within areas that have not been previously investigated, together with additional sampling of existing monitoring wells.

5.3.3 It is also recommended that surface water samples are taken from the River Itchen to determine the baseline conditions in the River, and this should include upstream and downstream samples.

5.4 Limitations

5.4.1 The groundwater monitoring wells, and groundwater samples were only targeted into the Seaford Chalk Formation and therefore no assessment has been undertaken on any perched water within the Made Ground or groundwater within the superficial deposits.

5.4.2 Only the first round of groundwater monitoring results were issued to Stantec for review and therefore our assessment if only based on a singular monitoring event.

5.4.3 The opinions and recommendations in this report are based on the information obtained from the PSSR and the ground investigation specified and carried out by others. Stantec can, therefore, only base any recommendations included in this report from the information provided within the Factual Ground Investigation Report (Soils, 2019).

5.4.4 The ground investigation undertaken was carried out within the Highways boundary and adjacent farmland, therefore there were some constraints locating the boreholes for the ground investigations due to extensive buried services and badger setts. The boundary has also changed since the original investigation and, therefore, certain areas of the extended boundary have not been investigated.

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Appendix CWRA 1 – Stantec Methodology

Stantec Guide: Methodology for Assessment of Land Contamination (England)

1 INTRODUCTION

This document defines the approach adopted by Stantec in relation to the assessment of land contamination in England. The aim is for the approach to (i) be systematic and objective, (ii) provide for the assessment of uncertainty and (iii) provide a rational, consistent, transparent framework.

When preparing our methodology, we have made reference to various technical guidance documents and legislation referenced in Section 7 of which the principal documents are (i) Contaminated Land Statutory Guidance (Defra 2012), (ii) online guidance Land Contamination: Risk Management (LC:RM) accessed from GOV.UK which is expected to replace Contaminated Land Research (CLR) Report 11: Model Procedures for the Management of Contamination (EA 2004). It should be noted that LCRM is currently due to be revised following consultation and CLR 11 is archived, (iii) Contaminated land risk assessment: A guide to good practice (C552) (CIRIA 2001) (iv) National Planning Policy Framework (NPPF, 2019) (v) BS 10175 Investigation of potentially contaminated sites - Code of Practice (BSI 2017) and (vi) The series of British Standards on Soil Quality BS 18400.

2 DEALING WITH LAND CONTAMINATION

Government policy on land contamination aims to prevent new contaminated land from being created and promotes a risk-based approach to addressing historical contamination. For historical contamination, regulatory intervention is held in reserve for land that meets the legal definition and cannot be dealt with through any other means, including through planning. Land is only considered to be "*contaminated land*" in the legal sense if it poses an unacceptable risk.

UK legislation on contaminated land is principally contained in Part 2A of the Environmental Protection Act, 1990 (which was inserted into the 1990 Act by section 57 of the Environment Act 1995). Part 2A was introduced in England on 1 April 2000 and provides a risk-based approach to the identification and remediation of land where contamination poses an unacceptable risk to human health or the environment.

The Model Procedures for the Management of Land Contamination (CLR 11), were developed to provide the technical framework for applying a risk management process when dealing with land affected by contamination. The process involves identifying, making decisions on, and taking appropriate action to deal with land contamination in a way that is consistent with government policies and legislation within the UK. The approach, concepts and principles for land contamination management promoted by LC:RM (and its predecessor CLR 11) are applied to the determination of planning applications. The guidance given in LC:RM follows the same principles.

Other legislative regimes may also provide a means of dealing with land contamination issues, such as the regimes for waste, water, environmental permitting, and environmental damage. Further, the law of statutory nuisance may result in contaminants being unacceptable to third parties whilst not attracting action under Part 2A or other environmental legislation.

2.1 Part 2A

The Regulations and Statutory Guidance that accompanied the Act, including the Contaminated Land (England) Regulations 2006, has been revised with the issue of The Contaminated Land (England) (Amendment) Regulations 2012 (SI 2012/263) and the Contaminated Land Statutory Guidance for England 2012.

Part 2A defines contaminated land as "*land which appears to the Local Authority in whose area it is situated to be in such a condition that, by reason of substances in, on or under the land that significant harm is being caused, or there is a significant possibility that such significant harm (SPOSH) could be caused, or significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution (SPOSP) being caused*".

Harm is defined as "*harm to the health of living organisms or other interference with the ecological systems of which they form part, and in the case of man, includes harm to his property*".

Part 2A provides a means of dealing with unacceptable risks posed by land contamination to human health and the environment, and under the guidance enforcing authorities should seek to find and deal with such land. It states that "*under Part 2A the starting point should be that land is not contaminated land unless there is reason to consider otherwise. Only land where unacceptable risks are clearly identified, after a risk assessment has been undertaken in accordance with the Guidance, should be considered as meeting the Part 2A definition of contaminated land*". Further, the guidance makes it clear that *"regulatory decisions should be based on what is reasonably likely, not what is hypothetically possible".*

The overarching objectives of the Government's policy on contaminated land and the Part 2A regime are:

"(a) To identify and remove unacceptable risks to human health and the environment.

(a) To seek to ensure that contaminated land is made suitable for its current use.

(b) To ensure that the burdens faced by individuals, companies and society as a whole are proportionate, manageable and compatible with the principles of

sustainable development".

The enforcing authority may need to decide whether and how to act in situations where decisions are not straight forward, and where there is uncertainty. "*In so doing, the authority should use its judgement to strike a reasonable balance between: (a) dealing with risks raised by contaminants in land and the benefits of remediating land to remove or reduce those risks; and (b) the potential impacts of regulatory intervention including financial costs to whoever will pay for remediation, health and environmental impacts of taking action, property blight, and burdens on affected people".*

The authority is required to "*take a precautionary approach to the risks raised by contamination, whilst avoiding a disproportionate approach given the circumstances of each case".* The aim is "*that the regime produces net benefits, taking account of local circumstances*".

The guidance recognises that *"normal levels of contaminants in soils should not be considered to cause land to qualify as contaminated land, unless there is a particular reason to consider otherwise".* Normal levels are quoted as:

"a) *natural presence of contaminants'* such as from underlying geology *'that have not been shown to pose an unacceptable risk to health and the environment*

b) *…low level diffuse pollution, and common human activity…"*

Similarly the guidance states that significant pollution or significant possibility of significant pollution of controlled waters is required for land to be considered contaminated and the "*fact that substances are merely entering water"* or "*where discharge from land is not discernible at a location immediately downstream"* does not constitute contaminated land.

To help achieve a more targeted approach to identifying and managing contaminated land in relation to the risk (or possibility) of harm to human health, the revised Statutory Guidance presented a new four category system for considering land under Part 2A, ranging from Category 4, where there is no risk that land poses a significant possibility of significant harm (SPOSH), or the level of risk is low, to Category 1, where the risk that land poses a significant possibility of significant harm (SPOSH) is unacceptably high.

For land that cannot be readily placed into Categories 1 or 4 further assessment is required. If there is sufficient concern that the risks could cause significant harm or have the significant possibility of significant harm the land is to be placed into Category 2. If the concern is not met land is considered Category 3.

The technical guidance clearly states that the currently published Soil Guidance Values (SGV's) and Generic Assessment Criteria (GAC's) represent *"cautious estimates of level of contaminants in soils"* which should be considered *"no risk to health or, at most, a minimal risk"*. These values do not represent the boundary between categories 3 and 4 and "*should be considered to be comfortably within Category 4".*

At the end of 2013 technical guidance in support of Defra's revised Statutory Guidance (SG) was published and then revised in 2014 (CL: AIRE 2014) which provided:

- A methodology for deriving C4SLs for four generic land-uses comprising residential, commercial, allotments and public open space; and

- A demonstration of the methodology, via the derivation of C4SLs for six substances – arsenic, benzene, benzo(a)pyrene, cadmium, chromium (VI) and lead.

For controlled waters, the revised Statutory Guidance states that the following types of pollution should be considered to constitute significant pollution of controlled waters:

"(a) Pollution equivalent to "environmental damage" to surface water or groundwater as defined by The Environmental Damage (Prevention and Remediation) Regulations 2009, but which cannot be dealt with under those Regulations.

(b) Inputs resulting in deterioration of the quality of water abstracted, or intended to be used in the future, for human consumption such that additional treatment would be required to enable that use.

(c) A breach of a statutory surface water Environment Quality Standard, either directly or via a groundwater pathway.

(d) Input of a substance into groundwater resulting in a significant and sustained upward trend in concentration of contaminants (as defined in Article 2(3) of the Groundwater Daughter Directive (2006/118/EC)".

The guidance also states that, in some circumstances, significant concentrations at a compliance point (in groundwater or surface water) may constitute pollution of controlled waters.

As with SPOSH for human health, the revised Statutory Guidance presents a four-category system for Significant Pollution of controlled waters. Category 1 covers land where there is a strong and compelling case for SPOSP, for example where significant pollution would almost certainly occur if no action was taken to avoid it. Category 4 covers land where there is no risk or the risk is low, for

example, where the land contamination is having no discernible impact on groundwater or surface water quality. Category 2 is for land where the risks posed to controlled waters are not high enough to consider the land as Category 1 but nonetheless are of sufficient concern to constitute SPOSP, Category 3 is for land where the risks posed to controlled waters are higher than low but not of sufficient concern to constitute SPOSP.

2.2 Planning

The Local Planning Authority (LPA) is responsible for the control of development, and in doing so it has a duty to take account of all material considerations, including contamination.

The principal planning objective is to ensure that any unacceptable risks to human health, buildings and other property and the natural and historical environment from the contaminated condition of the land are identified so that appropriate action can be considered and taken to address those risks.

The National Planning Policy Framework (NPPF, 2019), includes the following.

Paragraph 118 states that planning policies and decisions should "*(c) give substantial weight to the value of using suitable brownfield land within settlements for homes and other identified needs, and support appropriate opportunities to remediate despoiled, degraded, derelict, contaminated or unstable land*."

Paragraph 179 states "*Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner*".

Paragraph 170 states "*planning policies and decisions should contribute to and enhance the natural and local environment by:*

(e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; *and*

(f) remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate."

Paragraph 178 describes the policy considerations the Government expects LPA's to have in regard to land affected by contamination when preparing policies for development plans and in taking decisions on applications.

Paragraph 178 states "*planning policies and decisions should ensure that:*

(a) a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation);

(b) after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and

c) adequate site investigation information, prepared by a competent person, is available to inform these assessments."

Paragraph 183 states "*The focus of planning policies and decisions should be on whether proposed development is an acceptable use of land, rather than the control of processes or emissions (where these are subject to separate pollution control regimes). Planning decisions should assume that these regimes will operate effectively. Equally, where a planning decision has been made on a development, the planning issues should not be revisited through the permitting regimes operated by pollution control authorities.*"

The Glossary in Annex 2 provides the following:

***Brownfield land registers**: Registers of previously developed land that local planning authorities consider to be appropriate for residential development, having regard to criteria in the Town and Country Planning (Brownfield Land Registers) Regulations 2017. Local planning authorities will be able to trigger a grant of permission in principle for residential development on suitable sites in their registers where they follow the required procedures.*

***Competent person (to prepare site investigation information)**: A person with a recognised relevant qualification, sufficient experience in dealing with the type(s) of pollution or land instability, and membership of a relevant professional organisation.*

***Previously developed land**: Land which is or was occupied by a permanent structure, including the curtilage of the developed land (although it should not be assumed that the whole of the curtilage should be developed) and any associated fixed surface infrastructure. This excludes: land that is or was last occupied by agricultural or forestry buildings; land that has been developed for minerals extraction or waste disposal by landfill, where provision for restoration has been made through development management procedures; land in built-up areas such as residential gardens, parks, recreation grounds and allotments; and land that was previously developed but where the*

remains of the permanent structure or fixed surface structure have blended into the landscape.

***Site investigation information**: Includes a risk assessment of land potentially affected by contamination, or ground stability and slope stability reports, as appropriate. All investigations of land potentially affected by contamination should be carried out in accordance with established procedures (such as BS10175 Investigation of Potentially Contaminated Sites – Code of Practice).*

Stantec adopt the principle that a Preliminary Investigation (Desk Study and Site Reconnaissance) and Preliminary Risk Assessment (see below) is the minimum assessment requirement to support a planning application.

The level at which contamination is deemed to be unacceptable, or, gives rise to adverse effects under a planning context has not been identified but is envisaged to be more precautionary than the level required to determine land as contaminated under Part 2A.

2.3 Building Control

The building control department of the local authority or private sector approved inspectors are responsible for the operation and enforcement of the Building Regulations (DCLG 2010) to protect the health, safety and welfare of people in and around buildings. Approved Document C requires the protection of buildings and associated land from the effects of contamination, to be applied (non-exclusively) in all changes of use from commercial or industrial premises, to residential property.

3 APPROACH

As with CLR11 the guidance given in LC:RM presents three stages of risk management: -

(a) Stage 1 - Risk Assessment;

(b) Stage 2 - Options Appraisal; and

(c) Stage 3 - Remediation.

Each stage has three tiers. The three tiers of Stage 1 Risk Assessment are: -

- Tier 1 - Preliminary Risk Assessment (PRA) - first tier of RA that develops the outline conceptual model (CM) and establishes whether there are any potentially unacceptable risks.

- Tier 2 - Generic Quantitative Risk Assessment (GQRA) - carried out using generic assessment criteria and assumptions to estimate risk.

- Tier 3 - Detailed Quantitative Risk Assessment (DQRA) - carried out using detailed site-specific information to generate Site Specific Assessment Criteria (SSAC) as risk evaluation criteria.

For each tier of a Stage 1 - Risk Assessment you must:

1. Identify the hazard - establish contaminant sources.

2. Assess the hazard - use a source-pathway-receptor (S-P-R) pollutant linkage approach to find out if there is the potential for unacceptable risk.

3. Estimate the risk - predict what degree of harm or pollution might result and how likely it is to occur.

4. Evaluate the risk - decide whether a risk is unacceptable.

A Stantec Preliminary Investigation report normally comprises a desk study, walkover site reconnaissance and preliminary risk assessment (PRA). The project specific proposal defines the actual scope of work which might include review of ground investigation data in which case the report includes a GQRA.

Risk estimation involves identifying the magnitude of the potential consequence (taking into account both the potential severity of the hazard and the sensitivity of the receptor) and the magnitude of the likelihood i.e. the probability (taking into account the presence of the hazard and the receptor and the integrity of the pathway). This approach is promoted in current guidance such as R&D 66 (NHBC 2008).

For a PRA, Stantec's approach is that if a pollution linkage is identified then it represents a potentially unacceptable risk which either (1) remediation / direct risk management or (2) progression to further tiers of risk assessment (GQRA and GQRA) requiring additional data collection and enabling refinement of the CM using the site specific data.

4 IDENTIFICATION OF POLLUTANT LINKAGES AND DEVELOPMENT OF A CONCEPTUAL MODEL (CM)

For all Tiers of a Stage 1 Risk Assessment, the underlying principle to ground condition assessment is the identification of *pollutant linkages* in order to evaluate whether the presence of a source of contamination could potentially lead to harmful consequences. A pollutant linkage consists of the following three elements: -

- A source/hazard – a substance or situation which has the potential to cause harm or pollution;
- A pathway – a means by which the hazard moves along / generates exposure; and
- A receptor/target – an entity which is vulnerable to the potential adverse effects of the hazard.

The *Conceptual Model* identifies the types and locations of potential contaminant sources/hazards and potential receptors and potential migration/transportation pathway(s). The CM is refined through progression to further tiers of risk assessment (GQRA and GQRA) requiring additional data collection.

4.1 Hazard Identification

A hazard is a substance or situation that has the potential to cause harm. Hazards may be chemical, biological or physical.

In a PRA the potential for hazards to be present is determined from consideration of the previous or ongoing activities on or near to the site in accordance with the criteria presented in the **Table 1**.

Based on the land use information Contaminants of Potential Concern (COPC) are identified. The COPC direct the scope of the collection of site-specific data and the analytical testing selected for subsequent Tiers.

At Tier 2 the site-specific data is evaluated using appropriate published assessment criteria (refer to Stantec document entitled Rationale for the Selection of Evaluation Criteria for a Generic Quantitative Risk Assessment (GQRA)). In general, published criteria have been developed using highly conservative assumptions and therefore if the screening criterion is not exceeded (and if enough samples from appropriate locations have been analysed) then the COPC is eliminated as a potential Hazard. It should be noted that exceedance does not necessarily indicate that a site is contaminated and/or unsuitable for use only that the COPC is retained as a potential Hazard. Published criteria are generated using models based on numerous and complex assumptions. Whether or not these assumptions are appropriate or sufficiently protective requires confirmation on a project by project basis. Manipulation of the default assumptions would normally form part of a Tier 3 Detailed Quantitative Risk Assessment (DQRA).

When reviewing or assessing site specific data Stantec utilise published guidance on comparing contamination data with a critical concentration (CL:AIRE/CIEH 2008) which presents a structured process for employing statistical techniques for data assessment purposes.

4.2 Receptor and Pathway Identification

For all Tiers the potential receptors (for both on site and adjoining land) that will be considered are:

- Human Health – including current and future occupiers, construction and future maintenance workers, and neighbouring properties/third parties;
- Ecological Systems; [1]
- Controlled Waters [2] – Under section 78A(9) of Part 2A the term "pollution of controlled waters" means the entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter. The term "controlled waters" in relation to England has the same meaning as in Part 3 of the Water Resources Act 1991, except that "ground waters" does not include waters contained in underground strata but above the saturation zone.
- Property - Animal or Crop (including timber; produce grown domestically, or on allotments, for consumption; livestock; other owned or domesticated animals; wild animals which are the subject of shooting or fishing rights); and
- Property - Buildings (any structure or erection, and any part of a building including any part below ground level, but does not include plant or machinery comprised in a building, or buried services such as sewers, water pipes or electricity cables including archaeological sites and ancient monuments).

If a receptor is taken forward for further assessment it will be classified in terms of its sensitivity, the criteria for which are presented in **Table 2**. Table 2 has been generated using descriptions of environmental receptor importance/value given in various guidance documents including R&D 66 (NHBC 2008), EA 2017 and Transport Analysis Guidance (based on DETR 2000). Human health and buildings classifications have been generated by Stantec using the attribute description for each class. Surface water sensitivity is classified using the Water Framework Directive (WFD) status for the River Basin obtained from: [redacted]

[1] International or nationally designated sites (as defined in the statutory guidance (Defra Circular 04/12)) "*in the local area*" will be identified as potential ecological receptors. A search radius of 1, 2 or 5km will be utilised depending on the site-specific circumstances (see also pathway identification). The Environment Agency has published an ecological risk assessment framework (EA 2008) which promotes (as opposed to statutorily enforces) consideration of additional receptors to include locally protected sites and protected or notable species. These additional potential receptors will only be considered if a Phase 1 habitat survey, undertaken in accordance with guidance (JNCC 1993), is commissioned and the data provided to Stantec. It should be noted that without such a survey a Land Contamination risk assessment may conclude that the identification of potential ecological receptors is inconclusive (refer to Stantec Specification for a Preliminary Investigation (Desk Study and Site Reconnaissance).

[2] The definition of "pollution of controlled water" was amended by the introduction of Section 86 of the Water Act 2003. For the purposes of Part 2A groundwater does not include waters above the saturated zone and our assessment does not therefore address perched water other than where development causes a pathway to develop.

The exposure pathway and modes of transport that will be considered are presented in **Table 3**.

4.3 Note regarding Ecological Systems

The Environment Agency (EA) has developed an ecological risk assessment framework which aims to provide a structured approach for assessing the risks to ecology from chemical contaminants in soils (EA 2008). In circumstances where contaminants in water represent a potential risk to aquatic ecosystems then risk assessors will need to consider this separately.

The framework consists of a three-tiered process: -

- Tier 1 is a screening step where the site soils chemical data is compared to a soil screening value (SSV)
- Tier 2 uses various tools (including surveys and biological testing) to gather evidence for any harm to the ecological receptors
- Tier 3 seeks to attribute the harm to the chemical contamination

Tier 1 is preceded by a desk study to collate information about the site and the nature of the contamination to assess whether pollutant linkages are feasible. The framework presents ten steps for ecological desk studies and development of a conceptual model as follows.

1. Establish Regulatory Context
2. Collate and Assess Documentary Information
3. Summarise Documentary Information
4. Identify Contaminants of Potential Concern
5. Identify Likely Fate Transport of Contaminants
6. Identify Potential Receptors of Concern
7. Identify Potential Pathways of Concern
8. Create a Conceptual Model
9. Identify Assessment and Measurement Endpoints
10. Identify Gaps and Uncertainties

The information in a standard PRA report covers Steps 1 to 4 inclusive. Step 5 considers fate and transport of contaminants and it should be noted that our standard report adopts a simplified approach considering only transport mechanisms. A simplified approach has also been adopted in respect of Steps 6 and 7 receptors (a detailed review of the ecological attributes has not been undertaken) and pathways (a food chain assessment has not been undertaken). Step 9 is outside the scope of our standard PRA report.

It should be noted that the PRA report will present an assessment for ecological systems (where identified as a receptor for a land contamination assessment) considering the viability of the mode of transport given the site-specific circumstances and not specific pathways. The PRA may conclude that the risk to potential ecological receptors is inconclusive.

4.4 Note regarding controlled waters

Controlled waters are rivers, estuaries, coastal waters, lakes and groundwaters, but not perched waters.

The EU Water Framework Directive (WFD) 2000/60/EC provides for the protection of sub-surface, surface, coastal and territorial waters through a framework of river basin management. The EU Updated Water Framework Standards Directive 2014/101/EU amended the EU WFD to update the international standards therein; it entered into force on 20 November 2014 with the requirements for its provisions to be transposed in Member State law by 20 May 2016. Other EU Directives in the European water management framework include:

- the EU Priority Substances Directive 2013/39/EU;
- EU Groundwater Pollutants Threshold Values Directive 2014/80/EU amending the EU Groundwater Directive 2006/118/EC; and
- EU Biological Monitoring Directive 2014/101/EU.

The Ground Water Daughter Directive (GWDD) was enacted by the Groundwater Regulations (2009), which were subsumed by the Environmental Permitting Regulations (2010) which provide essential clarification including on the four objectives specifically for groundwater quality in the WFD: -

Achieve ‘Good’ groundwater chemical status by 2015, commonly referred to as ‘status objective’;
Achieve Drinking Water Protected Area Objectives;
Implement measures to reverse any significant and sustained upward trend in groundwater quality, referred to as ‘trend objective’; and

Prevent or limit the inputs of pollutants into groundwater, commonly referred to as ‘prevent or limit’ objectives

The Water Act 2003 (Commencement No.11) Order 2012 amends the test for 'contaminated land' which relates to water pollution so that pollution of controlled waters must now be "significant" to meet the definition of contaminated land.

The Water Framework Directive (WFD) requires the preparation, implementation and review of River Basin Management Plans (RBMP) on a six-year cycle. River basins are made up of lakes, rivers, groundwaters, estuaries and coastal waters, together with the land they drain. River Basin Districts (RBD) and the WFD Waterbodies that they comprise are important spatial management units, regularly used in catchment management studies. River Basin Management Plans (RBMP) have been developed for the 11 River Basin Districts in England and Wales.

These were released by Defra in 2009 (Defra 2009) and updated in 2015.

These RBMP's establish the current status of waters within the catchments of the respective Districts and the current status of adjoining waters identified. As part of a Tier 2 risk assessment water quality data is screened against the WFD assessment criteria. Comparison with the RBMP's current status of waters for the catchment under consideration would form part of a Tier 3 assessment.

5 RISK ESTIMATION

Risk estimation classifies what degree of harm might result to a receptor (defined as consequence) and how likely it is that such harm might arise (probability).
At Tier 1 the consequence classification is generated by multiplying the hazard classification score and the receptor sensitivity score. This approach follows that presented in the republished R&D 66 (NHBC 2008).

The criteria for classifying probability are set out in **Table 4** and have been taken directly from Table 6.4 CIRIA C552 (CIRIA 2001). Probability considers the integrity of the exposure pathway.

The consequence classifications detailed in **Table 5** have been adapted from Table 6.3 presented in C552 and R&D 66 (Annex 4 Table A4.3).

The Tier 1 risk classification is estimated for each pollutant linkage using the matrix given in **Table 6** which is taken directly from C552 (Table 6.5).

Subsequent Tiers refine the CM through retention or elimination of potential hazards and pollutant linkages.

6 RISK EVALUATION

Evaluation criteria are the parameters used to judge whether harm or pollution needs further assessment or is unacceptable. The evaluation criteria used will depend on:

- the reasons for doing the RA and the regulatory context such as Part 2A or planning;
- the CM and pollutant linkages present;
- any criteria set by regulators;
- any advisory requirements such as from Public Health England;
- the degree of confidence and precaution required;
- the level of confidence required to judge whether a risk is unacceptable;
- how you've used or developed more detailed assessment criteria in the later tiers of RA;
- the availability of robust scientific data;
- how much is known - for example, about the pathway mechanism and how the contaminants affect receptors; and
- any practical reasons such as being able to measure or predict against the criteria.

In order to put the Tier 1 risk classification into context the likely actions are described in **Table 7** which is taken directly from Table 6.6 of C552 (CIRIA 2001).

REFERENCES

BSI 2017 BS 10175:2011+A2:2017 Investigation of potentially contaminated sites - Code of Practice

BSI 2019 BS 8485:2015+A1:2019 Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings

CIRIA 2001: Contaminated land risk assessment – a guide to good practice C552.

CIRIA 2008: Assessing risks posed by hazardous ground gases to buildings C655

CL: AIRE/CIEH 2008 Guidance on Comparing Soil Contamination Data with a Critical Concentration. Published by Contaminated Land: Applications in Real Environments (CL: AIRE) and the Chartered Institute of Environmental Health (CIEH)

CL: AIRE 2013 SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination. Final Project Report published by Contaminated Land: Applications in Real Environments (CL: AIRE) 20th December 2013

DCLG 2010 Building Regulations 2010 Approved Document C Site preparation and resistance to contaminants and moisture.

DETR 2000 Methodology for Multi Modal Studies. Volume 2 Section 4. The Environmental Objective.

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DEFRA, 2006 The Contaminated Land (England) Regulations 2006.

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DEFRA, 2012 Environmental Protection Act 1990: Part 2A. Contaminated Land Statuary Guidance. April 2012.

DEFRA, 2013 Environmental Damage (Prevention and Remediation) Regulations 2009: Guidance for England and Wales

Defra '2009 Water for Life and Livelihoods. River Basin Management Plan. (11 Districts: Anglia, Dee, Humber, Northumbria, Northwest, Severn, Solway

and Tweed, Southeast, Thames, Western Wales) December 2009

EA 2004: Contaminated Land Research (CLR) Report 11: The Model Procedures for the Management of Land Contamination CRL 11 by the Environment Agency (EA).

EA 2008 Ecological Risk Assessment Science Report Series SC070009 published by the Environment Agency (EA).

EA 2017 New groundwater vulnerability mapping methodology in England and Wales Report – SC040016/R Environment Agency (EA) September 2017

JNCC 1993 Handbook for Phase 1 Habitat Survey – A Technical for Environmental Audit prepared by the Joint Nature Conservancy Council (JNCC)

NHBC/EA/CIEH 2008: R&D Publication 66 Guidance for the safe development of housing on land affected by contamination.

National Planning Policy Framework (February 2019 revised), published by the Ministry of Housing, Communities and Local Government (MHCLG) at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/810197/NPPF_Feb_2019_revised.pdf

Stantec Methodology for Assessment of Land Contamination (England)

Table 1: Criteria for Classifying Hazards / Potential for Generating Contamination

Classification/Score	Potential for generating contamination/gas based on land use
Very Low 1	Land Use: Residential, retail or office use, agriculture Contamination: Limited. Gas generation potential: Soils with low organic content
Low 2	Land Use: Recent small scale industrial and light industry Contamination: locally slightly elevated concentrations. Gas generation potential: Soils with high organic content (limited thickness)
Moderate 3	Land Use: Railway yards, collieries, scrap yards, engineering works. Contamination: Possible widespread slightly elevated concentrations and locally elevated concentrations. Gas generation potential: Dock silt and substantial thickness of organic alluvium/peat
High 4	Land Use: Heavy industry, non-hazardous landfills. Contamination: Possible widespread elevated concentrations. Gas generation potential: Shallow mine workings Pre 1960s landfill
Very High 5	Land Use: Hazardous waste landfills, gas works, chemical works, Contamination: Likely widespread elevated concentrations. Gas generation potential: Landfill post 1960

"Greenfield" is land which has not been developed and there has been no use of agrochemicals

Table 2: Criteria for Classifying Receptor Sensitivity/Value

Classification	Definition
Very Low 1	Receptor of limited importance • Groundwater: Unproductive strata (Strata with negligible significance for water supply or river baseflow) (previously Non-aquifer), Secondary B (water-bearing parts of non-aquifers), Secondary undifferentiated (previously minor or non-aquifer, but information insufficient to classify as secondary A or B) • Surface water: WFD Surface Water status Bad • Ecology: No local designation • Buildings: Replaceable • Human health: Unoccupied/limited access
Low 2	Receptor of local or county importance with potential for replacement • Groundwater: Secondary A aquifer • Surface water: WFD Surface Water status Poor • Ecology: local habitat resources • Buildings: Local value • Human health: Minimum score 4 where human health identified as potential receptor
Moderate 3	Receptor of local or county importance with potential for replacement • Groundwater: Principal aquifer • Surface water: WFD Surface Water status Moderate • Ecology: County wildlife sites, Areas of Outstanding Natural Beauty (AONB) • Buildings: Area of Historic Character • Human health: Minimum score 4 where human health identified as potential receptor
High 4	Receptor of county or regional importance with limited potential for replacement • Groundwater: Source Protection Zone 2 or 3 • Surface water: WFD Surface Water status Good • Ecology: SSSI, National or Marine Nature Reserve (NNR or MNR) • Buildings: Conservation Area • Human health: Minimum score 4 where human health identified as potential receptor
Very High 5	Receptor of national or international importance • Groundwater: Source Protection Zone (SPZ) 1 • Surface water: WFD Surface Water status High • Ecology: Special Areas of Conservation (SAC and candidates), Special Protection Areas (SPA and potentials) or wetlands of international importance (RAMSAR) • Buildings: World Heritage site • Human health: Residential, open spaces and uses where children are present

Table 3: Exposure Pathway and Modes of Transport

Receptor	Pathway	Mode of transport
Human health	Ingestion	Fruit or vegetable leaf or roots
		Contaminated water
		Soil/dust indoors
		Soil/dust outdoors
	Inhalation	Particles (dust / soil) – outdoor
		Particles (dust / soil) - indoor
		Vapours – outdoor - migration via natural or anthropogenic pathways
		Vapours - indoor - migration via natural or anthropogenic pathways
	Dermal absorption	Direct contact with soil
		Direct contact with waters (swimming / showering)
		Irradiation
Groundwater	Leaching	Gravity / permeation
	Migration	Natural – groundwater as pathway Anthropogenic (e.g. boreholes, culverts, pipelines etc.)
Surface Water	Direct	Runoff or discharges from pipes
	Indirect	Recharge from groundwater
	Indirect	Deposition of windblown dust
Buildings	Direct contact	Sulphate attack on concrete, hydrocarbon corrosion of plastics
	Gas ingress	Migration via natural or anthropogenic paths
Ecological systems	See Notes	Runoff/discharge to surface water body
	See Notes	Windblown dust
	See Notes	Groundwater migration
	See Notes	At point of contaminant source
Animal and crop	Direct	Windblown or flood deposited particles / dust / sediments
	Indirect	Plants via root up take or irrigation. Animals through watering
	Inhalation	By livestock / fish - gas / vapour / particulates / dust
	Ingestion	Consumption of vegetation / water / soil by animals

Table 4: Classification of Probability

Classification	Definition
High likelihood	There is a pollution linkage and an event either appears very likely in the short-term and almost inevitable over the long-term, or there is already evidence at the receptor of harm / pollution.
Likely	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short-term and likely over the long-term.
Low likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter-term.
Unlikely	There is a pollution linkage, but circumstances are such that it is improbable that an event would occur even in the very long-term.

Table 5: Classification of Consequence (score = magnitude of hazard and sensitivity of receptor)

Classification / Score	Examples
Severe **17-25** **(3 out of 25 outcomes)**	Human health effect - exposure likely to result in "significant harm" as defined in the Defra (2012) Part 2A Statutory Guidance [1]. Controlled water effect - short-term risk of pollution (note: Water Resources Act contains no scope for considering significance of pollution) of sensitive water resource. Equivalent to EA Category 1 incident (persistent and/or extensive effects on water quality leading to closure of potable abstraction point or loss of amenity, agriculture or commercial value. Major fish kill. Ecological effect - short-term exposure likely to result in a substantial adverse effect. Catastrophic damage to crops, buildings or property
Medium **10-16** **(7 out of 25 outcomes)**	Human health effect - exposure could result in "significant harm" [1]. Controlled water effect - equivalent to EA Category 2 incident requiring notification of abstractor Ecological effect - short-term exposure may result in a substantial adverse effect. Damage to crops, buildings or property
Mild **5-9** **(7 out of 25 outcomes)**	Human health effect - exposure may result in "significant harm" [1]. Controlled water effect - equivalent to EA Category 3 incident (short lived and/or minimal effects on water quality). Ecological effect - unlikely to result in a substantial adverse effect. Minor damage to crops, buildings or property. Damage to building rendering it unsafe to occupy (for example foundation damage resulting in instability).
Minor **1-4** **(8 out of 25 outcomes)**	No measurable effect on humans. Protective equipment is not required during site works. Equivalent to insubstantial pollution incident with no observed effect on water quality or ecosystems. Repairable effects to crops, buildings or property. The loss of plants in a landscaping scheme. Discolouration of concrete.

[1] Significant harm includes death, disease, serious injury, genetic mutation, birth defects or impairment of reproductive function. The local authority may also consider other health effects to constitute significant harm such as physical injury; gastrointestinal disturbances; respiratory tract effects; cardio-vascular effects; central nervous system effects; skin ailments; effects on organs such as the liver or kidneys; or a wide range of other health impacts. Whether or not these would constitute significant harm would depend on the seriousness of harm including impact on health, quality of life and scale of impact.

Table 6: Classification of Risk (Combination of Consequence Table 5 and Probability Table 4)

	Consequence			
Probability	***Severe***	***Medium***	***Mild***	***Minor***
High likelihood	Very high	High	Moderate	Low
Likely	High	Moderate	Moderate/	Low
Low likelihood	Moderate	Moderate	Low	Very low
Unlikely	Low	Low	Very low	Very low

Table 7: Description of Risks and Likely Action Required

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

Appendix CWRA 2 – Stantec Assessment Criteria Rationale

Stantec Guide: Generic Quantitative Risk Assessment - Evaluation Criteria (England)

1 INTRODUCTION

The aim of this document is to present an explanation for the selection of the evaluation criteria routinely used by Stantec UK Ltd when undertaking a land contamination Tier 2 Generic Quantitative Risk Assessment (GQRA).

A GQRA uses published criteria to screen the site-specific contamination testing data and identify potential hazards to specific receptors. Generic criteria are typically conservative in derivation and exceedance does not indicate that a site is statutorily contaminated and/or unsuitable for use in the planning context. These criteria are used to identify situations where further assessment and/or action may be required. This document is divided into general introductory text and sections on soils, waters and gases.

2 GENERAL NOTES

This document should be read in conjunction with another entitled "Stantec Methodology for Assessment of Land Contamination" which summarises the legislative regime and our approach to ground contamination and risk assessment.

Any Stantec interpretation of contamination test results is based on a scientific and engineering appraisal. The perceptions of, for example, banks, insurers, lay people etc are not taken into account.

Any tables included in this document are produced for ease of reference to the criteria, they do not in any way replace the documents of origin (which are fully referenced) and which should be read to ensure appropriate use and interpretation of the data.

Generic criteria provide an aid to decision-making, but they do not replace the need for sound professional judgement in risk assessment (EA, 2006). The criteria are based on numerous and complex assumptions. The appropriateness of these assumptions in a site-specific context requires confirmation on a project by project basis. Our interpretative report will comment on the appropriateness of the routine criteria for project objectives or ground conditions. In some cases the published criteria whilst typically conservative may in some circumstances not be suitable for the site being assessed, either because they do not address the identified pollutant linkages or because they may not be sufficiently precautionary in the context of the site. Under these circumstances it may be necessary to recommend deriving site-specific assessment criteria. Any deviation from the routine criteria and/or selection of criteria for parameters not covered in this document will be described in the report text.

3 CRITERIA FOR EVALUATING SOIL RESULTS

3.1 Potential Harm to Human Health

The criteria used by Stantec UK Ltd to assess the potential for harm to human health are:-

- Category 4 Screening Levels (C4SLs) (DEFRA, 2014).
- Suitable 4 Use Levels (S4ULs) (Nathanail *et al*, 2015).
- CL:AIRE/EIC/AGS Generic Assessment Criteria (GAC) (CL:AIRE, 2010).
- Soil Guideline Values (SGVs) (EA, 2009a).

These criteria have been generated using the Contaminated Land Exposure Assessment model (CLEA) and supporting technical guidance (EA, 2009b, 2009c, 2009d, 2009e). The CLEA model uses generic assumptions about the fate and transport of chemicals in the environment and a generic conceptual model for site conditions and human behaviour to estimate child and adult exposures to soil contaminants for those potentially living, working, and/or playing on contaminated sites over long time periods (EA, 2009c).

The S4ULs, SGVs and GACs are all based on use of minimal/tolerable risk Health Criteria Values (HCVs) as the toxicological benchmark whereas the C4SL are based on use of a "low level of toxicological concern" (LLTC) as the toxicological benchmark. The LLTC represents a slightly higher level of risk than the HCV.

An update to the software (1.071) was published on 04/09/2015 (the handbook (EA 2009f) referring to version 1.05 is still valid). The update includes the library data sets from the DEFRA research project SP1010 (Development of Category 4 Screening Levels for assessment of land affected by contamination).

The CLEA model uses ten exposure pathways (Ingestion (outdoor soil, indoor dust, homegrown vegetables and soil attached to homegrown vegetables), Dermal Contact (outdoor soil and indoor dust) and Inhalation (outdoor dust, indoor dust, outdoor vapours and indoor vapours)). There are exposure pathways not included in the CLEA model such as the permeation of organics into plastic water supply pipes.

The presence and/or significance of each of the potential exposure pathways is dependent on the land use being considered. The model uses standard land use scenarios as follows:-

Residential – habitation of a dwelling up to two storeys high with various default material and design parameters, access to either private or nearby community open space with soil track back

to form indoor dust. Assumes ingestion of homegrown produce.

Allotments – the model has default parameters for use and consumption of vegetables but not animals or their products (eggs).

Industrial/Commercial – assumes office or light physical work in a permanent three storey structure with breaks taken outside and that the site is NOT covered in hardstanding.

Public Open Space – two public open space (POS) scenarios are considered: POS_{resi} is shared communal space within a residential development where tracking back of soil into the home is assumed to occur. POS_{park} is intended for a public park sufficiently distant from housing (i.e. not adjacent to housing) such that tracking back of soil into the home is negligible. Note that the POS assessment criteria may not be appropriate for assessing sports fields.

The assessment criteria generated using CLEA can be used as a conservative starting point for evaluating long-term risks to human health from chemicals in soil.

It is important to note that the model does not assess all the potential exposure scenarios, for example risk to workers in excavations (short term exposure) or diffusion of contaminants through drinking water pipes.

Recent guidance (DEFRA 2012) introduces a four stage classification system where Category 1 sites are clearly contaminated land and Category 4 sites are definitely not contaminated land as defined by EPA 1990. Outside of these categories further specific risk assessment is required to determine if the site should fall into Category 2 (contaminated land) or Category 3 (not contaminated land). Category 4 screening values are considered to be more pragmatic than the current published SGV/GAC criteria but still strongly precautionary with the aim of allowing rapid identification of sites where the risk is above minimal but still low/acceptable.

Category 4 Screening Levels (C4SLs)

At the end of 2013, technical guidance in support of DEFRA's revised Statutory Guidance (SG) was published and then revised in 2014 (CL:AIRE 2014) which provided:

- A methodology for deriving C4SLs for the standard land-uses and two new public open space scenarios using the updated assumptions relating to the modelling of human exposure to soil contaminants; and
- A demonstration of the methodology, via the derivation of C4SLs for six substances – arsenic, benzene, benzo(a)pyrene, cadmium, chromium (VI) and lead.

Following issue of an Erratum in December 2014, a Policy Companion Document was published (DEFRA 2014).

A letter from Lord de Mauley dated 3rd September 2014 provides more explicit direction to local authorities on the use of the C4SL in a planning context. The letter identifies four key points:

1) that the screening values were developed expressly with the planning regime in mind

2) their use is recommended in DCLG's planning guidance

3) soil concentrations below a C4SL limit are considered to be 'definitely not contaminated' under Part IIA of the 1990 Environmental Protection Act and pose at most a 'low level of toxicological concern' and,

4) exceedance of a C4SL screening value does not mean that land is definitely contaminated land, just that further investigation may be warranted.

Stantec use the C4SLs as the Tier 2 soil screening criteria protective of human health for substances with C4SL available. Table 1 summarises the C4SL (DEFRA 2014) for each of the six substances.

Note that, with the exception of benzene, the DEFRA published C4SL are not dependent on soil organic matter content (SOM) ("*Given that BaP is non volatile and that empirical soil to plant concentration factors have been used, soil organic matter content has a negligible influence on the C4SLs for this chemical"*). The DEFRA published C4SL for benzene is based on an SOM of 6%. Stantec have used the CLEA model (v1.071) to derive C4SL for benzene for 1% and 2.5% SOM which are also shown in Table 1.

Note that an industry led project to derive C4SL for a further 20 substances has commenced (CL:AIRE, 2018). The project is being project managed by CL:AIRE and is funded by the Soil and Groundwater Technology Association (SAGTA), the Society of Brownfield Briefing (SoBRA) and others. A dedicated steering group, made up of representatives from SAGTA, DEFRA, Welsh Government, Public Health England, Environment Agency, Natural Resources Wales, Food Standards Agency, Homes England and further Land Forum representatives, has been set up to oversee the project. The new C4SL will be added to this document as they are published.

Suitable 4 Use Levels (S4ULs)

In July 2009, Generic Assessment Criteria (GACs) for 82 substances were published (LQM and CIEH, 2009) using the then current version of the CLEA software v1.04 and replaced those generated in

2006 using the original version of the model CLEA UK *beta*. In 2015 S4ULs were published by LQM/CIEH (Nathanail *et al*, 2015) to replace the second edition GACs. Table 2 summarises the S4ULs which are reproduced with permission; Publication Number S4UL3202.

Soil Guideline Values (SGVs) and Generic Assessment Criteria (GAC)

In 2009, Soil Guideline Values (SGVs) were published by the Environment Agency for arsenic, cadmium, mercury, nickel, selenium, benzene, toluene, ethyl benzene, xylenes, phenol and dioxins, furans and dioxin-like PCBs. These were derived using the CLEA model for residential, allotments and commercial land-uses.

These SGVs have now largely been superseded by the C4SLs and the S4ULs, with the exception of the SGVs for dioxins, furans and dioxin-like PCBs which are shown in Table 3.

In January 2010, Generic Assessment Criteria (GAC) derived using CLEA were published by CL:AIRE for 35 substances. These GAC are listed in Table 4.

Note that the SGVs for dioxins, furans and dioxin like PCBs and CL:AIRE GAC were derived using an older version of CLEA (v1.06) than used to derive the S4UL and C4SL (v1.07). This older version used slightly more conservative values for some exposure parameters and therefore the derived SGVs/GAC are still considered suitably precautionary for use as screening criteria.

Note on Mercury, Chromium and Arsenic

The analytical testing routinely undertaken by Stantec determines total concentration, however, the toxicity depends on the form of the contaminant.

If a source of Mercury, Chromium or Arsenic is identified or the total concentration exceeds the relevant worst case speciated criteria it will be desirable/necessary to undertake additional speciated testing and further assessment.

Note on Polycyclic Aromatic Hydrocarbons

Polycyclic Aromatic Hydrocarbons (PAHs) are a family of hundreds of different congeners whose chemical structures contain two or more fused aromatic rings. Whilst it is recognised that there is an ongoing debate on the most appropriate method to assess health effects of PAH mixtures, in 2010 the Health Protection Agency recommended the use of benzo[a]pyrene (BaP) as a surrogate marker approach in the assessment of carcinogenic risks posed by PAHs in soils (HPA, 2010).

In most cases, BaP is chosen as the surrogate marker (SM) due to its ubiquitous nature and the vast amount of data available and has been used by various authoritative bodies to assess the carcinogenic risk of PAHs in food. The SM approach estimates the carcinogenic toxicity of a mixture of PAHs in an environmental matrix by using toxicity data for a PAH mixture for which the composition is known.

Exposure to the SM is assumed to represent exposure to all PAHs in that matrix therefore the toxicity of the SM represents the toxicity of the mixture. The SM approach relies on a number of assumptions (HPA, 2010).

- The SM (BaP) must be present in all the samples.
- The profile of the different PAH relative to BaP should be similar in all samples.
- The PAH profile in the soil samples should be sufficiently similar to that used in the pivotal toxicity study on which HBGV was based i.e. the Culp study (Culp et al. (1998)).

In order to justify the use of a surrogate marker assessment criterion (C4SL for benzo(a)pyrene and S4UL coal tar) the LQM PAH Profiling Tool is used by Stantec to assess the similarity of the PAH profile in a soil sample to that of the toxicity study. The spreadsheet calculates the relative proportions of the genotoxic PAHs and plots them relative to the composition of the two coal mixtures used by Culp et al. Provided that the relative proportions are within an order of magnitude of those from the Culp Study (as suggested by HPA) Stantec will use the C4SL for benzo(a)pyrene as a surrogate marker for the carcinogenic PAHs, i.e. benzo(a)pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(ah)anthracene, indeno(123-cd)pyrene and benzo(ghi)perylene. For projects where this approach is appropriate the results will be assessed using the Coal Tar criterion (BAP C4SL) and the criteria for non-carcinogenic PAHs (S4ULs), i.e. naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene and pyrene.

Note on Total Petroleum Hydrocarbons

The S4UL for Total Petroleum Hydrocarbon (TPH) fractions are based on 'threshold' health effects. In accordance with Environment Agency guidance (EA, 2005) and the S4UL report (Nathanail *et al*, 2015) the potential for additivity of toxicological effects between fractions should be considered. Practically, to address this issue the hazard quotient (HQ) for each fraction should be calculated by dividing the measured concentration of the fraction by the GAC. The HQs are then added to form a hazard index (HI) for that sample. An HI greater than 1 indicates an exceedance.

Note on Dioxins, Furans and Dioxin-like PCBs

The SGVs for dioxins, furans and dioxin-like PCBs

are based on an assumed congener profile for urban soils. The total measured concentration of dioxin, furan and dioxin-like PCB congeners listed in the SGV report (EA, 2009a) should be compared with the SGVs to make an initial assessment of risk. A more accurate assessment can be made using the Environment Agency's site specific worksheet for dioxins, furans and dioxin like PCBs available from [redacted] -
[redacted]

Note on Asbestos

Asbestos in soil and made ground is currently under review by a number of bodies. There are no current published guidance values for asbestos in soil other than the waste classification values given in the EA's Technical Guidance WM3, Hazardous Waste – Interpretation of the definition and classification of hazard waste (EA, 2015). This guidance is only appropriate for soils that are being discarded as waste.

Testing for asbestos will be carried out on selected samples of made ground encountered during investigation, initially samples will be subjected to an asbestos screen and, if asbestos is found to be present, subjected to quantification depending on the project specific requirements. The reader is directed to the report text for guidance on the approach adopted in respect to any asbestos found to be present.

Further guidance is also available in publication C733, Asbestos in soil and made ground: a guide to understanding and managing risks (CIRIA 2014).

Note on Soil Saturation Concentration

The soil saturation concentration is the concentration of an organic constituent in soil at which either the pore water or soil vapour has theoretically become saturated with the substance, i.e. the substance concentration has reached its maximum aqueous solubility or vapour pressure. The soil saturation concentration is related to the properties of the substance as well as the properties of the soil (including soil organic matter content).

The soil saturation concentrations are shown in Table 2 in brackets where exceeded by the assessment criteria and in Table 4 for all substances. Measured concentrations in excess of the soil saturation concentration have various potential implications as discussed below.

Firstly, where measured concentrations exceed the soil saturation concentration, the risk from vapour inhalation and/or consumption of produce may be limited. The CLEA model calculates the soil saturation concentration but it does not limit exposure where this concentration is exceeded. This adds an additional level of conservatism for CLEA derived assessment criteria where these exceed the calculated soil saturation concentration. Secondly, the soil saturation concentration is sometimes used to flag the potential presence of non-aqueous phase liquid (NAPL, a.k.a. free phase) in soil. The presence of NAPL is an important consideration in the Tier 2 assessment because, where present, the risks from NAPL may need to be considered separately. Theoretically, where a measured concentration exceeds the soil saturation concentration NAPL could be present. However, using theoretical saturation values is not always reliable for the following reasons: The soil saturation concentration is based on the aqueous solubility and vapour pressure of a pure substance and not a mixture, of which NAPLs are often comprised; and

The soil saturation concentration does not account for the sorption capacity of the soil. As a result, exceedance of the soil saturation concentration does not necessarily imply that NAPL is present. This is particularly the case for longer chain hydrocarbons such as PAHs which have low solubility and vapour pressure and hence a low soil saturation concentration but that are strongly sorbed to soil.

The measured concentrations will be compared to the soil saturation concentrations shown in Tables 2 and 4. Where exceeded Stantec will use additional lines of evidence (such as visual evidence and concentration of total TPH) to determine whether or not NAPL is likely to be present. If the presence of NAPL is deemed plausible the implications will be considered in the risk assessment.

3.2 Potential Harm to the Built Environment

Land contamination can pose risks to buildings, building materials and services (BBM&S) in a number of ways. Volatile contaminants and gases can accumulate and cause explosion or fire. Foundations and buried services can be damaged by corrosive substances and contaminants such as steel slags can create unstable ground conditions through expansion causing structural damage.

Stantec use the following primary guidance to assess the significance of soil chemistry with respect to its potential to harm the built environment.

i) Approved Document C - Site Preparation and Resistance to Contaminants and Moisture. (DCLG, 2013);
ii) Concrete in aggressive ground SD1 (BRE 2005);
iii) Guidance for the selection of water supply pipes to be used in brownfield sites (UK WIR 2011);
iv) Protocols published by agreement between Water UK and the Home Builders Federation providing supplementary guidance which

includes the Risk Assessment for Water Pipes (the 'RA') (Water UK 2014).
v) Performance of Building Materials in Contaminated Land report BR255 (BRE 1994).
vi) Risks of Contaminated Land to Buildings, Building Materials and Services. A Literature Review - Technical Report P331 (EA, 2000).
vii) Guidance on assessing and managing risks to buildings from land contamination - Technical Report P5 035/TR/01 (EA, 2001).

3.3 Potential to Harm Ecosystems, Animals, Crops etc

The criteria routinely used by Stantec as Tier 2 screening values to assess the potential of soil chemistry to harm ecosystems are taken from the following guidance and are summarised in Table 5.

i) Derivation and Use of Soil Screening Values for assessing ecological risks (EA, 2017a);
ii) The Restoration and Aftercare of Metalliferous Mining Sites for Pasture and Grazing (ICRCL 70/90, 1990);
iii) Sewage sludge on farmland: code of practice for England, Wales and Northern Ireland (DEFRA, 2018); and
iv) BS 3882:2015 Specification for topsoil and requirements for use (BSI, 2015).

Unless stated in the report the assessment is solely for phytotoxic parameters and additional assessment is required to determine suitability as a growing medium.

4 CRITERIA FOR EVALUATING LIQUID RESULTS

4.1 Potential Harm to Human Health via Ingestion

The Tier 2 water screening values routinely adopted by Stantec for assessing the potential for harm to human health via ingestion (presented as Table 6) are taken from The Water Supply (Water Quality) Regulations (S.I. 2018/647) unless otherwise indicated.

It should be noted that some of the prescribed concentrations listed in the Water Supply Regulations have been set for reasons other than their potential to cause harm to human health. The concentrations of iron and manganese are controlled because they may taint potable water with an undesirable taste, odour or colour or may potentially deposit precipitates in water supply pipes.

4.2 Potential Harm to Human Health via Inhalation of Vapours

The Tier 2 water screening values adopted by Stantec for assessing the potential for chronic human health risk from the inhalation of vapours from volatile contaminants in groundwater are presented in Table 7. These generic assessment criteria have been taken from a report published by the Society of Brownfield Risk Assessment (SoBRA) (SoBRA, 2017). The methodology adopted in their generation is considered compatible with the UK approach to deriving GAC and adopts a precautionary approach. As with all published GAC the suitability for use on the site being assessed has to be decided by the assessor based on a thorough understanding of the methodology and assumptions used in their derivation. Note, that the SoBRA groundwater vapour GAC are not intended for assessing risks to ground workers from short-term exposure.

Note that Table 7 shows the theoretical maximum aqueous solubility for each contaminant and indicates the GAC that exceed solubility. Measured concentrations in excess of solubility may be an indication that NAPL is present. As for the assessment of soils, if the presence of NAPL is deemed plausible the implications will be considered in the risk assessment.

4.3 Potential to Harm Controlled Waters

When assessing ground condition data and the potential to harm Controlled Waters Stantec uses the approach presented in the groundwater protection position statements published 14.03.17 (EA, 2017b) which describe the Environment Agency's approach to managing and protecting groundwater. They update and replace Groundwater Protection: principles and practice (GP3). Controlled Waters are rivers, estuaries, coastal waters, lakes and groundwaters. Water in the unsaturated zone is not groundwater but does come within the scope of the term "ground waters" as used and defined in the Water Resources Act 1991. It will continue to be a technical decision for the Environment Agency to determine what is groundwater in certain circumstances for the purposes of the Regulations. As discussed in our Methodology for Assessment of Land Contamination perched water is not considered a receptor in Stantec assessments.

The EU Water Framework Directive (WFD) 2000/60/EC provides for the protection of sub-surface, surface, coastal and territorial waters through a framework of river basin management.

The EU Updated Water Framework Standards Directive 2014/101/EU amended the EU WFD to update the international standards therein; it entered into force on 20 November 2014 with the requirement for its provisions to be transposed in Member State law by 20 May 2016.
Member States are required under the EU WFD to update their river basin management plans every six years. The first river basin management plans for England and Wales, Scotland and Northern

Ireland were published in December 2009, and these were updated in 2015.

Other EU Directives in the European water management framework include:

- the EU Priority Substances Directive 2013/39/EU;
- EU Groundwater Pollutants Threshold Values Directive 2014/80/EU amending the EU Groundwater Daughter Directive (GWDD) 2006/118/EC; and
- the EU Biological Monitoring Directive 2014/101/EU.

The Priority Substances Directive set environmental quality standards (EQS) for the substances in surface waters (river, lake, transitional and coastal) and confirmed their designation as priority or priority hazardous substances (PS), the latter being a subset of particular concern. Environmental Quality Standards for PS are determined at the European level and apply to all Member States. Member States identify and develop standards for 'Specific Pollutants'. Specific Pollutants (SP) are defined as substances that can have a harmful effect on biological quality.

The Water Framework Directive (Standards and Classification) Directions (England and Wales) (DEFRA, 2015) were issued to the Environment Agency as an associated document of the Water Environment (WFD) (England and Wales) Regulations 2015 (S.I. 2015/1623) and provide directions for the classification of surface water and groundwater bodies. Schedule 3 parts 2 and 3 relate to surface water standards for specific pollutants in fresh or salt water bodies and priority substances in inland (rivers, lakes and related modified/artificial bodies) or other surface waters respectively. Although Schedule 5 presents threshold values for groundwater the Direction specifically excludes their use as part of site-specific investigations.

Table 6 presents the criteria routinely used by Stantec as Tier 2 screening values. This table only presents a selection of the more commonly analysed parameters and the source documents should be consulted for other chemicals. For screening groundwater the criteria selected are the standards for surface water and/or human consumption as appropriate together with the following:-

For a **hazardous substance** Stantec adopts the approach that, if the concentration in a discharge to groundwater is less than the Minimum Reporting Value (MRV), the input is regarded as automatically meeting the Article 2 (b) 'de-minimus' requirement of exemption 6 (3) (b) of the GWDD. Stantec has selected hazardous substances from the latest list published by the Joint Agencies Groundwater Directive Advisory Group (JAGDAG, 2018). MRV is the lowest concentration of a substance that can be routinely determined with a known degree of confidence, and may not be equivalent to limit of detection. MRVs have been identified from DEFRA's guidance on Hazardous Substances to Groundwater: Minimum Reporting Values (DEFRA, 2017), and are shown in Table 6.

Note that for land contamination assessments, where hazardous substances have already entered groundwater, remediation targets would typically be based on achieving appropriate water quality standards (e.g. drinking water standard or EQS) at a compliance point rather than an MRV. For this reason, when assessing measured groundwater or soil leachate concentrations, the values for human consumption, fresh water and salt water shown in Table 6 (whichever is appropriate for the context of the site) will be used as the Tier 2 assessment criteria rather than MRV. For hazardous substances with no water quality standard the laboratory method detection limit will be used as the assessment criteria.

For **non-hazardous substances** the GWDD requires that inputs be limited to avoid deterioration. UKTAG guidance equates deterioration with pollution. Non-hazardous substances are all substances not classified as hazardous. For Stantec assessments the values for human consumption, fresh water and salt water shown in Table 6 (whichever is appropriate for the context of the site) are used as the assessment criteria for non-hazardous substances.

Note on Copper, Lead, Manganese, Nickel and Zinc

$EQS_{bioavailable}$ have been developed for UK Specific Pollutants copper, zinc and manganese and the EU priority substances lead and nickel. An EQS is the concentration of a chemical in the environment below which there is not expected to be an adverse effect on the specific endpoint being considered, e.g. the protection of aquatic life.

It is very difficult to measure the bioavailable concentration of a metal directly. The UK has developed simplified Metal Bioavailability Assessment Tool (M-BAT) for copper, zinc, nickel and manganese which uses local water chemistry data, specifically pH, dissolved organic carbon (DOC) (mg/L) and Calcium (Ca) (mg/L).

Where the recorded total dissolved concentration exceeds the screening criteria for these parameters ($EQS_{bioavailable}$) further assessment will be undertaken using the tools downloaded from [redacted]

The models calculate a risk characterisation ratio (RCR) and where this is greater than 1 this indicates the bioavailable concentration is above the EQS and the parameter is then identified as a potential hazard. The report will discuss this identified

hazard noting that the pH, calcium and, in particular, the dissolved organic carbon (DOC) in groundwater may be quite different to the receiving water (e.g. due to the presence to leaf litter or organic sediments dissolving in the water).

5 CRITERIA FOR EVALUATING GAS RESULTS

Stantec use the following primary guidance on gas monitoring methods and investigation, the assessment of risk posed by soil gases (including Volatile Organic Compounds (VOCs)) and mitigation measures/risk reduction during site development.

i) BS 8576:2013 – Guidance on Ground Gas Investigations: Permanent gases and Volatile Organic Compounds (VOCs) (BSI, 2013);
ii) TB18 Continuous Ground-Gas Monitoring and the Lines of Evidence Approach to Risk Assessment CL:AIRE Technical Bulletin TB18 (CL:AIRE 2019)
iii) RB17 A pragmatic approach to Ground Gas Risk Assessment. CL:AIRE Research Bulletin RB17 (Card et al, 2012);
iv) The VOCs Handbook. C682 (CIRIA, 2009).
v) Assessing risks posed by hazardous gases to buildings C665 (CIRIA, 2007);
vi) Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present. (NHBC, 2007); and
vii) BS 8485:2015+A1:2019- Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings (BSI, 2019).

Gas and borehole flow data are used to obtain the gas screening value (GSV) for methane and carbon dioxide. The GSV is used to establish the characteristic situation and to make recommendations for gas protection measures for buildings if required.

Radon

Stantec use the following primary guidance to assess the significance of the radon content of soil gas.

i) Radon: guidance on protective measures for new dwellings. Report BR211 (BRE, 2015); and
ii) Indicative Atlas of Radon in England and Wales (HPA & BGS, 2007).

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Table 1: Category 4 Screening Levels (C4SL)

	Allotments	Residential (with home-grown produce)	Residential (without home-grown produce)	Commercial	Public Open Space 1	Public Open Space 2
Arsenic	49	37	40	640	79	170
Benzene - 1% SOM* - 2.5% SOM* - 6% SOM	 0.039 0.081 0.18	 0.20 0.41 0.87	 0.89 1.6 3.3	 27 50 98	 140 140 140	 190 210 230
Benzo(a)pyrene (as a surrogate marker for carcinogenic PAHs)	5.7	5.0	5.3	77	10	21
Cadmium	3.9	22	150	410	220	880
Chromium VI	170	21	21	49	21	250
Lead	80	200	310	2300	630	1300

Units mg/kg dry weight

Values taken from SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document (Department for Environment, Food and Rural Affairs December 2014), unless stated otherwise
Public Open Space 1 – for grassed area adjacent to residential housing
Public Open Space 2 - Park Type Public Open Space Scenario
Based on a sandy loam as defined in SR3 (Environment Agency, 2009b)
Note that, with the exception of benzene, these C4SL are not SOM dependent
* - Stantec derived C4SL using CLEA v1.071

Table 2: Suitable 4 Use Levels (S4UL)

Determinand	Allotment	$R_{W}HP$	$R_{WO}HP$	Commercial/ Industrial	POSresi	POSpark
Metals						
Arsenic (**Inorganic**)[a, b, c]	43	37	40	640	79	170
Beryllium [a, b, d, e]	35	1.7	1.7	12	2.2	63
Boron [a, b, d]	45	290	11000	240000	21000	46000
Cadmium (**pH6-8**) [a, b, d, f]	1.9	11	85	190	120	560
Chromium (trivalent) [a, b, d, g]	18000	910	910	8600	1500	33000
Chromium (hexavalent) [a, b, c]	1.8[h]	6[i]	6[i]	33[i]	7.7[i]	220[i]
Copper [a, b, c]	520	2400	7100	68000	12000	44000
Mercury (elemental) [a, b, c, j]	21	1.2	1.2	58[vap] (25.8)	16	30[vap] (25.8)
Mercury (inorganic) [a, b, c]	19	40	56	1100	120	240
Methylmercury [a, b, c]	6	11	15	320	40	68
Nickel [a, b, c]	53[k]	130[e]	180[e]	980[e]	230[e]	800[k]
Selenium [a, b, c]	88	250	430	12000	1100	1800
Vanadium [a, b, c, i, j]	91	410	1200	9000	2000	5000
Zinc [a, b, c]	620	3700	40000	730000	81000	170000
BTEX Compounds (SOM 1%/ 2.5%/ 6%)						
Benzene [a, b, l, m]	0.017/0.034/ 0.075	0.087/0.17/ 0.37	0.38/0.7/1.4	27 / 47 / 90	72 / 72 / 73	90 / 100 / 110
Toluene [a, b, l, m]	22 / 51 / 120	130 / 290 / 660	880[vap] (869) /1900/3900	56000[vap] (869) / 110000[vap] (1920)/ 180000[vap] (4360)	56000 / 56000 / 56000	87000[vap](869)/ 95000[vap](1920)/ 100000[vap](4360)
Ethylbenzene [a, b, l, m]	16 / 39 / 91	47 / 110 / 260	83 / 190 / 440	5700[vap] (518) / 13000[vap] (1220) / 27000[vap] (2840)	24000 / 24000 / 25000	17000[vap] (518) / 22000[vap](1220) / 27000[vap] (2840)
O – Xylene [a, b, l, m, n]	28 / 67 / 160	60 / 140 / 330	88 / 210 / 480	6600[sol] (478) / 15000[sol] (1120) / 33000[sol] (2620)	41000 / 42000 / 43000	17000[sol] (478) / 24000[sol] (1120) / 33000[sol] (2620)
M – Xylene [a, b, l, m, n]	31 / 74 / 170	59 / 140 / 320	82 / 190 / 450	6200[vap] (625) / 14000[vap] (1470) / 31000[vap] (3460)	41000 / 42000 / 43000	17000[vap] (625) / 24000[vap](1470) / 32000[vap] (3460)
P – Xylene [a, b, l, m, n]	29 / 69 / 160	56 / 130 / 310	79 / 180 / 430	5900[sol] (576) / 14000[sol] (1350) / 30000[sol] (3170)	41000 / 42000 / 43000	17000[sol] (576) / 23000[sol] (1350) / 31000[sol] (3170)
Total xylenes [t]	28 / 67 / 160	56 / 130 / 310	79 / 180 / 430	5900[sol] (576) / 14000[sol] (1350) / 30000[sol] (3170)	41000 / 42000 / 43000	17000[sol] (576) / 23000[sol] (1350) / 31000[sol] (3170)
Polycyclic Aromatic Hydrocarbons (SOM 1%/ 2.5%/ 6%) [a, b, l, p]						
Acenaphthene	34 / 85 / 200	210 / 510 / 1100	3000[sol](57.0)/ 4700[sol] (141)/ 6000[sol] (336)	84000[sol] (57.0)/ 97000[sol] (141)/ 100000	15000 / 15000 / 15000	29000/ 30000/ 30000
Acenaphthylene	28 / 69 / 160	170 / 420 / 920	2900[sol](86.1)/ 4600[sol] (212)/ 6000[sol] (506)	83000[sol] (86.1)/ 97000[sol] (212)/ 100000	15000 / 15000 / 15000	29000 / 30000 / 30000
Anthracene	380 / 950 / 2200	2400 / 5400 / 11000	31000[sol](1.17) /35000/ 37000	520000/ 540000/ 540000	74000 / 74000 / 74000	150000 / 150000 / 150000
Benzo(a)anthracene	2.9 / 6.5 / 13	7.2 / 11 / 13	11 / 14 / 15	170 / 170 / 180	29 / 29 / 29	49 / 56 / 62
Benzo(a)pyrene (Bap) [u]	0.97 / 2.0 / 3.5	2.2 / 2.7 / 3.0	3.2 / 3.2 / 3.2	35 / 35 / 36	5.7 / 5.7 / 5.7	11 / 12 / 13
Benzo(b)fluoranthene	0.99 / 2.1 / 3.9	2.6 / 3.3 / 3.7	3.9 / 4.0 / 4.0	44 / 44 / 45	7.1 / 7.2 / 7.2	13 / 15 / 16

Determinand	Allotment	R_WHP	$R_{WO}HP$	Commercial/ Industrial	POSresi	POSpark
Benzo(g,h,i)perylene	290 / 470 / 640	320 / 340 / 350	360 / 360 / 360	3900 / 4000 / 4000	640 / 640 / 640	1400 / 1500 / 1600
Benzo(k)fluoranthene	37 / 75 / 130	77 / 93 / 100	110 / 110 / 110	1200 / 1200 /1200	190 / 190 / 190	370 / 410 / 440
Chrysene	4.1 / 9.4 / 19	15 / 22 / 27	30 / 31 / 32	350 / 350 / 350	57 / 57 / 57	93 / 110 / 120
Dibenzo(ah)anthracene	0.14 / 0.27 / 0.43	0.24 / 0.28 / 0.3	0.31 / 0.32 / 0.32	3.5 / 3.6 / 3.6	0.57 / 0.57 / 0.58	1.1 / 1.3 / 1.4
Fluoranthene	52 / 130 / 290	280 / 560 / 890	1500 / 1600 / 1600	23000 / 23000 / 23000	3100 / 3100 / 3100	6300 / 6300 / 6400
Fluorene	27 / 67 / 160	170 / 400 / 860	2800[sol] (30.9) /3800[sol] (76.5) /4500[sol] (183)	63000[sol] (30.9) / 68000 / 71000	9900 / 9900 / 9900	20000 / 20000 / 20000
Indeno(1,2,3-cd)pyrene	9.5 / 21 / 39	27 / 36 / 41	45 / 46 / 46	500 / 510 / 510	82 / 82 / 82	150 / 170 / 180
Naphthalene [q]	4.1 / 10 / 24	2.3 / 5.6 / 13	2.3 / 5.6 / 13	190[sol] (76.4) / 460[sol] (183) / 1100[sol] (432)	4900/ 4900/ 4900	1200[sol] (76.4) / 1900[sol] (183) / 3000
Phenanthrene	15 / 38 / 90	95 / 220 / 440	1300[sol](36.0) / 1500 / 1500	22000 / 22000 / 23000	3100 / 3100 / 3100	6200 / 6200 / 6300
Pyrene	110 / 270 / 620	620 / 1200 / 2000	3700 / 3800 / 3800	54000 / 54000 / 54000	7400 / 7400 / 7400	15000 / 15000 / 15000
Coal Tar (Bap as surrogate marker) [u]	0.32 / 0.67 / 1.2	0.79 / 0.98 / 1.1	1.2 / 1.2 / 1.2	15 / 15 / 15	2.2 / 2.2 / 2.2	4.4 / 4.7 / 4.8
Explosives [a, b, l, p]						
2, 4, 6 Trinitrotoluene	0.24 / 0.58 / 1.40	1.6 / 3.7 / 8.0	65 / 66 / 66	1000 / 1000 / 1000	130 / 130 / 130	260 / 270 / 270
RDX (Royal Demolition Explosive $C_3H_6N_6O_6$)	17 / 38 / 85	120 / 250 / 540	13000 / 13000 / 13000	210000 / 210000 / 210000	26000 / 26000 / 27000	49000[sol] (18.7) / 51000 / 53000
HMX (High Melting Explosive $C_4H_8N_8O_8$)	0.86 / 1.9 / 3.9	5.7 / 13 / 26	6700 / 6700 / 6700	110000 / 110000 / 110000	13000 / 13000 / 13000	23000[vap] (0.35) /23000[vap] (0.39) /24000[vap] (0.48)
Petroleum Hydrocarbons (SOM 1%/ 2.5%/ 6%) [a, b, l, m]						
Aliphatic EC 5-6	730 / 1700 / 3900	42 / 78 / 160	42 / 78 / 160	3200[sol] (304) / 5900[sol] (558) / 12000[sol] (1150)	570000[sol](304) 590000 / 600000	95000[sol] (304) / 130000[sol] (558)/ 180000[sol](1150)
Aliphatic EC >6-8	2300 / 5600 / 13000	100 / 230 / 530	100 / 230 / 530	7800[sol] (144) / 17000[sol] (322) / 40000[sol] (736)	600000 / 610000 / 620000	150000[sol] (144) 220000[sol] (322)/ 320000[sol] (736)
Aliphatic EC >8-10	320 / 770 / 1700	27 / 65 / 150	27 / 65 / 150	2000[sol] (78) / 4800[vap] (190) / 11000[vap] (451)	13000 / 13000 / 13000	14000[sol] (78) / 18000[vap] (190) / 21000[vap] (451)
Aliphatic EC >10-12	2200 / 4400 / 7300	130v[ap] (48) / 330[vap] (118) / 760[vap] (283)	130v[ap] (48) / 330[vap] (118) / 770[vap] (283)	9700[sol] (48) / 23000[vap] (118) / 47000[vap] (283)	13000 / 13000 / 13000	21000[sol] (48) / 23000[vap] (118) / 24000[vap] (283)
Aliphatic EC >12-16	11000 / 13000 / 13000	1100[sol] (24) / 2400[sol] (59) / 4300[sol] (142)	1100[sol] (24) / 2400[sol] (59) / 4400[sol] (142)	59000[sol] (24) / 82000[sol] (59) / 90000[sol] (142)	13000 / 13000 / 13000	25000[sol] (24) / 25000[sol] (59) / 26000[sol] (142)
Aliphatic EC >16-35 °	260000 / 270000 / 270000	65000[sol](8.48 92000[sol] (21) 110000	65000[sol] (8.48 92000[sol] (21) 110000	1600000 / 1700000 / 1800000	250000 / 250000 / 250000	450000 / 480000 / 490000
Aliphatic EC >35-44 °	260000 / 270000 / 270000	65000[sol](8.48 92000[sol] (21) / 110000	65000[sol](8.48 92000[sol] (21) 110000	1600000 / 1700000 / 1800000	250000 / 250000 / 250000	450000 / 480000 / 490000
Aromatic EC 5-7 (benzene)	13 / 27 / 57	70 / 140 / 300	370 / 690 / 1400	26000[sol] (1220) / 46000[sol] (2260) / 86000[sol] (4710)	56000 / 56000 / 56000	76000[sol] (1220) /84000[sol](2260)/ 92000[sol] (4710)
Aromatic EC >7-8 (toluene)	22 / 51 / 120	130 / 290 / 660	860 / 1800 / 3900	56000[vap] (869)/ 110000[sol] (1920)/ 180000[vap] (4360)	56000 / 56000 / 56000	87000[vap](869) / 95000[sol] (1920)/ 100000[vap](4360)
Aromatic EC >8-10	8.6 / 21 / 51	34 / 83 / 190	47 / 110 / 270	3500[vap] (613) / 8100[vap] (1500) / 17000[vap] (3580)	5000 / 5000 / 5000	7200[vap](613) / 8500[vap] (1500) / 9300[vap] (3580)
Aromatic EC >10-12	13 / 31 / 74	74 / 180 / 380	250 / 590 / 1200	16000[sol] (364) / 28000[sol] (899) / 34000[sol] (2150)	5000 / 5000 / 5000	9200[sol] (364) / 9700[sol] (899) / 10000
Aromatic EC >12-16	23 / 57 / 130	140 / 330 / 660	1800 / 2300[sol] (419) / 2500	36000[sol] (169) / 37000 / 38000	5100 / 5100 / 5000	10000 / 10000 / 10000
Aromatic EC >16-21 °	46 / 110 / 260	260 / 540 / 930	1900 / 1900 / 1900	28000 / 28000 / 28000	3800 / 3800 / 3800	7600 / 7700 / 7800
Aromatic EC >21-35 °	370 / 820 / 1600	1100 / 1500 / 1700	1900 / 1900 / 1900	28000 / 28000 / 28000	3800 / 3800 / 3800	7800 / 7800 / 7900
Aromatic EC >35-44 °	370 / 820 / 1600	1100 / 1500 / 1700	1900 / 1900 / 1900	28000 / 28000 / 28000	3800 / 3800 / 3800	7800 / 7800 / 7900
Aliphatic+Aromatic EC >44-70 °	1200 / 2100 / 3000	1600 / 1800 / 1900	1900 / 1900 / 1900	28000 / 28000 / 28000	3800 / 3800 / 3800	7800 / 7800 / 7900
Chloroalkanes & Chloroalkenes (SOM 1%/ 2.5%/ 6%) [a, b, l, p]						
1,2-Dichloroethane	0.0046 / 0.0083 / 0.016	0.0071 / 0.011 / 0.019	0.0092 / 0.013 / 0.023	0.67 / 0.97 / 1.7	29 / 29 / 29	21 / 24 / 28

Determinand	Allotment	R_WHP	$R_{WO}HP$	Commercial/ Industrial	POSresi	POSpark
1,1,1 Trichloroethane (TCA)	48 / 110 / 240	8.8 / 18 / 39	9.0 / 18 / 40	660 / 1300 / 3000	140000 / 140000 / 140000	57000[vap](1425) 76000[vap](2915)/ 100000[vap](6392)
1,1,1,2 Tetrachloroethane	0.79 / 1.9 / 4.4	1.2 / 2.8 / 6.4	1.5 / 3.5 / 8.2	110 / 250 / 560	1400 / 1400 / 1400	1500 / 1800 / 2100
1,1,2,2 Tetrachloroethane	0.41 / 0.89 / 2.0	1.6 / 3.4 / 7.5	3.9 / 8.0 / 17	270 / 550 / 1100	1400 / 1400 / 1400	1800 / 2100 / 2300
Tetrachloroethene (PCE)	0.65 / 1.5 / 3.6	0.18 / 0.39 / 0.90	0.18 / 0.4 / 0.92	19 / 42 / 95	1400 / 1400 / 1400	810[sol](424)/1100[s ol] (951)/1500
Tetrachloromethane (Carbon Tetrachloride)	0.45 / 1.0 / 2.4	0.026 / 0.056 / 0.13	0.026 / 0.056 / 0.13	2.9 / 6.3 / 14	890 / 920 / 950	190 / 270 / 400
Trichloroethene (TCE)	0.041 / 0.091 / 0.21	0.016 / 0.034 / 0.075	0.017 / 0.036 / 0.080	1.2 / 2.6 / 5.7	120 / 120 / 120	70 / 91 / 120
Trichloromethane (Chloroform)	0.42 / 0.83 / 1.7	0.91 / 1.7 / 3.4	1.2 / 2.1 / 4.2	99 / 170 / 350	2500 / 2500 / 2500	2600 / 2800 / 3100
Chloroethene (Vinyl Chloride)	0.00055/ 0.001/ 0.0018	0.00064 / 0.00087/ 0.0014	0.00077 / 0.001 / 0.0015	0.059 / 0.077 / 0.12	3.5 / 3.5 / 3.5	4.8 / 5.0 / 5.4
Phenol & Chlorophenols [a, b, l, p]						
Phenol	23 / 42 / 83	120 / 200 / 380	440 / 690 / 1200	440[dir] (26000) / 690[dir] (30000) / 1300[dir] (34000)	440[dir] (10000)/ 690[dir](10000) 1300[dir](10000)	440[dir] (7600) / 690[dir] (8300) / 1300[dir] (93000)
Chlorophenols (excluding PCP) [r]	0.13[s] / 0.3 / 0.7	0.87[s] / 2.0 / 4.5	94 / 150 / 210	3500 / 4000 / 4300	620 / 620 / 620	1100 / 1100 / 1100
Pentachlorophenol (PCP)	0.03 / 0.08 / 0.19	0.22/ 0.52 / 1.2	27[vap] (16.4) / 29 / 31	400 / 400 / 400	60 / 60 / 60	110 / 120 / 120
Other [a, b, l, p]						
Carbon Disulphide	4.8 / 10 / 23	0.14 / 0.29 / 0.62	0.14 / 0.29 / 0.62	11 / 22 / 47	11000 / 11000 / 12000	1300 / 1900 / 2700
Hexachlorobutadiene (HCBD)	0.25 / 0.61 / 1.4	0.29 / 0.7 / 1.6	0.32 / 0.78 / 1.8	31 / 66 / 120	25 / 25 / 25	48 / 50 / 51
Pesticides (SOM 1%/ 2.5%/ 6%) [a, b, l, p]						
Aldrin	3.2 / 6.1 / 9.6	5.7/ 6.6 /7.1	7.3 / 7.4 / 7.5	170 / 170 / 170	18 / 18 / 18	30 / 31 / 31
Atrazine	0.5 / 1.2 / 2.7	3.3 / 7.6 / 17.4	610 / 620 / 620	9300 / 9400 / 9400	1200 / 1200 / 1200	2300 / 2400 / 2400
Dichlorvos	0.0049 / 0.010 / 0.022	0.032 / 0.066 / 0.14	6.4 / 6.5 / 6.6	140 / 140 / 140	16 / 16 / 16	26 / 26 / 27
Dieldrin	0.17/0.41/0.96	0.97/ 2 / 3.5	7.0 / 7.3 / 7.4	170 / 170 / 170	18 / 18 / 18	30 / 30 / 31
Alpha - Endosulfan	1.2 / 2.9 / 6.8	7.4 / 18 / 41	160[vap] (0.003)/ 280[vap] (0.007)/ 410[vap] (0.016)	5600[vap] (0.003) / 7400[vap] (0.007) / 8400[vap] (0.016)	1200 / 1200 / 1200	2400 / 2400 / 2500
Beta - Endosulfan	1.1 / 2.7 / 6.4	7.0 / 17 / 39	190[vap](0.00007) /320[vap](0.0002) /440[vap](0.0004)	6300[vap](0.00007) /7800[vap](0.0002) / 8700	1200 / 1200 / 1200	2400 / 2400 / 2500
Alpha-Hexachlorocyclohexane	0.035/0.087/ 0.21	0.23/0.55 / 1.2	6.9 / 9.2 / 11	170 / 180 / 180	24 / 24 / 24	47 / 48 / 48
Beta - Hexachlorocyclohexane	0.013 / 0.032 / 0.077	0.085 / 0.2 / 0.46	3.7 / 3.8 / 3.8	65 / 65 / 65	8.1 / 8.1 / 8.1	15 / 15 / 16
Gamma – Hexachlorocyclohexane	0.0092 / 0.023 / 0.054	0.06 / 0.14 / 0.33	2.9 / 3.3 / 3.5	67 / 69 / 70	8.2 / 8.2 / 8.2	14 / 15 / 15
Chlorobenzenes [a, b, l, p]						
Chlorobenzene	5.9 / 14 / 32	0.46 / 1.0 / 2.4	0.46 / 1.0 / 2.4	56 / 130 / 290	11000 / 13000 / 14000	1300[sol](675)/ 2000[sol](1520)/ 2900
1,2-dichlorobenzene (1,2-DCB)	94 / 230 / 540	23 / 55 / 130	24 / 57 / 130	2000[sol] (571) / 4800[sol] (1370) / 11000[sol] (3240)	90000 / 95000 / 98000	24000[sol] (571) / 36000[sol] (1370) /51000[sol] (3240)
1,3-dichlorobenzene (1,3-DCB)	0.25 / 0.6 / 1.5	0.4 / 1.0 / 2.3	0.44 /1.1 / 2.5	30 / 73 / 170	300 / 300 / 300	390 / 440 / 470
1-4-dichlorobenzene (1,4-DCB)	15[i] / 37[i] / 88 [i]	61[q] / 150[q] /350 [q]	61[q] / 150[q] / 350[q]	4400[vap,q] (224) / 10000[vap,q] (540) / 25000[vap,q] (1280)	17000[i] / 17000[i] / 17000[i]	36000[vap,i] (224) 36000[vap, i](540)/ 36000[vap,i](1280)
1,2,3-Trichlorobenzene	4.7 / 12 / 28	1.5 / 3.6 / 8.6	1.5 / 3.7 / 8.8	102 / 250 / 590	1800 / 1800 / 1800	770[vap] (134) / 1100[vap] (330) / 1600[vap] (789)
1,2,4- Trichlorobenzene	55 / 140 / 320	2.6 / 6.4 / 15	2.6 / 6.4 / 15	220 / 530 / 1300	15000 / 17000 / 19000	1700[vap] (318) / 2600[vap] (786) / 4000[vap] (1880)
1,3,5- Trichlorobenzene	4.7 / 12 / 28	0.33 / 0.81 / 1.9	0.33 / 0.81 / 1.9	23 / 55 / 130	1700 / 1700 / 1800	380[vap] (36.7) / 580[vap] (90.8) / 860[vap] (217)
1,2,3,4-Tetrachlorobenzene	4.4 / 11 / 26	15 / 36 / 78	24 / 56 / 120	1700[vap] (122) / 3080[vap] (304) / 4400[vap] (728)	830 / 830 / 830	1500[vap] (122) / 1600 / 1600
1,2,3,5- Tetrachlorobenzene	0.38 / 0.90 / 2.2	0.66 / 1.6 / 3.7	0.75 / 1.9 / 4.3	49[vap] (39.4) / 120[vap] (98.1) / 240[vap] (235)	78 / 79 / 79	110[vap] (39.4) / 120 / 130
1,2,4,5- Tetrachlorobenzene	0.06 / 0.16 / 0.37	0.33 / 0.77 / 1.6	0.73 / 1.7 / 3.5	42[sol] (19.7) / 72[sol] (49.1) / 96	13 / 13 / 13	25 / 26 / 26

Determinand	Allotment	R_WHP	$R_{WO}HP$	Commercial/ Industrial	POSresi	POSpark
Pentachlorobenzene (P_ECB)	1.2 / 3.1 / 7.0	5.8 / 12 / 22	19 / 30 / 38	640^{sol} (43.0) / 770^{sol} (107) / 830	100 / 100 / 100	190 / 190 / 190
Hexachlorobenzene (HCB)	0.47 / 1.1 / 2.5	1.8^{vap} (0.20) / 3.3^{vap} (0.5) / 4.9	4.1^{vap} (0.20) / 5.7^{vap} (0.5) / 6.7^{vap} (1.2)	110^{vap} (0.20) / 120 / 120	16 / 16 / 16	30 / 30 / 30

Units are mg/kg Dry Weight

R_WHP Residential with homegrown produce
$R_{WO}HP$ Residential without homegrown produce
POSresi public open spaces near residential housing
POSpark public open space for recreational use but not dedicated sports pitches
SOM Soil Organic Matter – ***the S4UL for all organic compounds will vary according to SOM***

a Based on a sandy loam soil as defined in SR3 (Environment Agency, 2009b) and 6% soil organic matter (SOM)
b Figures rounded to two significant figures
c Based only on a comparison of oral and dermal soil exposure with oral Index Dose
d The background ADE is limited to being no larger than the contribution from the relevant soil ADE
e Based on comparison of inhalation exposure with inhalation TDI only
f Based on a lifetime exposure via the oral, dermal and inhalation pathways
g Based on localised effects comparing inhalation exposure with inhalation ID only
h Based on comparison of inhalation exposure with inhalation ID
i Based on comparison of oral and dermal exposure with oral TDI
j Based on comparison of oral, dermal and inhalation exposure with inhalation TDI
k Based on comparison of all exposure pathways with oral TDI
l S4ULs assume that free phase contamination is not present
m S4ULs based on a sub-surface soil to indoor air correction factor of 10
n The HCV applied is based on the intake of total Xylene and therefore exposure should not consider an isomer in isolation
o Oral, dermal and inhalation exposure compared with oral HCV
p S4ULs based on a sub-surface soil to indoor air correction factor of 1
q Based on a comparison of inhalation exposure with the inhalation TDI for localised effects
r Based on 2,4-dichlorophenol unless otherwise stated
s Based on 2,3,4,6-tetrachlorophenol
t Based on lowest GAC for all three xylene isomers
u Measured concentrations of benzo(a)pyrene should be compared to the S4UL for benzo(a)pyrene as a single compound and to the S4UL for benzo(a)pyrene as a surrogate marker of genotoxic PAHs.
vap S4UL presented exceeded the vapour saturation limit, which is presented in brackets
sol S4UL presented exceeds the solubility saturation limit, which is presented in brackets
dir S4ULs based on a threshold protective of direct skin contact, guideline in brackets based on the health effects following long term exposure provided for illustration only

Table 3: Soil Guideline Values (SGVs) for dioxins, furans and dioxin like PCBs

Determinand	Allotments	Residential with consumption of homegrown produce	Residential without consumption of homegrown produce	Commercial
Sum of PCDDs, PCDFs and dioxin-like PCBs	0.008	0.008	0.008	0.24

Units are mg/kg Dry Weight

Table 4: EIC/AGS/CL:AIRE Generic Assessment Criteria (GAC)

	Allotments	Residential with consumption of homegrown produce	Residential without consumption of homegrown produce	Commercial	Soil Saturation Concentration
Metals					
Antimony	ND	ND	550	7500	NA
Barium	ND	ND	1300	22000	NA
Molybdenum	ND	ND	670	17000	NA
Organics (SOM 1%/ 2.5%/ 6%)					
1,1,2 Trichloroethane	0.28 / 0.61 / 1.4	0.6 / 1.2 / 2.7	0.88 / 1.8 / 3.9	94 / 190 / 400	4030 / 8210 / 18000
1,1-Dichloroethane	9.2 / 17 / 35	2.4 / 3.9 / 7.4	2.5 / 4.1 / 7.7	280 / 450 / 850	1830 / 2960 / 5600
1,1-Dichloroethene	2.8 / 5.6 / 12	0.23 / 0.4 / 0.82	0.23 / 0.41 / 0.82	26 / 46 / 92	2230 / 3940 / 7940
1,2,4-Trimethylbenzene	0.38 / 0.93 / 2.2	0.35 / 0.85 / 2	0.41 / 0.99 / 2.3	42 / 99 / 220	557 / 1360 / 3250
1,2-Dichloropropane	0.62 / 1.2 / 2.6	0.024 / 0.042 / 0.084	0.024 / 0.042 / 0.085	3.3 / 5.9 / 12	1190 / 2110 / 4240
2,4-Dimethylphenol	3.1 / 7.2 / 17	19 / 43 / 97	210 / 410 / 730	16000 / 24000 / 30000	1380 / 3140 / 7240
2,4-Dinitrotoluene	0.22 / 0.49 / 1.1	1.5 / 3.2 / 7.2	170 / 170 / 170	3700 / 3700 / 3800	141 / 299 / 669
2,6-Dinitrotoluene	0.12 / 0.27 / 0.61	0.78 / 1.7 / 3.9	78 / 84 / 87	1900 / 1900 / 1900	287 / 622 / 1400
2-Chloronaphthalene	40 / 98 / 230	3.7 / 9.2 / 22	3.8 / 9.3 / 22	390 / 960 / 2200	114 / 280 / 669
Biphenyl	14 / 35 / 83	66 / 160 / 360	220 / 500 / 980	18000 / 33000 / 48000	34.4 / 84.3 / 201
Bis (2-ethylhexyl) phthalate	47 / 120 / 280	280 / 610 / 1100	2700 / 2800 / 2800	85000 / 86000 / 86000	8.68 / 21.6 / 51.7

	Allotments	Residential with consumption of homegrown produce	Residential without consumption of homegrown produce	Commercial	Soil Saturation Concentration
Bromobenzene	3.2 / 7.6 / 18	0.87 / 2 / 4.7	0.91 / 2.1 / 4.9	97 / 220 / 520	853 / 1970 / 4580
Bromodichloromethane	0.016 / 0.032 / 0.068	0.016 / 0.03 / 0.061	0.019 / 0.034 / 0.07	2.1 / 3.7 / 7.6	1790 / 3220 / 6570
Bromoform	0.95 / 2.1 / 4.6	2.8 / 5.9 / 13	5.2 / 11 / 23	760 / 1500 / 3100	2690 / 5480 / 12000
Butyl benzyl phthalate	220 / 550 / 1300	1400 / 3300 / 7200	42000 / 44000 / 44000	940000 / 940000 / 950000	26.3 / 64.7 / 154
Chloroethane	110 / 200 / 380	8.3 / 11 / 18	8.4 / 11 / 18	960 / 1300 / 2100	2610 / 3540 / 5710
Chloromethane	0.066 / 0.13 / 0.23	0.0083 / 0.0098 / 0.013	0.0085 / 0.0099 / 0.013	1 / 1.2 / 1.6	1910 / 2240 / 2990
Cis 1,2 Dichloroethene	0.26 / 0.5 / 1	0.11 / 0.19 / 0.37	0.12 / 0.2 / 0.39	14 / 24 / 47	3940 / 6610 / 12900
Dichloromethane	0.1 / 0.19 / 0.34	0.58 / 0.98 / 1.7	2.1 / 2.8 / 4.5	270 / 360 / 560	7270 / 9680 / 15300
Diethyl Phthalate	19 / 41 / 94	120 / 260 / 570	1800 / 3500 / 6300	150000 / 220000 / 290000	13.7 / 29.1 / 65
Di-n-butyl phthalate	2 / 5 / 12	13 / 31 / 67	450 / 450 / 450	15000 / 15000 / 15000	4.65 / 11.4 / 27.3
Di-n-octyl phthalate	940 / 2100 / 3900	2300 / 2800 / 3100	3400 / 3400 / 3400	89000 / 89000 / 89000	32.6 / 81.5 / 196
Hexachloroethane	0.27 / 0.67 / 1.6	0.2 / 0.48 / 1.1	0.22 / 0.54 / 1.3	22 / 53 / 120	8.17 / 20.1 / 48.1
Isopropylbenzene	32 / 79 / 190	11 / 27 / 64	12 / 28 / 67	1400 / 3300 / 7700	390 / 950 / 2250
Methyl tert-butyl ether (MTBE)	23 / 44 / 90	49 / 84 / 160	73 / 120 / 220	7900 / 13000 / 24000	20400 / 33100 / 62700
Propylbenzene	34 / 83 / 200	34 / 82 / 190	40 / 97 / 230	4100 / 9700 / 21000	402 / 981 / 2330
Styrene	1.6 / 3.7 / 8.7	8.1 / 19 / 43	35 / 78 / 170	3300 / 6500 / 11000	626 / 1440 / 3350
Total Cresols (2-, 3- and 4-methylphenol)	12 / 27 / 63	80 / 180 / 400	3700 / 5400 / 6900	160000 / 180000 / 180000	15000 / 32500 / 73300
Trans 1,2 Dichloroethene	0.93 / 1.9 / 4	0.19 / 0.34 / 0.7	0.19 / 0.35 / 0.71	22 / 40 / 81	3420 / 6170 / 12600
Tributyl tin oxide	0.042 / 0.1 / 0.24	0.25 / 0.59 / 1.3	1.4 / 3.1 / 5.7	130 / 180 / 200	41.3 / 101 / 241

Units are mg/kg Dry Weight

Table 5: Tier 2 Criteria for the Assessment of Soils – Protection of Flora and Fauna

Parameter	ICRCL 70/90 [a]		SSVs [b]	Code of Practice for Agricultural Use of Sewage Sludge [c]	BS 3882:2015 Specification for topsoil and requirements for use
	Maximum				Phytotoxic contaminants
	Livestock	Crop Growth			
	mg/kgDW	mg/kgDW	mg/kgDW	mg/kgDW	mg/kgDW
Antimony			37		
Arsenic	500	1000		50	
Cadmium	30	50	0.6	3	
Chromium				400	
Cobalt			4.2		
Copper	500	250	35.1	80/ 100/ 135/ 200 [d]	<100/<135/<200 [e]
Fluoride	1000			500	
Lead	1000			300	
Mercury				1	
Molybdenum			5.1	4	
Nickel			28.2	50/ 60/ 75/ 110 [d]	<60/<75/<110 [e]
Selenium				3	
Silver			0.3		
Vanadium			2.0		
Zinc	3000	1000	35.6	200/200/200/300 [d]	<200/<200/<300 [e]
Benzo(a)pyrene			0.15		
Bis(2-ethylhexyl) phthalate			13		
Hexachlorobenzene			0.002		
Pentachlorobenzene					
Pentachlorophenol			0.6		
Perfluorooctanoic acid			0.022		
Perfluorooctane sulfonate			0.014		
Polychlorinated alkanes medium chain			11.9		
Tetrachloroethene					
Toluene					
Triclosan			0.13		

Parameter	ICRCL 70/90 [a]		SSVs [b]	Code of Practice for Agricultural Use of Sewage Sludge [c]	BS 3882:2015 Specification for topsoil and requirements for use
	Maximum				Phytotoxic contaminants
	Livestock	Crop Growth			
	mg/kgDW	mg/kgDW	mg/kgDW	mg/kgDW	mg/kgDW
Tris(2-chloroethyl)phosphate			1.1		
Tris(2-chloro-1-methylethyl) phosphate			1.8		

a. Interdepartmental Committee on the Redevelopment of Contaminated Land (ICRCL) 70/90 Restoration and Aftercare of Metalliferous Mining Sites for Pasture and Grazing 1st edition 1990.
b. Soil screening values for assessing ecological risks, EA 2017a Report – ShARE id26
c. Maximum permissible concentration of potentially toxic elements for Arable land from the Sewage sludge in agriculture: code of practice.. There are also criteria for Grassland which are higher than for Arable.
d. Where four values are presented, concentrations are for soils with pH values 5.0-5.5/ 5.5-6.0/ 6.0-7.0/ >7.0 (and the soils contain more than 5% calcium carbonate)
e. Where three values are presented, concentrations are for soils with pH values <6.0/ 6.0-7.0/ >7.0

Table 6: Tier 2 Criteria for Screening Liquids

	Screening Concentration (mg/l)			
	Minimum Reporting Value	Human Consumption	Fresh Water/Inland	Salt Water/Other
Arsenic SP	-	0.01	0.05 (2)	0.025 (2)
Boron	-	1	-	-
Cadmium PS	0.0001	0.005	≤0.00008, 0.00008, 0.00009, 0.00015, 0.00025 (14)	0.0002
Chromium (total)	-	0.05	-	-
Chromium (III) SP	-	-	0.0047	-
Chromium (VI) SP	-	-	0.0034	0.0006
Copper SP	-	2	0.001 bioavailable	0.00376 bioavailable
Iron SP	-	0.2	1	1
Lead PS	-	0.01	0.0012 bioavailable	0.0013 bioavailable
Mercury compounds PS	0.00001	0.001	0.00007 max	0.00007 max
Manganese SP	-	0.05	0.123 bioavailable	-
Nickel PS	-	0.02	0.004 bioavailable	0.0086 bioavailable
Selenium	-	0.01	-	-
Zinc SP	-	5(3)	0.0109bioavailable(13)	0.0068bioavailable (13)
Chlorinated Compounds				
C10-13 chloroalkanes PS short chain chlorinated paraffins	-	-	0.0004	0.0004
Dichloromethane PS	-	-	0.02	0.02
1,2-Dichloroethane PS	0.001	0.003	0.01	0.01
Trichloroethene PS	0.0001	0.01(5)	0.01	0.01
1,1,1-Trichloroethane	0.0001	-	-	-
1,1,2-Trichloroethane	0.0001	-	-	-
Trichloromethanes PS	-	0.1(1)	0.0025	0.0025
1, 2, 4-Trichlorobenzene	0.00001			
Tetrachloroethene PS	0.0001	0.01(5)	0.01	0.01
Tetrachloromethane PS	0.0001	0.003	0.012	0.012
Tetrachloroethane SP	-		0.140	
Vinyl chloride	-	0.0005	-	-
Trichlorobenzene (TCB) PS	-	-	0.0004	0.0004
Chloroform	0.0001			
Chloronitrotoluenes(CNT)(11)	0.001	-	-	-
Hexachlorobutadiene PS	0.000005	-	0.0006 max	0.0006 max
Hexachlorocyclohexanes (HCH) PS	0.000001	-	0.00002	0.000002
Polycyclic Aromatic Hydrocarbons				
Acenaphthene	-	-	-	-

	Screening Concentration (mg/l)			
	Minimum Reporting Value	**Human Consumption**	**Fresh Water/Inland**	**Salt Water/Other**
Acenaphthylene	-	-	-	-
Anthracene PS	-	-	0.0001	0.0001
Benzo(a)anthracene	-	-	-	-
Benzo(b)fluoranthene PS	-	0.0001 (10)	0.000017 max (12)	0.000017 max (12)
Benzo(a)pyrene PS	-	0.00001	0.00000017	0.00000017
Benzo(k)fluoranthene PS	-	0.0001 (10)	0.000017 max (12)	0.000017 max (12)
Benzo(g,h,i)perylene PS	-	0.0001 (10)	0.0000082 max (12)	0.00000082 max (12)
Indeno(1,2,3-cd)pyrene PS	-	0.0001 (10)	- (12)	- (12)
Chrysene		-	-	-
Dibenzo(a,h)anthracene		-	-	-
Fluoranthene PS	-	-	0.0000063	0.0000063
Fluorene	-	-	-	-
Phenanthrene	-	-	-	-
Pyrene	-	-	-	-
Naphthalene PS	-	-	0.002	0.002
Polycyclic Aromatic Hydrocarbons		0.0001(10)		
Petroleum hydrocarbons				
Total petroleum hydrocarbons	-	0.01(3)	-	-
Benzene PS	0.001	0.001	0.01	0.008
Toluene SP	0.004	0.7(9)	0.074	0.074
Ethylbenzene	-	0.3(9)	-	-
Xylenes	0.003(4)	0.5(9)		
Methyl tert-butyl ether (MTBE)	-	0.015(7)	-	-
Pesticides and Herbicides				
Alachlor PS	-	-	0.0003	0.0003
Aldrin PS	0.000003	0.00003	0.00001(8)	0.000005(8)
Dieldrin PS	0.000003	0.00003		
Endrin PS	0.000003	0.0006(9)		
Isodrin	0.000003	-	-	-
2,4 dichlorophenol SP	0.0001	-	0.0042	0.00042
2,4 D ester SP	0.0001	-	0.0003	0.0003
op and pp DDT (each) PS		0.001(6)	0.000025 (6)	0.000025 (6)
op and pp DDE (each)				
op and pp TDE (each)				
Dimethoate SP	0.00001	-	0.00048	0.00048
Endosulfan PS	0.000005	-	0.000005	0.0000005
Hexachlorobenzene PS	0.000001		0.00005 max	0.00005 max
Permethrin SP		-	0.000001	0.0000002
Atrazine PS	0.00003	-	0.0006	0.0006
Simazine PS	0.00003	-	0.001	0.001
Linuron SP		-	0.0005	0.0005
Mecoprop SP		-	0.018	0.018
Trifluralin PS	0.00001	-	0.00003	0.00003
Total pesticides		0.0005		
Miscellaneous				
Ammoniacal nitrogen (as NH4+)	-	0.5	0.26 16 0.39 17	-
Ammoniacal nitrogen (as N)	-	0.39	0.2 16 0.3 17	-
Unionised Ammonia (NH3) SP	-	-	-	0.021
Chloride	-	250		
Chlorine SP			0.002	0.01 max
Cyanide SP (hydrogen cyanide)	-	0.05	0.001	0.001
Nitrate (as NO_3)	-	50	-	-
Nitrite (as NO_2)	-	0.1	-	-
Phenol SP	-	0.005 (3)	0.0077	0.0077
Pentachlorophenol PS	0.0001	-	0.0004	0.0004
PCBs (individual congeners)	0.000001	-	-	-
Sodium	-	200	-	-
Sulphate	-	250		-

	Screening Concentration (mg/l)			
	Minimum Reporting Value	Human Consumption	Fresh Water/Inland	Salt Water/Other
Tributyl and triphenyl tin compounds (each) PS	0.000001	-	0.0000002	0.0000002
Di(2-ethylhexyl)-phthalate PS	-	-	0.0013	0.0013

Substances highlighted in yellow are hazardous substances, PS = Priority Substances, SP = Specific Pollutants, '-' screening concentration is not available, 'max' – maximum allowable concentration used where no annual average provided

Notes:

1. Concentration for trihalomethanes is the sum of chloroform, bromoform, dibromochloromethane and bromodichloromethane.
2. Concentration is the dissolved fraction of a water sample obtained by filtration through a 0.45um filter.
3. Concentration is taken from Statutory Instrument 1989 No. 1147. The Water Supply (Water Quality) Regulations 1989, as amended.
4. Concentration for xylenes is 0.003mg/l each for o-xylene and m/p xylene.
5. Concentration is the Sum of TCE and PCE.
6. Concentration is for Total DDT. Para DDT on its own has a target concentration of 0.00001mg/l.
7. Concentration for MTBE is taken from Environment Agency guidance, dated 2006.
8. Concentration is the sum of aldrin, dieldrin, endrin.
9. Concentration is taken from WHO (2004) guidelines for drinking-water quality.
10. Sum of benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(1,2,3-cd)pyrene
11. Concentration is for 2,6-CNT, 4,2-CNT, 4,3-CNT, 2,4-CNT, 2,5-CNT
12. BAP can be considered as a marker of the other PAHs for comparison with the annual average
13. Concentration plus ambient background concentration (dissolved)
14. For cadmium and its compounds the EQS depends on the hardness of the water (Class 1: < 40 mg CaCO3/l, Class 2: 40 to < 50 mg CaCO3/l, Class 3: 50 to < 100 mg CaCO3/l, Class 4: 100 to < 200 mg CaCO3/l and Class 5: ≥ 200 mg CaCO3/l).
15. Manufactured and used in industrial applications, such as flame retardants and plasticisers, as additives in metal working fluids, in sealants, paints, adhesives, textiles, leather fat and coatings. Persistent, bioaccumulate and toxic to aquatic life (carcinogen in rat studies). Candidate Persistent Organic Pollutant (POP).
16. Acceptable 90th percentile concentration for a freshwater lake/river with "High" chemical quality standard and alkalinity (as mg/l CaCO3) < 50 mg/L or alkalinity < 200 mg/L where river elevation > 80 m above Ordnance Datum (mAOD). See the Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 for further details.
17. Acceptable 90th percentile concentration for a freshwater lake/river with "High" chemical quality standard and alkalinity (as mg/l CaCO3) ≥ 50 mg/L where river elevation < 80 m mAOD or > 200 mg/l where river elevation > 80 mAOD. See the Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 for further details.

Table 7: Tier 2 Criteria for Screening Groundwater Vapour Generation Hazard

Chemical	CAS	GAC_{gwvap}(µg/l)[1,2]		Aqueous Solubility (µg/l)
		Residential	Commercial	
Petroleum Hydrocarbons				
1,2,4-Trimethylbenzene	95-63-6	24	2,200	559,000
Benzene [3]	71-43-2	210	20,000	1,780,000
Ethylbenzene [3]	100-41-4	10,000	*960,000 (sol)*	180,000
Isopropylbenzene	98-82-8	850	*86,000 (sol)*	56,000
Propylbenzene	103-65-1	2,700	*240,000 (sol)*	54,100
Styrene	100-42-5	8,800	*810,000 (sol)*	290,000
Toluene [3]	108-88-3	230,000	*21,000,000 (sol)*	590,000
TPH Aliphatic EC5-EC6 [3]		1,900	*190,000 (sol)*	35,900
TPH Aliphatic >EC6-EC8 [3]		1,500	*150,000 (sol)*	5,370
TPH Aliphatic >EC8-EC10 [3]		57	*5,700 (sol)*	427
TPH Aliphatic >EC10-EC12 [3]		37	*3,600 (sol)*	34
TPH Aromatic >EC5-EC7 [2,3]		210,000	*20,000,000 (sol)*	1,780,000
TPH Aromatic >EC7-EC8 [3]		220,000	*21,000,000 (sol)*	590,000
TPH Aromatic >EC8-EC10 [3]		1,900	*190,000 (sol)*	64,600
TPH Aromatic >EC10-EC12 [3]		6,800	*660,000 (sol)*	24,500
TPH Aromatic >EC12-EC16 [3]		39,000	*3,700,000 (sol)*	5,750
meta-Xylene [3,5]	108-38-3	9,500	*940,000 (sol)*	200,000
ortho-Xylene [3,5]	95-47-6	12,000	*1,100,000 (sol)*	173,000
para-Xylene [3,5]	106-42-3	9,900	*980,000 (sol)*	200,000
Polycyclic Aromatic Hydrocarbons (PAH)				
Acenaphthene	83-32-9	*170,000 (sol)*	*15,000,000 (sol)*	4,110

Chemical	CAS	GAC_{gwvap}(µg/l)[1,2]		Aqueous Solubility (µg/l)
		Residential	Commercial	
Acenaphthylene	208-96-8	*220,000 (sol)*	*20,000,000 (sol)*	7,950
Fluorene	86-73-7	*210,000 (sol)*	*18,000,000 (sol)*	1,860
Naphthalene	91-20-3	220	*23,000 (sol)*	19,000
Pesticides				
Aldrin	309-00-2	*47 (sol)*	*3,700 (sol)*	20
alpha-Endosulfan	959-98-8	*7,400 (sol)*	*590,000 (sol)*	530
beta-Endosulfan	33213-65-9	*7,500 (sol)*	*600,000 (sol)*	280
Halogenated Organics				
1,1,1,2-Tetrachloroethane	79-34-5	240	22,000	1,110,000
1,1,1-Trichloroethane	71-55-6	3,000	290,000	1,300,000
1,1,2,2-Tetrachloroethane	79-35-4	1,600	150,000	2,930,000
1,1,2-Trichloroethane	79-00-5	520	49,000	4,491,000
1,1-Dichloroethane	75-34-3	2,700	260,000	3,666,000
1,1-Dichloroethene	75-35-4	160	1,6000	3,100,000
1,2,3,4-Tetrachlorobenzene	634-66-2	240	*31,000 (sol)*	7,800
1,2,3,5-Tetrachlorobenzene	634-90-2	7.0	*600*	3,500
1,2,3-Trichlorobenzene	87-61-7	35	3,100	21,000
1,2,4,5-Tetrachlorobenzene	95-94-3	8.1	*700 (sol)*	600
1,2,4-Trichlorobenzene	120-82-1	68	7,200	41,400
1,2-Dichlorobenzene	95-50-1	2,000	*220,000 (sol)*	133,000
1,2-Dichloroethane	107-06-2	8.9	850	8,680,000
1,2-Dichloropropane	78-87-5	22	2,600	2,050,000
1,3,5-Trichlorobenzene	108-70-3	7.4	660	6,000
1,3-Dichlorobenzene	541-73-1	31	2,800	103,000
1,4-Dichlorobenzene	106-46-7	5,000	*460,000 (sol)*	51,200
Bromobenzene	108-86-1	220	20,000	388,040
Bromodichloromethane	75-27-4	17	1,600	3,000,000
Bromoform (Tribromomethane)	75-25-2	3,100	400,000	3,000,000
Chlorobenzene	108-90-7	98	15,000	387,000
Chloroethane	75-00-3	10,000	1,000,000	5,742,000
Chloroethene (Vinyl Chloride)	75-01-4	0.62	63	2,760,000
Chloromethane	74-87-3	14	1,400	5,350,000
cis-1,2-Dichloroethene	156-59-2	130	13,000	7,550,000
Dichloromethane	75-09-2	3,300	370,000	20,080,000
Hexachlorobenzene	118-74-1	*16 (sol)*	*1,400 (sol)*	10
Hexachlorobutadiene	87-68-3	1.7	230	4,800
Hexachloroethane	67-72-1	8.5	740	49,900
Pentachlorobenzene	608-93-5	140	*12,000 (sol)*	500
Tetrachloroethene	127-18-4	34	4,600	225,000
Tetrachloromethane (Carbon Tetrachloride)	56-23-5	5.3	770	846,000
trans-1,2-Dichloroethene	156-60-5	160	16,000	5,250,000
Trichloroethene	79-01-6	5.7	530	1,370,000
Trichloromethane (Chloroform)	67-66-3	790	85,000	8,950,000
Others (organic and inorganic)				
2-Chloronaphthalene	91-58-7	160	*14,000 (sol)*	11,700
Biphenyl (Lemonene)	92-52-4	*15,000 (sol)*	*1,300,000 (sol)*	4,060
Carbon Disulphide	75-15-0	56	5,600	2,100,000
Mercury, elemental	7439-97-6	1.1	*95 (sol)*	56
Methyl tertiary butyl ether (MTBE)	1634-04-4	83,000	7,800,000	48,000,000

Notes

1. GAC in *italics* with (sol) exceed aqueous solubility.
2. GAC rounded to two significant figures.
3. The GAC for these petroleum hydrocarbon contaminants have been calculated using a sub-surface soil to indoor air correction factor of 10 in line with the physical-chemical data sources.
4. The GAC for TPH fractions do not account for genotoxic mutagenic effects. Concentrations of TPH Aromatic >EC5-EC7 should therefore also be compared with the GAC for benzene to ensure that such effects are also assessed.
5. The Health Criteria Value used for each xylene isomer was for total xylene. If site specific additivity assessments are not completed, as a conservative measure the sum of isomer concentrations should be compared to the lowest xylene GAC (as is the case for soil GAC).

Appendix CWRA 3 – Data Assessment Tables

TABLE SUMMARISING WATER RESULTS AND HIGHLIGHTING EXCEEDANCES ABOVE WATER ASSESSMENT CRITERIA
M3 JUNCTION 9 IMPROVEMENTS

			Assessment Criteria	Summary				DS110	DS110	DS112	DS114	DS203	DS213	DS216	DS301	DS302
Analyte	**Units**	**LOD**	**Fresh Water**	**No. of Tests**	**Min**	**Max**	**No. > Limit**	**12.0m**	**29.5m**	**17.0m**	**18.5m**	**5.2m**	**29.5m**	**14.0m**	**29.0m**	**29.0m**
Alkalinity as $CaCO_3$	µg/l		-													
Arsenic	µg/l	5	50	9	5	5		5	5	5	5	5	5	5	5	5
Boron	µg/l	5	-	9	14	28		15	28	14	15	21	23	27	14	15
Cadmium	µg/l	0.4	0.08	9	0.4	0.4	**9**	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Chromuim (Total)	µg/l	5	-	9	5	10		8	5	8	8	5	10	8	10	5
Chromium Trivalent	µg/l		4.7													
Chromium Hexavalant	µg/l	20	3.4	9	20	20	**9**	20	20	20	20	20	20	20	20	20
Copper	µg/l	5	1	9	5	9	**9**	5	5	5	5	9	5	5	5	5
Iron	µg/l		1000													
Lead	µg/l	5	1.2	9	5	5	**9**	5	5	5	5	5	5	5	5	5
Mercury	µg/l	0.05	0.07	9	0.05	18.3	**2**	0.05	0.24	0.05	0.05	18.3	0.05	0.05	0.05	0.05
Manganese	µg/l		123													
Nickel	µg/l	5	4	9	5	68	**9**	5	5	5	5	68	5	5	5	5
Selenium	µg/l	5	-	9	5	5		5	5	5	5	5	5	5	5	5
Zinc	µg/l	2	10.9	9	2	27	**1**	2	2	2	2	27	2	2	2	2
Ammoniacal Nitrogen as NH_4	µg/l	50	260	9	50	107		54	50	50	107	107	50	50	96	50
Ammoniacal Nitrogen as NH_3	µg/l		-													
Chloride	µg/l		-													
Chlorine	µg/l		2													
Cyanide	µg/l	5	1	9	5	5	**9**	5	5	5	5	5	5	5	5	5
Nitrate as NO_3	µg/l	500	-	9	14300	56000		28800	56000	38800	37400	14300	49200	54600	38900	38000
Nitrite as NO_2	µg/l		-													
Phenol	µg/l		7.7													
Pentachlorophenol	µg/l		0.4													
PCBs	µg/l		-													
Sodium	µg/l		-													
Sulphate	µg/l	1000	-	9	6000	31000		8000	31000	9000	10000	6000	16000	14000	9000	9000
pH	pH Units	1	-	9	7.7	7.8		7.7	7.7	7.7	7.7	7.7	7.8	7.7	7.7	7.7
Dichloromethane	µg/l		-													
1,2 Dichloroethane	µg/l		10													
Trichloroethene (PCE)	µg/l		10													
1,1,1 Trichloroethane	µg/l		-													
1,1,2 Trichloroethane	µg/l		-													
Trichloromethane (Chloroform)	µg/l		2.5													
1,2,3 Trichlorobenzene	µg/l		-													
1,2,4 Trichlorobenzene	µg/l		-													
Trichlorobenzene (1,2,3 & 1,2,4)	µg/l		0.4													
Tetrachloroethene	µg/l		10													
Tetrachloromethane	µg/l		12													
1,1,1,2 Tetrachloroethane	µg/l		140													
Vinyl Chloride (Chloroethene)	µg/l		-													
>C5 to C6 Aliphatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C6 to C8 Aliphatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C8 to C10 Aliphatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C10 to C12 Aliphatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C12 to C16 Aliphatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C16 to C21 Aliphatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C21 to C35 Aliphatic	µg/l	10	-	9	10	18		10	10	10	10	18	10	10	10	10
>C35 to C44 Aliphatic	µg/l		-													
Total Aliphatic C5-35	µg/l	70	-	9	70	70		70	70	70	70	70	70	70	70	70
>C5 to C7 Aromatic	µg/l		-													
>C7 to C8 Aromatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C8 to C10 Aromatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C10 to C12 Aromatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C12 to C16 Aromatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C16 to C21 Aromatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C21 to C35 Aromatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C35 to C44 Aromatic	µg/l		-													
Total Aromatic C5-C35	µg/l		-													
TPH Ali/Aro	µg/l		-													
Benzene	µg/l	1	10	9	1	1		1	1	1	1	1	1	1	1	1
Ethylbenzene	µg/l	5	-	9	5	5		5	5	5	5	5	5	5	5	5
Toluene	µg/l	5	74	9	5	5		5	5	5	5	5	5	5	5	5
Xylene	µg/l		30													
M- & P-Xylene	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
O-Xylene	µg/l	5	-	9	5	5		5	5	5	5	5	5	5	5	5
Total Xylene (M, P & O)	µg/l	15	-	9	15	15		15	15	15	15	15	15	15	15	15
MTBE	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
naphthalene	µg/l	0.01	2	9	0.01	0.04		0.01	0.02	0.01	0.01	0.01	0.04	0.01	0.01	0.01
acenaphthylene	µg/l	0.01	-	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
acenaphthene	µg/l	0.01	-	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
fluorene	µg/l	0.01	-	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
phenanthrene	µg/l	0.01	-	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
anthracene	µg/l	0.01	0.1	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
fluoranthene	µg/l	0.01	0.0063	9	0.01	0.01	**9**	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
pyrene	µg/l	0.01	-	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
benzo(a)anthracene	µg/l	0.01	-	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
chrysene	µg/l	0.01	-	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
benzo(b)fluoranthene	µg/l	0.01	0.017	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
benzo(k)fluoranthene	µg/l	0.01	0.017	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
benzo(a)pyrene	µg/l	0.01	0.00017	9	0.01	0.01	**9**	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
benzo(g,h,i)perylene	µg/l	0.01	0.0082	9	0.01	0.01	**9**	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
dibenzo(ah)anthracene	µg/l	0.01	-	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
indeno(1,2,3-c,d)pyrene	µg/l	0.01	-	9	0.008	0.008		0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
Sum (benzo b, k, ghi & indeno123cd)	µg/l	0.04	-	9	0.038	0.038		0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038
Total PAH	µg/l		-													

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TABLE SUMMARISING WATER RESULTS AND HIGHLIGHTING EXCEEDANCES ABOVE WATER ASSESSMENT CRITERIA
M3 JUNCTION 9 IMPROVEMENTS

			Assessment Criteria	Summary				DS110	DS110	DS112	DS114	DS203	DS213	DS216	DS301	DS302
Analyte	Units	LOD	Human Consumption	No. of Tests	Min	Max	No. > Limit									
Alkalinity as $CaCO_3$	µg/l		-													
Arsenic	µg/l	5	10	9	5	5		5	5	5	5	5	5	5	5	5
Boron	µg/l	5	1000	9	14	28		15	28	14	15	21	23	27	14	15
Cadmium	µg/l	0.4	5	9	0.4	0.4		0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Chromuim (Total)	µg/l	5	50	9	5	10		8	5	8	8	5	10	8	10	5
Chromium Trivalent	µg/l		-													
Chromium Hexavalant	µg/l	20	-	9	20	20		20	20	20	20	20	20	20	20	20
Copper	µg/l	5	2000	9	5	9		5	5	5	5	9	5	5	5	5
Iron	µg/l		200													
Lead	µg/l	5	10	9	5	5		5	5	5	5	5	5	5	5	5
Mercury	µg/l	0.05	1	9	0.05	18.3	1	0.05	0.24	0.05	0.05	18.3	0.05	0.05	0.05	0.05
Manganese	µg/l		50													
Nickel	µg/l	5	20	9	5	68	1	5	5	5	5	68	5	5	5	5
Selenium	µg/l	5	10	9	5	5		5	5	5	5	5	5	5	5	5
Zinc	µg/l	2	5000	9	2	27		2	2	2	2	27	2	2	2	2
Ammoniacal Nitrogen as NH_4	µg/l	50	500	9	50	107		54	50	50	107	107	50	50	96	50
Ammoniacal Nitrogen as NH_3	µg/l		-													
Chloride	µg/l		250000													
Chlorine	µg/l		-													
Cyanide	µg/l	5	50	9	5	5		5	5	5	5	5	5	5	5	5
Nitrate as NO_3	µg/l	500	50000	9	14300	56000	2	28800	56000	38800	37400	14300	49200	54600	38900	38000
Nitrite as NO_2	µg/l		100													
Phenol	µg/l		0.5													
Pentachlorophenol	µg/l		-													
PCBs	µg/l		-													
Sodium	µg/l		200000													
Sulphate	µg/l	1000	250000	9	6000	31000		8000	31000	9000	10000	6000	16000	14000	9000	9000
pH	pH Units	1	-	9	7.7	7.8		7.7	7.7	7.7	7.7	7.7	7.8	7.7	7.7	7.7
Dichloromethane	µg/l		-													
1,2 Dichloroethane	µg/l		3													
Trichloroethene (PCE)	µg/l		10													
1,1,1 Trichloroethane	µg/l		-													
1,1,2 Trichloroethane	µg/l		-													
Trichloromethane (Chloroform)	µg/l		100													
1,2,3 Trichlorobenzene	µg/l		-													
1,2,4 Trichlorobenzene	µg/l		-													
Trichlorobenzene (1,2,3 & 1,2,4)	µg/l		-													
Tetrachloroethene	µg/l		10													
Tetrachloromethane	µg/l		3													
1,1,1,2 Tetrachloroethane	µg/l		-													
Vinyl Chloride (Chloroethene)	µg/l		0.05													
>C5 to C6 Aliphatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C6 to C8 Aliphatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C8 to C10 Aliphatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C10 to C12 Aliphatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C12 to C16 Aliphatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C16 to C21 Aliphatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C21 to C35 Aliphatic	µg/l	10	-	9	10	18		10	10	10	10	18	10	10	10	10
>C35 to C44 Aliphatic	µg/l		-													
Total Aliphatic C5-35	µg/l	70	-	9	70	70		70	70	70	70	70	70	70	70	70
>C5 to C7 Aromatic	µg/l		-													
>C7 to C8 Aromatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C8 to C10 Aromatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C10 to C12 Aromatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C12 to C16 Aromatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C16 to C21 Aromatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C21 to C35 Aromatic	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
>C35 to C44 Aromatic	µg/l		-													
Total Aromatic C5-C35	µg/l		-													
TPH Ali/Aro	µg/l		10													
Benzene	µg/l	1	1	9	1	1		1	1	1	1	1	1	1	1	1
Ethylbenzene	µg/l	5	300	9	5	5		5	5	5	5	5	5	5	5	5
Toluene	µg/l	5	700	9	5	5		5	5	5	5	5	5	5	5	5
Xylene	µg/l		500													
M- & P-Xylene	µg/l	10	-	9	10	10		10	10	10	10	10	10	10	10	10
O-Xylene	µg/l	5	-	9	5	5		5	5	5	5	5	5	5	5	5
Total Xylene (M, P & O)	µg/l	15	-	9	15	15		15	15	15	15	15	15	15	15	15
MTBE	µg/l	10	15	9	10	10		10	10	10	10	10	10	10	10	10
naphthalene	µg/l	0.01	-	9	0.01	0.04		0.01	0.02	0.01	0.01	0.01	0.04	0.01	0.01	0.01
acenaphthylene	µg/l	0.01	-	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
acenaphthene	µg/l	0.01	-	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
fluorene	µg/l	0.01	-	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
phenanthrene	µg/l	0.01	-	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
anthracene	µg/l	0.01	-	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
fluoranthene	µg/l	0.01	-	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
pyrene	µg/l	0.01	-	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
benzo(a)anthracene	µg/l	0.01	-	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
chrysene	µg/l	0.01	-	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
benzo(b)fluoranthene	µg/l	0.01	0.1	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
benzo(k)fluoranthene	µg/l	0.01	0.1	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
benzo(a)pyrene	µg/l	0.01	0.01	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
benzo(g,h,i)perylene	µg/l	0.01	0.1	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
dibenzo(ah)anthracene	µg/l	0.01	-	9	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
indeno(1,2,3-c,d)pyrene	µg/l	0.01	0.1	9	0.008	0.008		0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
Sum (benzo b, k, ghi & indeno123cd)	µg/l	0.04	0.1	9	0.038	0.038		0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038
Total PAH	µg/l		-													

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Appendix CWRA 4 – PNEC Calculations

INPUT DATA						RESULTS (Pb)			
ID	Location	Waterbody	Date	Measured Pb Concentration (dissolved) (µg l^{-1})	DOC	Site Specific PNEC Dissolved Pb (µg l^{-1})	BioF	Available Pb (µg l^{-1})	Risk Characterisation Ratio
1	DS110			5.00	10.10	12.12	0.10	0.50	0.41
2	DS112			5.00	15.30	18.36	0.07	0.33	0.27
3	DS114			5.00	9.90	11.88	0.10	0.51	0.42
4	DS203			5.00	14.90	17.88	0.07	0.34	0.28
5	DS213			5.00	11.20	13.44	0.09	0.45	0.37
6	DS216			5.00	13.20	15.84	0.08	0.38	0.32
7	DS301			5.00	11.20	13.44	0.09	0.45	0.37
8	DS302			5.00	10.80	12.96	0.09	0.46	0.39

INPUT DATA											RESULTS (Copper)				RESULTS (Zinc)				RESULTS (Mn)				RESULTS (Ni)			
ID	Location	Waterbody	Date	Measured Cu Concentration (dissolved) (µg l^{-1})	Measured Zn Concentration (dissolved) (µg l^{-1})	Measured Mn Concentration (dissolved) (µg l^{-1})	Measured Ni Concentration (dissolved) (µg l^{-1})	pH	DOC	Ca	Site-specific PNEC Dissolved Copper (µg l^{-1})	BioF	Bioavailable Copper Concentration (µg l^{-1})	Risk Characterisation Ratio	Site-specific PNEC Dissolved Zinc (µg l^{-1})	BioF	Bioavailable Zinc Concentration (µg l^{-1})	Risk Characterisation Ratio	Site-specific PNEC Dissolved Manganese (µg l^{-1})	BioF	Bioavailable Manganese Concentration (µg l^{-1})	Risk Characterisation Ratio	Site-specific PNEC Dissolved Nickel (µg l^{-1})	BioF	Bioavailable Nickel Concentration (µg l^{-1})	Risk Characterisation Ratio
1	DS110			5	2		5	7.72	900	109	40.77	0.02	0.12	0.12	78.51	0.14	0.28	0.03	377.53	0.33			34.58	0.12	0.58	0.14
2	DS112			5	2		5	7.72	900	117	40.77	0.02	0.12	0.12	78.06	0.14	0.28	0.03	377.53	0.33			34.58	0.12	0.58	0.14
3	DS114			5	2		5	7.72	900	103	40.77	0.02	0.12	0.12	78.88	0.14	0.28	0.03	377.53	0.33			34.58	0.12	0.58	0.14
4	DS203			5	27		68	7.72	900	102	40.77	0.02	0.12	0.12	78.94	0.14	3.73	0.34	377.53	0.33			34.58	0.12	7.87	1.97
5	DS213			5	2		5	7.72	900	107	40.77	0.02	0.12	0.12	78.63	0.14	0.28	0.03	377.53	0.33			34.58	0.12	0.58	0.14
6	DS216			5	2		5	7.72	900	123	40.77	0.02	0.12	0.12	77.73	0.14	0.28	0.03	377.53	0.33			34.58	0.12	0.58	0.14
7	DS301			5	2		5	7.72	900	104	40.77	0.02	0.12	0.12	78.81	0.14	0.28	0.03	377.53	0.33			34.58	0.12	0.58	0.14
8	DS302			5	2		5	7.72	900	102	40.77	0.02	0.12	0.12	78.94	0.14	0.28	0.03	377.53	0.33			34.58	0.12	0.58	0.14

Appendix E Ground Gas Risk Assessment

TECHNICAL NOTE

Job Name:	M3 Junction 9 Improvements
Job No:	48176/3502
Doc Ref:	HE551511-VFK-EGT-X_XXXX_XX-TN-GE-004
Date:	December 2020
Prepared By:	Natasha Caton
Reviewed By:	Kate Riley
Subject:	**Ground Gas Risk Assessment**

1 Introduction

1.1 Preamble

1.1.1 Stantec UK Limited (Stantec) has been commissioned by VolkerFitzpatrick Limited and Highways England (the Client) to undertake a Ground Gas Risk Assessment for the M3 Junction 9 improvement Site, Winchester, based on the factual findings of the Factual Ground Investigation Report (HE551511-HEX-EGT-ZZ-RP-CE-0001) (Soils Limited, August 2019, amended July 2020).

1.1.2 This Technical Note has been written to accompany the Phase 2 Ground Investigation Report undertaken by Stantec (December 2020b) which contains information on the ground conditions. The Ground Investigation specification was undertaken by Jacobs and the field data and laboratory analysis was undertaken by the Principal Contractor, Geoffrey Osborne Limited, who employed the ground investigation contractor Soils Limited and SM Associates.

1.1.3 This Technical Note presents a ground gas risk assessment in respect to receptors identified within the Ground Investigation Report (Stantec, 2020b) and also has been prepared to support the Development Consent Order (DCO) application.

1.2 Sources of Information

1.2.1 The following sources of information were used in the preparation of this technical note:

- Factual Ground Investigation Report (HE551511-HEX-EGT-ZZ-RP-CE-0001) (Soils Limited, August 2019, amended July 2020)
- PCF Stage 2 – Preliminary Sources Study Report (HE551511-WSP-HGT-ZZ-RP-CE-0001) (WSP, September 2017)
- Preliminary Environmental Information Report (PEIR) (GFD19_0101_M3 Junction 9) (Jacobs, June 2019)
- Project Control Framework (PCF) Stage 2 – Preliminary Sources Study Report (HE551511-WSP-HGT-ZZ-RP-CE-0001) (WSP, September 2017)
- PCF Stage 3B: Phase 1 Ground Condition Assessment (Contamination and Stability for Proposed Deposition and Compound Areas (HE551511-VFK-EGT-X_XXXX_XX-RP-GE-0001) (Stantec, December 2020a)
- PCF Stage 3B: Ground Investigation Report (HE552988-VFK-HGT-X_XXXX_XX-RP-CE-0001) (Stantec, December 2020b)

2 Site Setting

2.1 Geology & Ground Conditions

2.1.1 The anticipated ground conditions within the M3 J9 Improvement Site have been determined through review of the published geological mapping, and also site specific intrusive information contained within both the Factual Ground Investigation Report (Soils Limited, 2020) and the Ground Investigation Report (Stantec, 2020b).

Published Geology

2.1.2 The published BGS geological mapping indicates that the majority of the M3 J9 Improvement Site is underlain by solid geology comprising the Seaford Chalk formation, with the overlying Newhaven Chalk only present in the area to the east of the M3, in the northern part of the study area. The Seaford Chalk formation is underlain by the Lewes Nodular Chalk formation, and in the southern extent of the Site, the Lewes Nodular Chalk is indicated to outcrop at the ground surface.

2.1.3 Along the route of the River Itchen, which traverses the northern part of the M3 J9 Improvement Site, the solid geology is overlain by superficial deposits comprising Alluvium. There are also smaller transects of superficial deposits, comprising Head, overlying the solid geology, located to the north and to the south of the existing junction, and in the northern parts of the Site,

2.1.4 In the area to the east of the M3 and to the south of the River Itchen, the geological mapping also indicates there may be an area of Clay with Flints and Head deposits overlying the Newhaven Chalk Formation (which overlies the Seaford Chalk Formation where present).

Encountered Geology

2.1.5 A Phase 2 geotechnical and geo-environmental ground investigation was undertaken across parts of the M3 J9 Improvement Site between March 2019 and June 2019. The information from the investigation generally confirms the anticipated/published ground conditions. Further details can be found within the Ground Investigation Report (Stantec, 2020b).

2.1.6 In addition to the published geology described above, made ground and engineered fill is also present within the Site, associated with the construction of the M3, A34, A33 and other infrastructure. The made ground and engineering fill material predominantly comprises reworked natural strata with lenses of organic soil and extends to a maximum of 11.35m below ground level.

2.1.7 The Ground Investigation Report did not identify any evidence of contamination or exceedances of the relevant assessment criteria within the soil results.

2.2 Historical Land Use

2.2.1 The historical land use (relevant to the potential for contamination) has previously been determined and presented in the Preliminary Sources Study Report (PSSR) (WSP, 2017), and Phase 1 Desk Study (Stantec, 2020a) respectively. These are based on historical Ordnance Survey maps obtained as part of an Envirocheck Report. In summary, the area of the current M3 J9 roundabout and its immediate surroundings remained undeveloped until the construction of the A33 in the late 1930's and later, in the early 1980's, when J9 of the M3 is shown to have been constructed.

2.2.2 The Didcot, Newbury and Southampton railway line is indicated to have been constructed in the late 1890's 200m to the west of the Site, along the eastern bank of the River Itchen, crossing the northern section of the Site. The railway line remained until the 1960's when it was dismantled. In the wider area there have been various industrial uses such as iron and gas

works, although these sites have since been redeveloped and are outside of the proposed works.

2.2.3 A review of available other published information has identified records for three historical landfills or close to the Site. These are located beneath the existing M3 J9 roundabout (Spitfire Link), on the western side of the A34 at the northern tip of Wykeham Industrial Estate (land between Old Newbury Railway and A33) and between the A34/A33 and M3 carriageways, south of the River Itchen (land adjacent to Winchester Bypass). Further commentary is given below:

- The 'Spitfire Link, Easton Lane' landfill was investigated in part by Soils Limited (2020) with six exploratory holes undertaken within or immediately adjacent to the mapped extents of the landfill. No evidence of waste or Made Ground was indicated on those exploratory hole records. It is considered unlikely that the landfill therefore represents a source of significant contamination.

- The 'Land Adjacent to Winchester Bypass, Abbots Worth, Hampshire' landfill is recorded as accepting inert waste from 1967 through to 1968. The licence holder is listed as D Hewestson-Brown. The recorded operational period broadly corresponds with the widening of the Winchester Bypass and construction of a gantry crossing the River Itchen. It is considered that the landfill may therefore have been used to accept earthworks arisings from that scheme and is therefore unlikely to represent a source of significant contamination.

- The third landfill 'Land Between Old Newbury Railway and A33' is located to the west of Winchester bypass and is very small therefore unlikely to have operated commercially and therefore unlikely to represent a significant risk.

2.2.4 Based on the information above the risk from the historical landfills to the M3 J9 Improvement Site is considered to be Low. The current development proposals do not include any works within or over the historical landfills and therefore these areas will not be disturbed by the M3 J9 Improvement Site.

2.2.5 Contrary to the 'published information' outlined above, a review of the available historical OS mapping has not specifically identified the presence of infilled workings/landfills.

Current Land Use

2.2.6 The majority of the M3 J9 Improvement Site comprises the carriageways of the M3, A33 and A34. In the area to the east of the M3, the land use is predominantly agricultural.

2.2.7 In the areas to the west of the A34, the land use is predominantly highway land or undeveloped land adjacent to the highway. However, in the wider Site, the land use is varied including flood plain, residential and mixed use industrial.

2.2.8 In the northern part of the M3 J9 Improvement Site, the predominant current land use is mixed, comprising residential, agricultural and flood plain.

3 Ground Gas Conceptual Site Model

3.1 Introduction

3.1.1 The conceptual site model (CSM) describes the types and locations of potential ground gas sources, the identification of potential receptors and the identification of potential transport/migration pathways.

3.1.2 For a pollutant linkage to be identified a connection between all three elements (source-pathway-receptor) is required. A ground gas conceptual site model (CSM) has been developed

for the Site, based on the Stantec 2020 GIR which draws on a ground investigation by Soils Limited which took place between March and June 2019.

3.1.3 The CSM summarises the potential ground gas source(s), transport pathways and receptors in order to assess potential ground gas risk linkages.

3.1.4 It should be noted that this CSM only addresses potential risks from ground gases. A contaminant assessment and Geoenvironmental risk assessment are provided in the Stantec Phase 2 Ground Investigation Report (2020b).

3.2 Sources

3.2.1 The potential ground gas sources are presented in the table below:

Table 3-1 Potentially Contaminative Land Uses and Contaminants of Concern

Source	Potential Contaminants of Concern
Historical Landfill	Methane and Carbon Dioxide
Peat and Organic Matter within Alluvial Deposits	Methane and Carbon Dioxide
Seaford Chalk – dissolution of calcium carbonate by acidic water	Carbon Dioxide

3.3 Receptors

3.3.1 The following receptors have been identified that could be impacted by ground gases along with the sensitivity of the receptor, which is detailed in **Table 2.2** below:

Table 3-2 Receptor and Sensitivity

Receptor	Sensitivity
Construction and Maintenance workers	High
Off-site residents	Very High

3.4 Pathways

3.4.1 The following pathways are considered viable:

- Vertical and lateral migration of ground gas through permeable strata
- Ingress into confined spaces
- Inhalation
- Migration along services and underground structures
- Vertical and lateral migration through fractures in the Seaford Chalk Formation

4 Ground Gas Risk Assessment

4.1 Introduction

4.1.1 Ground gas monitoring was undertaken at twenty-one monitoring locations on five occasions. All of the monitoring wells were installed within the Seaford Chalk Formation.

4.1.2 The 'Spitfire Link, Easton Lane' landfill was investigated during the Soils Limited ground investigation (2019). No evidence of waste or Made Ground was indicated within the area investigated; however, two monitoring wells were installed within the boundary of the suspected landfill within the Seaford Chalk Formation.

4.1.3 The Alluvium has been identified as a potential source of ground gas, however, as the alluvial material does not appear to contain large quantities of organic material and this material only degrades very slowly by biological respiration producing very little ground gas the risk is considered to be Very Low in accordance with BS8578:2013 and therefore ground gas monitoring isn't required.

4.1.4 A copy of the ground gas monitoring data is presented within the Soils Limited Factual Report (2019).

4.2 Data Summary

4.2.1 The following table summarises the ground gas concentrations recorded in the gas monitoring wells installed as part of the ground investigation.

Table 4-1 Ground Gas Concentrations and Gas Flow

Gas	Concentrations
Methane, %v/v	0
Carbon Dioxide, %v/v	0 – 2.9
Oxygen, %v/v	10.3 - 24
Gas Flow, l/hr	-0.5 – 0.21

4.2.2 It is noted that the groundwater is above the slotted section of the standpipe in DS104, DS112, DS114, DS213, DS301, DS302, during all of the monitoring rounds, and as such the data may give a false impression of the gas risk due to a build-up in the pressure, caused by the rising water, which traps the gas within the solid section of the pipe. The data from these wells has therefore not been used in the assessment.

4.2.3 In all of the monitoring rounds in all locations monitored, the measured concentrations of carbon dioxide were below 3% v/v and methane was not detected in any location.

4.2.4 Very low gas flow rates were detected in all wells and typically <0.2l/hr. The exception to this was in DS207 on one occasion which recorded a gas flow of -0.5l/hr. BS8485+A1 (2019) advocates that if a negative flow is recorded then an assessment should be undertaken to determine if this flow could be equally positive (see section 4.3.3).

4.3 Characterisation

4.3.1 In each well the maximum gas concentration and steady state flow rate for each round have been used to calculate a Gas Screening Value (GSV). In this scenario the gas regime for both methane and carbon dioxide is identified as Characteristic Situation 1.

4.3.2 Using the highest maximum gas concentration and highest steady state flow rate for each well, the gas regime is also identified as Characteristic Situation 1 for both methane and carbon dioxide.

4.3.3 A further worst case check has also been undertaken using the highest gas flow of 0.0021l/hr and the highest gas concentration of 2.9%v/v for carbon dioxide, this also produced a GSV of 0.006 which equates to a gas regime of Characteristic Situation 1. Also, if the -0.5l/hr gas flow was assumed to be equally positive this would produce a GSV of 0.0145 also indicating a Characteristic Situation 1 gas regime.

4.3.4 In accordance with Table 6 within BS 8576:2013 the Gas Generation Potential of the Made Ground/Engineered fill, Alluvium and Peat is considered to be Low to Very Low given the limited degradable content indicated within the logs. The Chalk is also considered to have a Very Low Gas Generation Potential.

5 Conclusions

5.1 Assessed Ground Gas Risk

5.1.1 It has been assessed that the gas regime within the Seaford Chalk Formation is a Characteristic Situation 1 whereby no gas protection measures are required, and although this classification is designed for new buildings it does give a good indication of the ground gas risks.

5.1.2 Based on the information available, the potential for a significant ground gas risk to be present is considered to be **Very Low** in accordance with BS8485+A1 (2019). The estimated risks to the sensitive receptors are summarised below:

Table 5-1 Estimated Risk

Receptor	Assessed Sensitivity	Estimated Risk
Construction and Maintenance workers	High	Very Low
Off-site residents	Very High	Very Low

5.1.3 It is also recognised that any construction activities and follow on maintenance work will be managed under an appropriate Environmental Management Plan, CDM regulations and compliance-based risk assessments which will further protect Construction and Maintenance workers.

5.2 Recommendations

5.2.1 Whilst the current assessment would advise that no special protection measures are required, it is recognised that this assessment of a CS1 situation is based on a limited data set. as such it is recommended that further boreholes are drilled, and gas monitoring undertaken within the areas of suspected landfill, made ground/fill if it is found to contain considerable degradable material and within areas that have not been previously investigated.

5.3 Limitations

5.3.1 The ground gas monitoring wells were only targeted into the Seaford Chalk Formation and therefore no assessment has been undertaken on the Made Ground except from the descriptions within the logs. No installations were provided into the areas of potential landfill or within areas of made ground/engineered fill, albeit that two monitoring locations were located at the boundary of this area.

5.3.2 Current guidance indicates that ground gas monitoring should be carried out over a long enough period to allow prediction of worst-case conditions. At the current time none of the data appears to be taken during low or falling atmospheric pressure which is recommended to capture worst case conditions.

5.3.3 The opinions and recommendations in this report are based on the information obtained from the PSSR and the ground investigation specified and carried out by others. Stantec can, therefore, only base any recommendations included in this report from the information provided within the Factual Ground Investigation Report (Soils, 2019).

5.3.4 The ground investigation undertaken was carried out within the highway boundary and adjacent farmland, therefore there were some constraints locating the boreholes for the ground investigations due to extensive buried services and badger setts. The boundary has also changed since the original investigation as therefore certain areas of the extended boundary has not been investigated.

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Appendix F Geotechnical Risk Register

GEOTECHNICAL RISK REGISTER

Project:	M3 Junction 9 Improvement		
Project No:	48176	**Date:**	May 2021
Register Number:	GIR – GRR01	**Revision**	P02

Ref No	Activity/Hazard	Consequence	Probability	Impact	HA Risk Rating	Mitigation/Action	Probability	Impact	HA Risk Rating	Comments
G1	**General**									
/a	Encountering unexpected contaminated ground	Risk of harm to site workers, general public and the environment. Delay and additional design and construction costs	2	2	4	Make provision for dealing with any unexpected sources of contamination	2	1	2	From known history of the site, being predominantly greenfield, and the results of chemical testing during the ground investigation the potential for contamination to be present is assessed to be very low.
/b	Inadequate existing geology / geotechnical information	Potential to have a significant impact on programme, costs and design.	5	5	25	Undertake an appropriate targeted supplementary GI and subsequent laboratory testing to inform the design process	2	3	6	There are significant data gaps in the current Ground investigation in key areas of the scheme.
/c	Encountering unexpected Shallow Groundwater Levels near or adjacent to River Itchen	Inadequate design of temporary works. Unplanned and potentially unsafe to construction sequence. Inundation of excavation. Cost and delay	3	3	9	Utilise information on ground conditions from supplementary GI in design and for consideration of temporary works. Provision of pumping equipment to control water ingress.	3	2	6	Groundwater unlikely to be encountered in excavations except for adjacent to the River Itchen
/d	Changes to groundwater regime and Chalk Aquifer	Changes in aquifer recharge and groundwater flow. Contamination of underlying aquifer from construction works. Delay and additional design and construction costs	3	4	12	Undertake piling risk assessment and hydrogeological risk assessment as required	3	3	9	
/e	Aggressive Ground Conditions	Long term chemical attack to foundations- Corrosion or weakening of supporting structural elements	2	3	6	Design process to account for aggressive ground when designing below ground structural components	1	2	2	

Notes:						
	a) Probability	1: Negligible	2: Unlikely	3: Probable	4: Likely	5: Very likely
	b) Impact	1: Very low	2: Low	3: Medium	4: High	5: Severe
	c) Rating	1-4: Negligible	5-9: Low	10-12: Medium	13-19: High	20-25: Severe

Ref No	Activity/Hazard	Consequence	Probability	Impact	HA Risk Rating	Mitigation/Action	Probability	Impact	HA Risk Rating	Comments
/f	Natural cavities; solution features	Local loss of ground support resulting in excess settlement or local failure of supported infrastructure or third-party property	3	3	9	Make the provision for inspection of exposed foundation and road formations for evidence of infilled natural cavities during construction works. Treat any features by backfilling / grouting. Consider inclusion of geogrids as part of road construction and design foundations accordingly.	2	3	6	No records of natural cavities within the scheme extents. Generally, the risk of solution features is very low, except where Head Deposits overlies the Chalk where the risk increases to moderate.
/g	Mining Cavities: Historical Chalk Mines or Chalk Pits.	Local loss of ground support resulting in excess settlement or local failure of supported infrastructure or third-party property	2	3	6	Treat any features by backfilling / grouting. Consider inclusion of geogrids as part of road construction and design foundations accordingly.	2	2	4	No records of mining cavities within the scheme extents, though chalk pits have been recorded in the vicinity. Generally, the risk of mining cavities is low except in the vicinity of where chalk pits have been recorded. Then the risk increases to medium to very high.
/h	Encountering unexpected in-ground obstructions associated with existing road and junctions and associated infrastructure	Potential variable foundation/subgrade strength which may cause differential settlement Delay and cost of breaking out and removal	2	2	4	Design to considers variable ground conditions and eliminates/mitigates any long-term settlement impacts	1	2	2	
/i	Encountering unexpected utilities	Damage during works posing risk to site workers and public; additional works to disconnect or realign services	2	3	6	Make provision for detailed survey to identify all live services before construction works.	1	3	4	
/j	Archaeology	Delay to programme due to heritage approval following archaeological finds	1	3	3	Keep watching brief during ground works	1	3	3	Unlikely as the areas of archaeological important have previously been highlighted.
G2	**Slopes and Earthworks**									
/a	Instability of existing slopes	Additional works to stabilise existing slopes and allow safe completion of works	1	3	3	Stability analysis as part of the GDR. Make provision for adequate control of earthworks.	1	3	3	No evidence of existing slope instability during ground investigation.

Notes:						
	a) Probability	1: Negligible	2: Possible	3: Probable	4: Likely	5: Very likely
	b) Impact	1: Negligible	2: Low	3: Medium	4: High	5: Severe
	c) Rating	1-4: Negligible	5-9: Low	10-12: Medium	13-19: High	20-25: Severe

Ref No	Activity/Hazard	Consequence	Probability	Impact	HA Risk Rating	Mitigation/Action	Probability	Impact	HA Risk Rating	Comments
/b	Instability of proposed side slopes - Embankments	Road closure, harm to road users and third parties, additional works to excavate failed material and reconstruct side slopes	3	3	9	Stability analysis as part of GDR Make provision for adequate engineering control of earthworks	2	3	6	
/c	Low strength or compressible foundation formation. Excess settlement of proposed embankments	Serviceability of road surface, potential road closure, additional materials as required to make up embankment and replace pavement – Cost and delay	3	4	12	Undertake assessment and settlement analysis as part of GDR. Make provision for adequate monitoring of earthworks and time for settlement	2	3	6	Peat highlighted in the Ground Investigation, full extent and nature is unknown at this stage, will require further Ground Investigation works.
/d	Chalk unsuitable for use as fill	Delay to programme and additional costs due to chalk treatment being required to use the material as fill.	3	4	12	Additional ground investigation and laboratory testing required to confirm the chalk quality. Develop appropriate earthworks strategy and specification to maximise reuse of site won chalk.	3	2	6	
/e	Earthwork volume surplus	Purchasing additional land to incorporating landscaping areas	4	3	12	Engineer slopes and alignment during design to minimise surplus soils Additional ground investigation required.	2	3	6	
/f	Double handling/stockpiling chalk for re-use	Deterioration of the chalk, may require treatment to be suitable for re-use. Collapse settlement	3	4	12	Additional ground investigation to provide information on the quality of the chalk in areas of Cut. Avoid double handling of the material and make sure material is protected from weather than may cause deterioration. Appropriate material control on site including placement and compaction.	2	4	8	
/g	Weather	Delay to programme and additional costs due to chalk treatment being required to use the material as fill. Potential slurry formed requiring off site disposal	4	5	20	Do not undertake excavation or placement of chalk during or when wet weather is expected	4	3	12	
G3	**Pavement Construction**									

Notes:						
	a) Probability	1: Negligible	2: Possible	3: Probable	4: Likely	5: Very likely
	b) Impact	1: Negligible	2: Low	3: Medium	4: High	5: Severe
	c) Rating	1-4: Negligible	5-9: Low	10-12: Medium	13-19: High	20-25: Severe

Ref No	Activity/Hazard	Consequence	Probability	Impact	HA Risk Rating	Mitigation/Action	Probability	Impact	HA Risk Rating	Comments
/a	Low strength or compressible formation to pavement construction	Additional works to excavate and replace unacceptable material	3	3	9	All proposed fill to be suitably engineered to achieve design CBR	2	2	4	The road in the area of Peat is to remain in place as it. No redevelopment of the road or pavements in the area of Peat.
G4	**Highway Structures**									
/a	Foundation design	Overdesign of foundations due to inadequate GI	5	5	25	Undertake additional GI to confirm ground conditions and design parameters	2	4	8	
/b	Stability of the proposed retaining walls	Road closure, harm to road users and third parties. Additional earthworks. Delay to programme	3	3	9	Undertake assessment and analysis as part of GDR.	2	2	4	Further ground investigation to determine design parameters due to insufficient data in the existing GI.
/c	Bearing capacity and stability of proposed Highway Structures	Road closures, harm to road users and third parties. Delay to programme.	3	3	9	Undertake assessment and analysis as part of the GDR.	2	2	4	Further ground investigation to determine design parameters due to insufficient data in the existing GI.

Notes:						
	a) Probability	1: Negligible	2: Possible	3: Probable	4: Likely	5: Very likely
	b) Impact	1: Negligible	2: Low	3: Medium	4: High	5: Severe
	c) Rating	1-4: Negligible	5-9: Low	10-12: Medium	13-19: High	20-25: Severe

The likelihood of the occurrence and impact of the hazard has been determined in line with the criteria given in the following tables.

	Criteria	Description
Probability of occurrence	5: Near Certain	Near certain to occur, probably on numerous occasions
	4: Likely	Likely to occur, possibly on numerous occasions.
	3: Probable	May occur, probably on a single occasion
	2: Possible	May occur, but unlikely
	1: Negligible	Not expected to occur

	Criteria	Description
Magnitude of Impact	5: Severe	Would result in a delay to completion of 10 weeks or more and/or additional costs of £1 million or more
	4: High	Would result in a delay to completion up to 10 weeks and/or additional costs up to £1 million
	3: Medium	Would result in a delay to completion up to 1 week and/or additional costs up to £200k
	2: Low	Would result in additional works up to 4 weeks and/or additional costs up to £50k but no delay to completion
	1: Negligible	Would result in additional works up to 1 weeks and/or additional costs up to £5k but no delay to completion

The rating of the risks has been assessed using the following matrix and is defined in line with the criteria given in the following table.

		Risk Rating				
Probability of occurrence	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
		Magnitude of Impact				

	Criteria	Description
Risk Rating	Severe (20-25)	High probability of occurrence and a high impact on the proposed scheme
	High (13-19)	Medium to high probability of occurrence and also a medium to high impact on the proposed scheme
	Medium (10-12)	Medium to high probability of occurrence or a medium to high impact on the proposed scheme
	Low (5-9)	Low to medium probability of occurrence or low to medium impact on the proposed scheme
	Negligible (1-4)	Negligible to low probability of occurrence and a negligible to low impact on the proposed scheme

Appendix N – Technical Note: Climate Change allowances applied to Drainage Design & Exceedance

HE551511-VFK-HDG-X_XXXX_XX-TN-CD-0001 Climate Change allowances applied to Drainage Design & Exceedance

TECHNICAL NOTE

Job Name: M3 Junction 9 Improvement Scheme

Job No: 48176/2000

Note No: HE551511-VFK-HDG-X_XXXX_XX-TN-CD-0001

Revision: P02

Date: May 2022

Prepared By: P. Rogers / A. Champion (P02 by J.Harvey)

Checked by: T. Allen

Subject: **Climate Change allowances applied to the Drainage Design & Exceedance**

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	P02	Jul'22	JH	LC	MF	MF

T: E:

TECHNICAL NOTE

1. Executive Summary

The design of carriageway-edge drainage is based on critical rainfall events of short-duration and high-intensity, required by DMRB design documents CG 501 - Design of highway drainage systems and CD 521 - Hydraulic design of road edge surface water channels and outlets. The design of scheme-wide attenuation features (SuDS) is dictated by critical rainfall events that are typically longer-duration and lower-intensity, required by flood management planning policy, The SuDS Manual, CG 501 and CD 532 Vegetated drainage systems for highway runoff. Furthermore, the carriageway-edge drainage and the wider SUDS network, each employ different climate change (CC) criteria (20% and 40% respectively) in accordance with their respective design codes.

This Technical Note sets out the differing design criteria between Carriageway-edge Drainage and the wider Highway Drainage (SuDS) and demonstrates that both areas of the drainage design fulfil their design criteria, without detriment to overall highway operation or SUDS operation.

Carriageway Drainage has been sensitivity-tested for 40% climate change and it has been shown that surface flooding in the 40% climate change condition is not detrimental to the safe operation of the highway.

Drainage performance and mitigation measures during exceedance events have also been indicated.

2. Introduction

This document should be read in conjunction with the following documents:

- HE551511-VFK-HDG-X_XXXX_XX-RP-CD-0001 rev P02 - M3J9 Improvement Scheme Stage 3 Drainage Strategy Report (DSR)
- Technical Note HE551511-VFK-HDG-X_XXXX_XX-TN-CH-0002 - Resilience to Blockages in the Drainage Design
- Highway Drainage Drawings, prepared by Stantec.

This Technical Note assumes the following distinction in the naming of drainage assets:

2.1. Carriageway Drainage (CD)

CD refers to drainage components within carriageway or at the edge-of-carriageway (road edge), i.e. gullies, edge channels, filter drains, collector pipes and chambers in running lanes, verges and footways. These are items that can cause carriageway flooding when surcharging to surface, during exceedance events.

2.2. Highway Drainage Network (HDN)

The HDN refers to drainage assets that comprise the wider network of conveyance and attenuation out-of-carriageway but within the highway boundary, i.e. strategic pipelines, ditches, basins and soakaways. These are items that do not cause carriageway flooding when surcharging to surface during exceedance events but would cause overland flow that may contribute to watercourse flooding or groundwater flooding.

2.3. Adjacent M3 Junction 9 to 14 Safety Barrier Improvement Scheme

The modelling presented in this Technical Note includes the flow volumes that are generated from hard surfaces within the adjacent Safety Barrier Scheme, to the south of M3J9, and which flow into the M3J9 highway drainage network.

3. Project Overview

The M3J9 scheme runs north-south, and lies immediately to the east of Winchester, centred in the Winnall area and extending north to Headbourne Worthy.

Abutting the west of the scheme are commercial and light industrial land uses associated with the Wykeham Trade Park and Winnall Industrial Estate, which fall away from the M3J9 towards the River Itchen.

Land rises to the east of the M3J9 and comprises entirely arable land or woodland, with a low density of minor agricultural settlements. 206 hectares (ha) of arable land drain overland from the east towards M3J9. The 206 ha overland catchment is intercepted by M3J9 before it would otherwise reach the River Itchen. Overland flow from 192 ha drains to ground on the eastern side of the M3J9 scheme in existing soakage features maintained by National Highways Overland flow from 14 ha of the 206 ha passes under the M3J9 in an existing 300mm dia culvert and then flows overland towards the River Itchen.

Proposed modifications to M3J9 comprise the introduction of new on/off slip-roads to both northbound and southbound sides of the M3, new link roads between A33/A34/A272 and M3 roads and a new overhead gyratory above the M3 corridor. Junction 9 is located in a low spot of the M3, towards which a total of approximately 1.6km of the existing M3 corridor drains.

A separate Safety Barrier Improvement Scheme is currently being constructed immediately to the south of M3J9 between Junctions 9 to 14. The Safety Barrier Improvement Scheme to the mainline M3 will extend into the M3J9 Improvement scheme works boundary.

Safety Barrier Improvements to the M3 to the south of M3J9 are to be undertaken on a phased approach. The first phase consists of hardening of the existing central reserve, installation of the safety barrier system and improvements to the existing drainage infrastructure to account for the increased impermeable areas. Approximately 2 ha of the Safety Barrier Improvements Scheme will drain into the 14 ha M3J9 project area, resulting in an overall drained area of 16 ha passing through M3J9 drainage.

4. Design Rationale

4.1. Carriageway Drainage

The design of CD is defined by the following Design Manual for Roads and Bridges (DMRB) design codes.

CG 501 (Rev 2) - Design of Highway Drainage Systems

- No surcharging to surface (i.e., flooding of carriageway) in the 5yr + 20% Climate Change (CC) event. This applies to CD.
- Sensitivity testing to 40% CC to be documented in the design.
- Surface flooding not to extend beyond the highway boundary in the 100-year + CC event. This applies to HDN.
- Use of an increase in peak rainfall intensity of greater that 20% in carriageway drainage design shall be subject to approval by the Overseeing Organisation.

CD 521 (Rev 1) - Hydraulic design of **road edge** surface water channels and outlets

- Road runoff flows to be contained to within 1.5m of the edge of motorway carriageway in events of 2-minutes duration with a 5-year return period.

- Allowances for climate change to follow CG 501, i.e., design for 20% and document a sensitivity test to 40%.

CD 524 - Edge of pavement details

- Road runoff flows to be contained to within 1.5m of the edge of motorway carriageway in the 5-year design event.

4.2. Highway Drainage Network

The SuDS Manual (Ciria C753)

- Climate change allowances to follow current Environment Agency guidelines.

CD 532 - Vegetated drainage systems for highway runoff.

- Follow CG 501 for climate change guidance.

The design of the HDN, which is out-of-carriageway but within the highway boundary, is also defined by the DMRB design codes above but, in addition falls within the remit of the Lead Local Flood Authority (LLFA), Hampshire County Council (HCC), under the National Planning Policy Framework, the Flood and Water Management Act, and HCC planning policies on SuDS and flood risk.

Under planning policy, the design of the HDN (SuDS) is expected to provide flood risk management up to a 1 in 100 year event plus an appropriate % for climate change for the project lifetime. The Environment Agency's current advice for planning authorities over the lifetime of M3J9 (to 2115) would be to apply a 40% increase in rainfall intensities for the design of SuDS (HDN conveyance and attenuation features downstream of the CD). Refer to Table 2, FRA: Climate Change Allowances, [redacted]

HCC's role is to manage Local Flood Risk Sources (Surface water, groundwater flooding and ordinary watercourses) and to comment on, as part of the planning process, the design of Sustainable Drainage Systems (SuDS) for all major planning applications in Hampshire.

5. Stage of Design

At the time of writing, the project is at Stage 3 Preliminary design. Calculations identifying the sizing and spacing of CD surface components such as road gullies, concrete, grassed or grated channels to CD 521, will be undertaken during Stage 5 Detailed Design, as such are not yet complete. However, below-ground collector drains and chambers in carriageway and verge, which serve the surface drainage components, have been included in the Stage 3 hydraulic design in accordance with the return-period design criteria specified in CD 521. Hydraulic calculations are advanced enough to demonstrate conveyance capacity and levels of surcharging in the below ground Highway Drainage Network.

Refer to the Drainage Strategy Report (DSR) for full details of Stage 3 (Preliminary Design) Drainage calculations.

6. Design Implications

The design guidance in Section 4 effectively dictates that edge-of-carriageway drainage is designed to a 5-year + 20% CC standard and that out-of-carriageway drainage (of which SUDS is a component) is designed for the 100-year + 40% CC condition.

In order to consider the impact of 40% CC design criterion on carriageway drainage, the CD has been tested for several 20% and 40% scenarios, in Section 6.1.

6.1. Carriageway Drainage

Table 6.1 below indicates the volume and location of flooding at cover level within carriageway drainage, during the CG 501 design event, i.e., critical-duration 5-year rain event + 20% CC.

A sensitivity test for the 5-year + 40% CC event has been undertaken and the volume and location of surface flooding is indicated.

It can be seen that the carriageway design meets the mandatory 5-yr + 20%CC design criteria (CG 501), with no surface flooding. In the 5-yr + 40% event, surface flooding starts to become evident in carriageway drainage but in minor volumes, which are very likely to be accommodated within the allowable 1.5m width of surface flow alongside kerb lines.

In order to provide a wider indication of the capacity of the carriageway drainage, a further sensitivity test has been undertaken for the critical duration rainfall events with return periods of 10-years and 30-years + 40% CC.

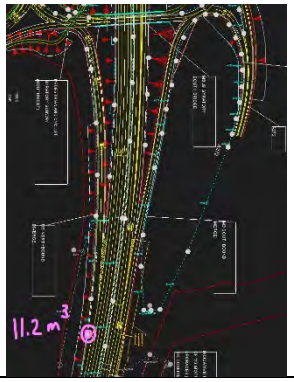
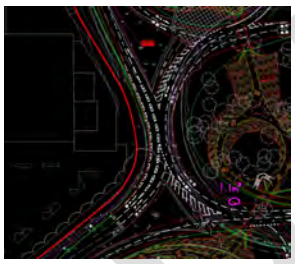
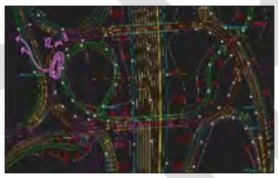
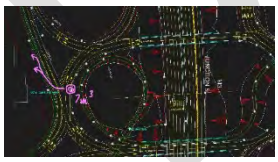
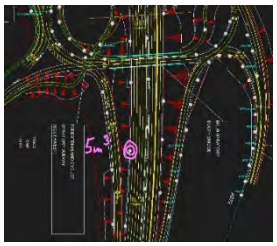
The 10-year + 40% CC scenario incurs surface flooding but the extent of flooding and presence of exceedance flow routes, results in the 10-yr flooding being unlikely to cause highway operation to cease.

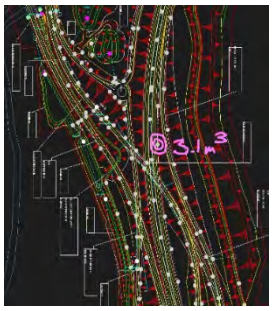
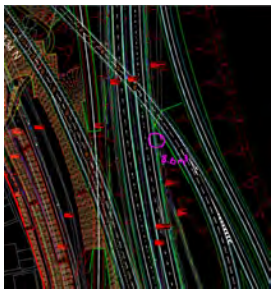
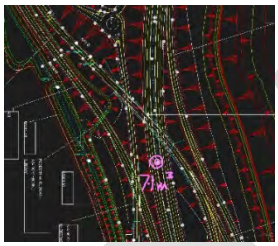
In the 30-year + 40% CC event, surface flooding may be unable to be accommodated in the allowable 1.5m flow width against kerb lines. **The 10-yr event nor the 30-yr event are design criteria required by DMRB, but are indicated here for clarity of carriageway drainage design resilience only.**

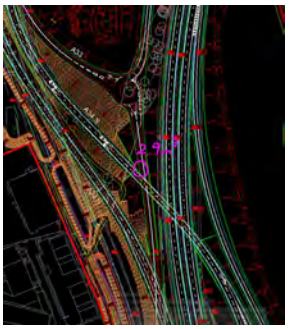
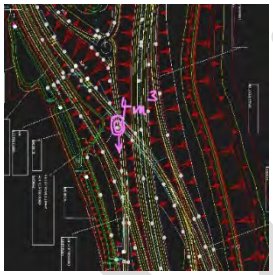
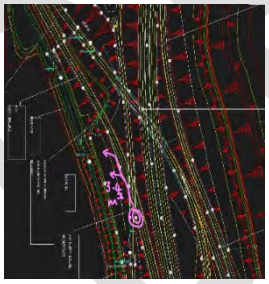
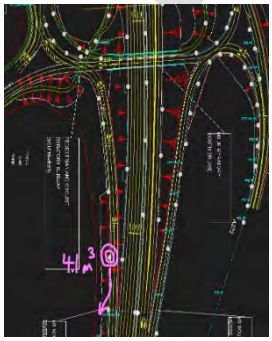
The flooding locations of the 5 year + 40% CC are also indicated on the scheme-wide Drainage Schematic Plan in Appendix A.

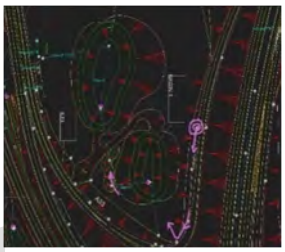
Table 6.1 - Flooding (m^3) on carriageway - Sensitivity of Climate change in 5-yr, 10-yr & 30-yr design events

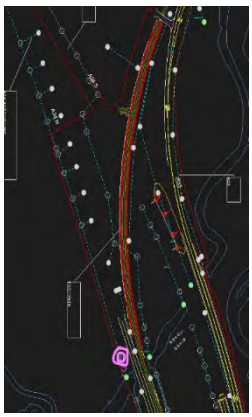
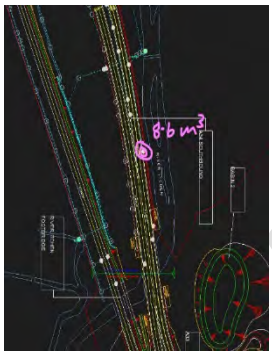
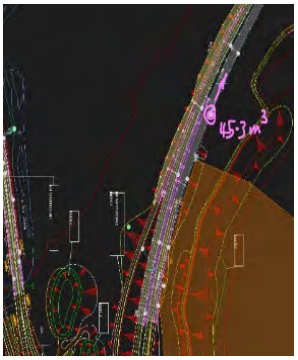
		Return Period + Climate Change %	Required (CG 501)	Sensitivity Test (CG 501)	*Further context only*		
			5yr + 20% CC	5yr + 40% CC	*10yr + 40% CC*	*30yr + 40% CC*	Notes
Pipe ref.	**Location**	**Duration of critical event**	**Volume of surface flooding (m^3)**				

336.007 (MUP catchment)		30 mins.	0	11.2	*26.9*	*59.6*	Exceedance vols from MUP design (tbc by MUP design team). Vol. expected to be accommodated by soakage ditch in western verge
343.005		15 mins.	0	0	*0.4*	*11.6*	Exceedance flow 'over-the-edge' intercepted by swale to Basin 2
316.007		15 mins.	0	0	*0*	*1.1*	Exceedance volume to lie against inner roundabout kerb line for until levels subside below cover level.
317.007		15 mins.	0	0	*0*	*12.2*	Exceedance flow to pass to landscaped area west of A33 NB.
316.009		15 mins.	0	0	*0*	*7.1*	Exceedance flow to pass to landscaped area west of A33 NB.
324.001		15 mins	0	0	*0*	*5.1*	Exceedance flow to pass to landscaped area behind western verge of M3

326.001		15 mins	0	0	*0*	*3.1*	Exceedance flow to pass to M3 low point via verge and to A34NB surface exceedance exit to Basin 4
326.002		15 mins	0	0	*0*	*8.6*	Exceedance flow to pass to landscaped area behind eastern verge of M3
328.003		15 mins	0	0	*0*	*7.1*	Exceedance flow to pass to M3 low point via verge and to A34NB surface exceedance exit to Basin 4
329.000		15 mins	0	0	*0*	*13.9*	Exceedance volume to lie against central reserve until levels subside below cover level.
329.001		15 mins.	0	0	*0*	*5.1*	Exceedance volume to lie against central reserve until levels subside below cover level.

330.000		15 mins	0	0	*0*	*5.6*	Exceedance flow to pass 'over the edge' to A33 underpass approach and through surface water overflow to Basin 3A
331.000		15 mins	0	0	*0*	*2.9*	Exceedance flow to pass to additional overflow capacity at A33 underpass approach then to Basin 3A
331.001		15 mins	0	0	*0*	*4.0*	Exceedance flow to pass to additional overflow capacity at A33 underpass approach then to Basin 3A
333.000		15 mins	0	0	*0*	*3.4*	Exceedance flow to pass 'over the edge' to NMU and Basin 3A
338.002		15 mins	0	0	*0*	*4.1*	Exceedance flow to pass to landscaped area behind western verge of M3

352.001		15 mins	0	0	*0*	*1.6*	Exceedance flow to pass to landscaped area behind eastern verge of M3
352.002		15 mins	0	0	*0*	*4.7*	Exceedance flow to pass to landscaped area behind eastern verge of M3
344.002		15 mins	0	0	*0*	*2.3*	Exceedance flow 'over-the-edge' intercepted by swale to Basin 2
369.005		2 hrs	0	1.5	*30*	*93.4*	60 min. surcharge above CL due to new 185mm limiting pipe dia. in CR. Exceedance vols. to run north via carriageway edge. to triple gullies in M3 low spot.

342.004		1 hr	0	36.2	*57.7*	*98.0*	Exceedance volume from existing carriageway areas to Outfall 4. No change in areas from M3J9 works
362.001		15 mins	0	0	*2.2*	*8.6*	30-year flood volume due to existing carriageway areas.
364.007		15 mins	0	0	*0*	*16.3*	30-year flood volume due to existing carriageway areas.
368.003		30 mins	0	0	*0*	*45.3*	10 min. surcharge above CL due to new 150mm limiting pipe dia. in CR. Exceedance vols. to run north via carriageway edge. to triple

							gullies in M3 low spot.
369.000 to 369.002		30 mins	0	0	*10.7*	*53.1*	Approx. 1/3 to Basin 2, 1/3 to floodplain and 1/3 to M3 low spot triple gullies

6.2. Highway Drainage Network (including SUDS)

Design criteria for the HDN (including SuDS) require flooding to be contained within the works boundary up to the 100-year design event.

In a similar way, the wider, out-of-carriageway HDN has been designed for 20% CC (to suit DMRB) and tested for 40% CC (to suit EA and LLFA) design criterion. Results are set out in Table 6.2 below.

It can be seen that freeboard in SUDS attenuation basins range between 114mm to 2.985m in the 100-year + 40% CC design event set by the Environment Agency for SUDS planning purposes.

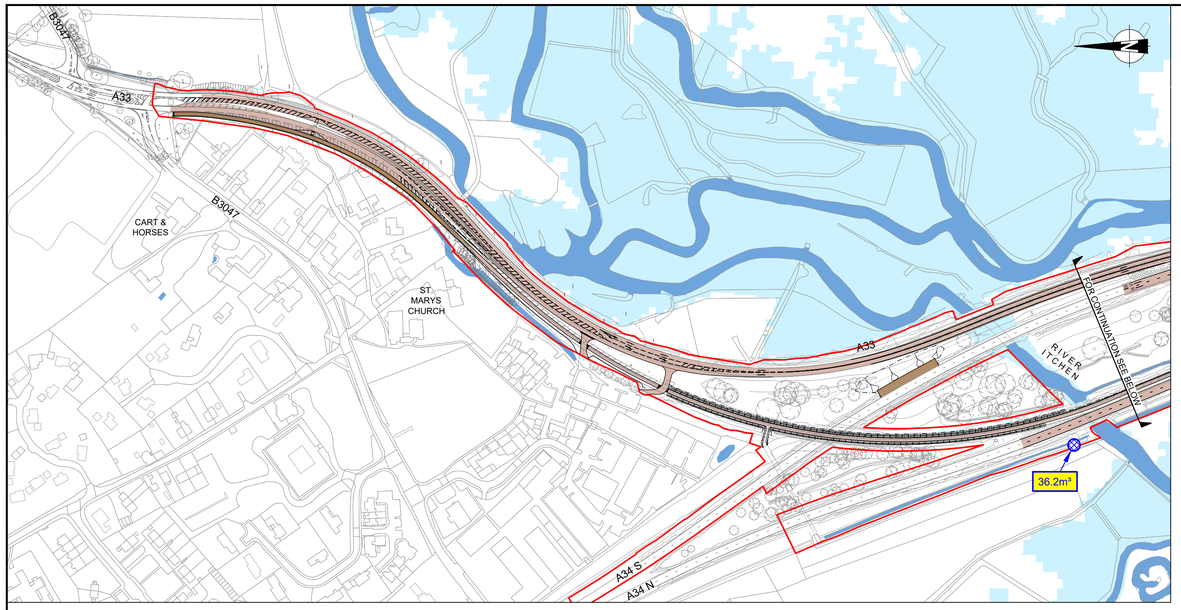
Freeboard increases typically by 124mm to 267mm in the 100-year event with 20% CC.

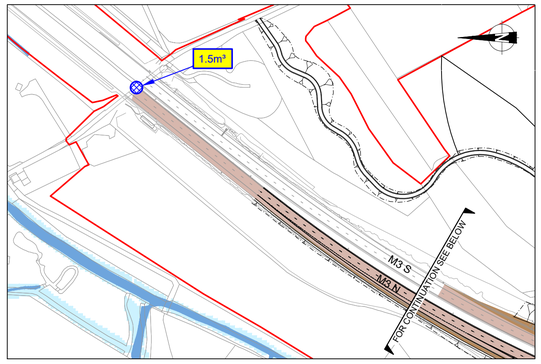
SUDS features therefore meet the criteria set for flood management by the LLFA and accommodate the design criteria set by DMRB for carriageway drainage.

Table 6.2 - Levels in Attenuation Basins - Sensitivity to Climate Change in 100-yr design event

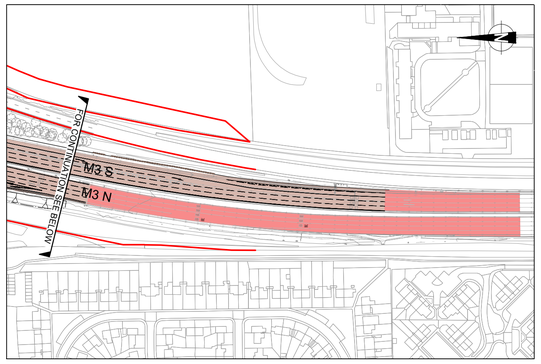
Basin	1	2	3A	3B	3C	4	5 (excluding overland flows)	6 (overland only)	7 (A33/34 Geocell)
Crest Level (maOD)	50.600	43.650	45.400	44.000	43.250	54.650	53.000	n/a	40.700
Invert Level (maOD)	48.604	41.000	43.000	42.075	40.850	51.332	49.000	n/a	38.700
Critical Duration of 100-yr event (hrs)	12 hrs	7 day	1 day	36 hrs	4 days	4 hrs	7 days	n/a	10 hrs
Max WL @ 20% CC (maOD)	49.922	42.009	45.101	43.511	42.869	54.221	49.880	n/a	40.514
Max WL @ 40% CC (maOD)	50.089	42.133	45.282	43.748	43.136	54.387	50.015	n/a	40.878
Freeboard @ 20% CC (m)	0.678	1.641	0.299	0.489	0.381	0.429	3.120	n/a	0.186
Freeboard @ 40% CC (m)	0.511	1.517	0.118	0.252	0.114	0.263	2.985	n/a	-0.178

Appendix A Locations of carriageway flooding in 5-year 40% CC event.





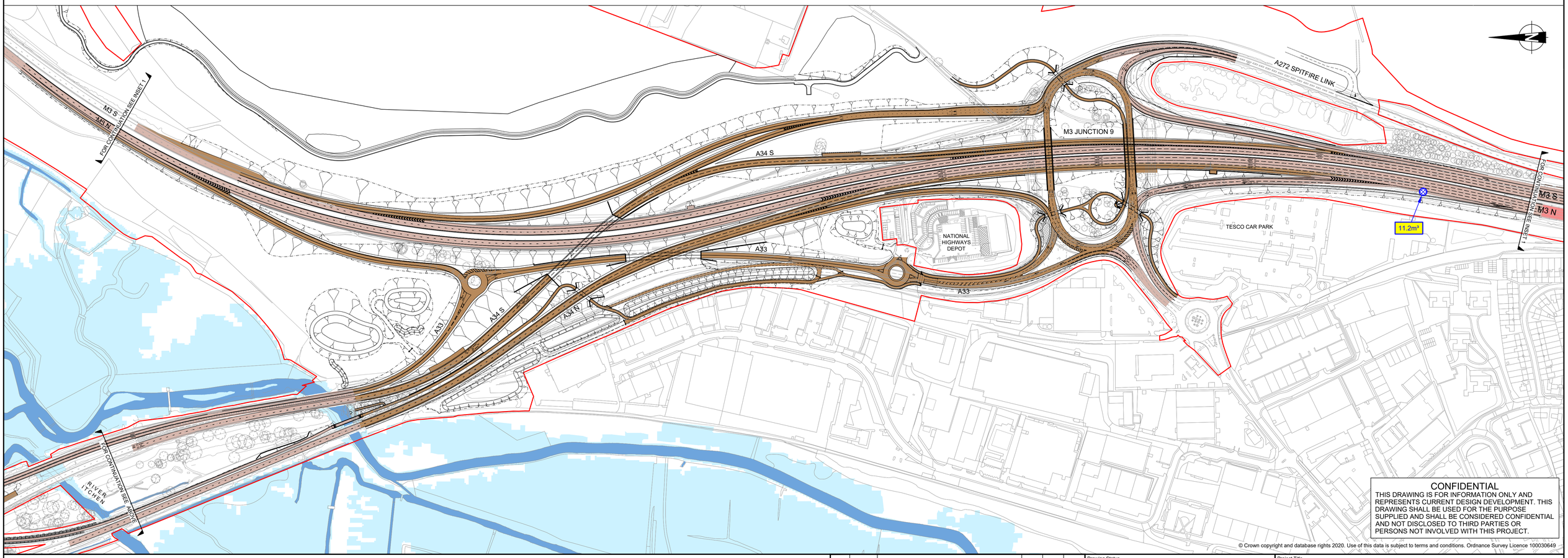
INSET 1: M3 NORTHBOUND CONTINUATION EXTRACT



INSET 2: M3 SOUTHBOUND CONTINUATION EXTRACT

KEY:

- DEVELOPMENT CONSENT ORDER BOUNDARY
- RIVER ITCHEN
- ENVIRONMENT AGENCY FLOOD ZONE 3 EXTENT
- NEW CARRIAGEWAY AREA
- EXISTING CARRIAGEWAY AND DRAINAGE FEATURES TO BE RETAINED
- PROPOSED M3 JUNCTION 9 TO 14 SAFETY BARRIER IMPROVEMENT SCHEME TO BE CONSTRUCTED PRIOR TO JUNCTION 9 IMPROVEMENT SCHEME
- 1.5m³ LOCATION AND VOLUME OF OF SURFACE WATER FLOODING IN THE 5 YEAR + 40% CLIMATE CHANGE EVENT



NOTES:

1. THIS DRAWING SHOULD BE PRINTED IN COLOUR.
2. DO NOT SCALE FROM THIS DRAWING.
3. THE LAYOUT SHOWN IS PRELIMINARY AND SUBJECT TO DETAILED DESIGN.
4. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL OTHER SGAR 3 SUBMISSION DRAWINGS AND DOCUMENTS.
5. FOR PROPOSED AND EXISTING HIGHWAY CATCHMENTS REFER TO DRAWING NUMBERS HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0513 AND 0515.
6. FOR DETAIL OF M3 JUNCTION 9-14 MOTORWAY UPGRADE DRAINAGE DESIGN REFER TO MOTORWAY UPGRADE SCHEME DRAWING NUMBERS HE549338-MMSJV-HDG-000-DR-CD-31001 TO 31007.
7. PROPOSED SCHEME SHOWN IS SUBJECT TO REVIEW BY THE RESPECTIVE HIGHWAY AUTHORITIES, LEAD LOCAL FLOOD AUTHORITY AND THE ENVIRONMENT AGENCY.
8. RE-USE OF EXISTING DRAINAGE ASSETS IS SUBJECT TO REVIEW OF SURVEY DATA, ASSET RECORDS AND SITE VERIFICATION. THIS IS TO BE UNDERTAKEN DURING SGAR 5 (DETAILED DESIGN).
9. DRAWING TO BE READ IN CONJUNCTION WITH:
   - DRAINAGE STRATEGY REPORT REF: HE551511-VFK-HDG-X_XXXX_XX-RP-CD-0001
   - POLLUTION PREVENTION TECHNICAL NOTE REF: HE551511-VFK-HGN-X_XXXX_XX-TN-CH-0003
   - CLIMATE CHANGE TECHNICAL NOTE REF: HE551511-VFK-HDG-X_XXXX_XX-TN-CD-0001
10. FIN DRAINS ARE NOT SHOWN ON THIS DRAWING.
11. CONTROL OF RUNOFF AND SEDIMENT DURING CONSTRUCTION TO BE STRICTLY IN ACCORDANCE WITH THE CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN, WHICH MAY INCLUDE PIPES, SWALES AND BASINS NOT SHOWN ON THIS DRAWING.
12. FOR THE PROPOSED DRAINAGE STRATEGY LAYOUT REFER TO DRAWING NUMBER HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512.

0 50 100 150 200 250m

SCALE 1:2500

Rev.	Date	Description	Drawn	Chk'd	App'd
P03	08.07.22	DRAWING UPDATED TO REVISED M3 J9 SOUTHBOUND TIE IN	JH	LC	MF
P02	23.11.21	ISSUED FOR S3 SUBMISSION	ljj	AC	TRA
P01	15.10.21	FIRST ISSUE	NK	AC	TRA

Drawing Status: S3 - FOR REVIEW & COMMENT

VolkerFitzpatrick

Client: national highways

Project Title: M3 JUNCTION 9 IMPROVEMENT

Drawing Title: SGAR 3 PRELIMINARY DESIGN PROPOSED DRAINAGE NETWORK FLOOD SENSITIVITY TEST DURING 40% CLIMATE CHANGE

Scale	Designed	Drawn	Checked	Approved
1:2500	PR	NK	AC	TRA
Original Size: Size	Date: 15.10.21	Date: 15.10.21	Date: 15.10.21	Date: 15.10.21

Drawing Number: HE551511 - VFK - HDG - X_XXXX_XX - DR - CD - 0519
(HE PIN | Originator | Volume | Location | Type | Role | Number)

Project Ref. No.: 48176

Revision: P03

Appendix O – Consenting Requirements Layout and Table

HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0517 - Water Resources, Land Drainage & Groundwater Consenting Layout

HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0522 - Water Resources Consenting Table

EXISTING DITCHES TO BE RETAINED WITH PROPOSED LOCALISED AMENDMENT TO GULLY AND SURFACE CHANNEL CONNECTIONS TO EXISTING PIPE NETWORKS/DITCHES

300mm DIA. PIPE UPSTREAM OF EXISTING OUTFALL TO THROTTLE ADDITIONAL CARRIAGEWAY RUN-OFF TO LIMIT DISCHARGE FLOW RATES TO NO GREATER THAN EXISTING

EXISTING DRAINAGE TRENCHES

EXISTING DRAINAGE FILTER TRENCHES

EXISTING DRAINAGE TRENCHES

FOR CONTINUATION SEE BELOW

FOR CONTINUATION SEE ABOVE

RIVER ITCHEN

A33

A34 S

A34 N

B3047

CART & HORSES

ST. MARYS CHURCH

INSET 1: M3 NORTHBOUND CONTINUATION EXTRACT

5m LENGTH OF EXISTING 225mm PIPE REPLACED WITH NEW 185mm DIA. PIPE TO LIMIT FLOW RATES TO EXISTING (86 l/s @ 1.704m HEAD IN 5-YEAR DESIGN EVENT)

100m x 900mm DIA. PIPE + 100m x 450mm DIA. PIPE TO PROVIDE ATTENUATION UPSTREAM OF THROTTLE ARRANGEMENT

M3 S

M3 N

FOR CONTINUATION SEE BELOW

EXISTING GROUNDWATER PROTECTION ZONES

ZONE 3

ZONE 2

ZONE 1

M3 JUNCTION 9

0 1 2km

SCALE 1:50000

KEY

- DEVELOPMENT CONSENT ORDER BOUNDARY
- PROPOSED HIGHWAY SURFACE WATER DRAINAGE NETWORK (PIPED)
- RETAINED EXISTING HIGHWAY SURFACE WATER DRAINAGE (PIPED)
- PROPOSED SURFACE WATER FILTER DRAIN
- RIVER ITCHEN
- ENVIRONMENT AGENCY FLOOD ZONE 3 EXTENT
- EXISTING HIGHWAY SURFACE WATER DRAINAGE DITCHES / SOAKAGE FEATURES TO BE RETAINED
- EXISTING HIGHWAY SURFACE WATER DRAINAGE DITCHES / SOAKAGE FEATURES TO BE DECOMMISSIONED
- 2 — PROPOSED EXTENDED DETENTION BASIN (A DRY INFILTRATION DETENTION BASIN WITH LOW-LYING MARSH / POOLS INCORPORATED OVER MAX. OF 25% OF BASE)
- 4 — PROPOSED ATTENUATION BASIN (A DRY DETENTION BASIN WITH IMPERMEABLE LINER)
- PROPOSED GRASSED SWALE
- PROPOSED POLLUTION CONTROL DEVICE (LINED DITCH)
- PROPOSED GEOCELLULAR ATTENUATION
- EXISTING OIL INTERCEPTOR TO BE RETAINED
- EXISTING OIL INTERCEPTOR TO BE DECOMMISSIONED
- 30 — EXISTING HIGHWAY DRAINAGE SOAKAWAY FEATURE (WITH REFERENCE) TO BE RETAINED
- 100 — EXISTING HIGHWAY DRAINAGE SOAKAWAY FEATURE (WITH REFERENCE) TO BE DECOMMISSIONED
- 7 — RETAINED OUTFALL TO WATERCOURSE OR GROUND (WITH REFERENCE)
- A — PROPOSED OUTFALL TO WATERCOURSE OR GROUND (WITH REFERENCE)
- OVERLAND FLOW DIRECTION

5m LENGTH OF EXISTING 225mm PIPE REPLACED WITH NEW 150mm DIA. PIPE TO LIMIT FLOW RATES TO EXISTING (56 l/s @ 1.264m HEAD IN 5-YEAR DESIGN EVENT

98m x 600mm DIA. PIPE TO PROVIDE ATTENUATION UPSTREAM OF THROTTLE ARRANGEMENT

INFILTRATION BASIN 6 FOR OVERLAND FLOW (1,058m²) TBC

EXISTING OVERLAND FLOW ROUTES INTERCEPTED BY PROPOSED SCHEME ARE TO BE DRAINED TO GROUND THROUGH BASINS 5 & 6

NEW INFILTRATION BASIN 5 IN VALLEY BOTTOM (6,785m²)

EXISTING OVERLAND FLOW ROUTES INTERCEPTED BY PROPOSED SCHEME ARE TO BE DRAINED TO GROUND THROUGH BASINS 5 & 6

MOTORWAY UPGRADE PROJECT: EXTG1107/CR008A
160mm DIA. ORIFICE PLATE
MAX. HEAD = 1.009m
(CRITICAL 5 YEAR DESIGN STORM)
MAX. FLOW = 51.1 l/s
(EXISTING = 225mm DIA PIPE, ASSUMED)

MOTORWAY UPGRADE PROJECT: EXTG/SKB1
120mm DIA. ORIFICE PLATE
MAX. HEAD = 1.076m
(CRITICAL 5 YEAR DESIGN STORM)
MAX. FLOW = 30.3 l/s
(EXISTING = 150mm DIA. PIPE)

MAINTAIN EXISTING INFILTRATION DRAINAGE SERVING OVERLAND FLOWS FROM EAST

EXISTING DITCH DRAINING M3 TO BE ABANDONED

HIGHWAY RUN-OFF FILTER TRENCH

EXTEND EXISTING LAND DRAINAGE CULVERT TO TERMINATE ON NEW EMBANKMENT FACE IN NEW HEADWALL / CASCADE

BASIN 1 (SIZE 790m³) (LINED)

SWALE LINK FROM UPPER BASIN TO LOWER BASIN

BASIN 2 (SIZE 5,110m³)

TERTIARY SWALE CONNECTING BASIN OVERFLOW TO EXISTING OUTFALL TO RIVER ITCHEN

ABANDON EXISTING PCD DITCH AND INTERCEPTOR

CONNECT NEW SWALE TO EXISTING PIPE VIA NEW INLET HEADWALL

RETAIN EXISTING PIPE & OUTFALL 1 TO RIVER ITCHEN @ 2 l/s

225mm DIA. PIPE UPSTREAM OF EXISTING OUTFALL TO THROTTLE ADDITIONAL CARRIAGEWAY RUN-OFF TO LIMIT DISCHARGE FLOW RATES TO NO GREATER THAN EXISTING

TERTIARY TREATMENT AREA/ SWALE FROM BASIN TO OUTFALL TO RIVER ITCHEN (TBC)

95m x 2m² GEOCELLULAR ATTENUATION

OUTFALL B - AT RESTRICTED 6.0l/s INTO RIVER ITCHEN

OUTFALL A - AT RESTRICTED 29.3 l/s INTO RIVER

225mm DIA. PIPE UPSTREAM OF EXISTING OUTFALL TO THROTTLE ADDITIONAL CARRIAGEWAY RUN-OFF TO LIMIT DISCHARGE FLOW RATES TO NO GREATER THAN EXISTING

NEW BASIN 3A (SIZE 3,770m³) (LINED)

EXISTING DITCH TO BE ABANDONED

NEW INFILTRATION BASIN 3B (SIZE 2,920m³)

EXISTING DITCH TO BE ABANDONED / EXISTING SURFACE WATER HIGHWAY DITCH NOT REUSED

NEW INFILTRATION BASIN 3C (SIZE 9,014m³)

EXISTING DITCH TO BE ABANDONED / EXISTING SURFACE WATER HIGHWAY DITCH NOT REUSED

SURFACE WATER RUN-OFF FROM THE PROPOSED SCHEME TO BE CONVEYED VIA BELOW SURFACE PIPEWORK TO INFILTRATION AND ATTENUATION BASINS SHOWN

BASIN 4 (SIZE 2,370m³) (LINED)

NATIONAL HIGHWAYS DEPOT

TESCO CAR PARK

HAMPSHIRE COUNTY COUNCIL EASTON LANE: PROPOSED LOCALISED AMENDMENTS TO EXISTING GULLY LOCATIONS AND CONNECTIONS AND INTENDED RE-USE OF EXISTING SOAKAWAYS

A272 SPITFIRE LINK

M3 JUNCTION 9

A34 S

A34 N

A33

M3 S

M3 N

FOR CONTINUATION SEE INSET 1

FOR CONTINUATION SEE ABOVE

RIVER ITCHEN

SWALE

0 50 100 150 200 250m

SCALE 1:2500

NOTES:

1. THIS DRAWING SHOULD BE PRINTED IN COLOUR.
2. DO NOT SCALE FROM THIS DRAWING.
3. THE LAYOUT SHOWN IS PRELIMINARY AND SUBJECT TO DETAILED DESIGN.
4. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL OTHER SGAR 3 SUBMISSION DRAWINGS AND DOCUMENTS.
5. FOR PROPOSED AND EXISTING HIGHWAY CATCHMENT REFER TO DRAWINGS HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0513 AND 0515.
6. FOR DETAIL OF M3 JUNCTION 9-14 MANAGED MOTORWAY PROJECT DRAINAGE DESIGN REFER TO MMP DRAWINGS HE549338-MMSJV-HDG-000-DR-CD-31001 TO 31007.
7. PROPOSED SCHEME SHOWN IS SUBJECT TO REVIEW WITH THE RESPECTIVE HIGHWAY AUTHORITIES, LEAD LOCAL FLOOD AUTHORITY AND THE ENVIRONMENT AGENCY.
8. SUITABILITY OF RE-USE OF EXISTING DRAINAGE ASSETS IS SUBJECT TO REVIEW OF SURVEY, ASSET RECORDS AND SITE VERIFICATION.
9. DRAWING TO BE READ IN CONJUNCTION WITH THE FOLLOWING:
   - DRAINAGE STRATEGY REPORT REF: HE551511-VFK-HDG-X_XXXX_XX-RP-CD-0001
   - POLLUTION PREVENTION TECHNICAL NOTE REF: HE551511-VFK-HGN-X_XXXX_XX-TN-CH-0003
   - DECOMMISSIONING AND RENOVATION OF EXISTING HIGHWAY SOAKAWAYS TECHNICAL NOTE REF: HE551511-VFK-HDG-X_XXXX_XX-TN-CD-0003
10. FIN DRAINS ARE NOT SHOWN ON THIS DRAWING.
11. CONTROL OF RUNOFF AND SEDIMENT DURING CONSTRUCTION TO BE STRICTLY IN ACCORDANCE WITH THE CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN, WHICH MAY INCLUDE PIPES, SWALES AND BASINS NOT SHOWN ON THIS DRAWING.
12. FOR MORE INFORMATION ON THE PROPOSED DRAINAGE SCHEME PLEASE REFER TO DRAWING HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512.
13. FOR WATER RESOURCES CONSENTING TABLE REFER TO DRAWING HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0522.

Rev.	Date	Description	Drawn	Chk'd	App'd
P02	24.11.21	ISSUED FOR S3 SUBMISSION	ljj	AC	TRA
P02	15.10.21	FIRST ISSUE	RG	AC	TRA

Drawing Status: S3 - FOR REVIEW & COMMENT

VolkerFitzpatrick

Client: national highways

Project Title: M3 JUNCTION 9 IMPROVEMENT

Drawing Title: SGAR 3 PRELIMINARY DESIGN
WATER RESOURCES
LAND DRAINAGE AND GROUNDWATER CONSENTING LAYOUT

Scale	Designed	Drawn	Checked	Approved
1:2500	AC	RG	AC	TRA
Original Size: Size	Date: 15.10.21	Date: 15.10.21	Date: 15.10.21	Date: 15.10.21

Drawing Number: HE PIN I Originator I Volume
HE551511 - VFK -HDG-
X_XXXX_XX - DR - CD - 0517
Location I Type I Role I Number

Project Ref. No.: 48176

Revision: P02

LOCATION REFERENCE	FEATURE TYPE	EXISTING OR PROPOSED	RETAINED OR ABANDONED	RECEIVING CONTROLLED WATERS	EFFECTIVE CATCHMENT AREA (ha)	CATCHMENT TYPE	5yr +20CC PEAK FLOW (l/s)	M5-6hr + 20CC VOLUME TO SURFACE WATERS (m^3)	M5-6hr + 20CC VOLUME TO GROUNDWATER (m^3)	DESIGN EVENT	OWNERSHIP	LEAD LOCAL FLOOD AUTHORITY APPROVALS	ENVIRONMENT AGENCY APPROVALS	NOTES
1	OUTFALL	EXISTING	RETAINED	ORDINARY WATERCOURSE CONSENT	0.756	HIGHWAY	126	287		5-YEAR + 20% CC	NATIONAL HIGHWAYS	N/A	N/A	CHANGE IN FLOW VIA EXISTING OUTFALL
2	OUTFALL	EXISTING	RETAINED	ORDINARY WATERCOURSE CONSENT	0.054	HIGHWAY	7	18		5-YEAR + 20% CC	NATIONAL HIGHWAYS	N/A	N/A	CHANGE IN FLOW VIA EXISTING OUTFALL
3	OUTFALL	EXISTING	RETAINED	ORDINARY WATERCOURSE CONSENT	0.107	HIGHWAY	25	41		5-YEAR + 20% CC	NATIONAL HIGHWAYS	N/A	N/A	CHANGE IN FLOW VIA EXISTING OUTFALL
4	OUTFALL	EXISTING	RETAINED	ORDINARY WATERCOURSE CONSENT	0.604	HIGHWAY	41	229		5-YEAR + 20% CC	NATIONAL HIGHWAYS	N/A	N/A	CHANGE IN FLOW VIA EXISTING OUTFALL
5	OUTFALL	EXISTING	RETAINED	ORDINARY WATERCOURSE CONSENT	0.298	HIGHWAY	61	111		5-YEAR + 20% CC	NATIONAL HIGHWAYS	N/A	N/A	CHANGE IN FLOW VIA EXISTING OUTFALL
6	OUTFALL	EXISTING	RETAINED	MAIN RIVER	0.734	HIGHWAY	118	278		5-YEAR + 20% CC	NATIONAL HIGHWAYS	N/A	FLOOD RISK ACTIVITY ENVIRONMENTAL PERMIT	TBC BY ENVIRONMENT AGENCY - HIGHWAY RUN-OFF EXEMPT IF OIL SEPARATOR PRESENT, BUT NOT ALL RUN-OFF TO OUTFALL 6 IS INTERCEPTED.
7	OUTFALL	EXISTING	RETAINED	ORDINARY WATERCOURSE CONSENT	0.421	HIGHWAY	49	159		5-YEAR + 20% CC	NATIONAL HIGHWAYS	N/A	N/A	CHANGE IN FLOW VIA EXISTING OUTFALL
8	OUTFALL	EXISTING	RETAINED	MAIN RIVER	1.617	HIGHWAY	2	346		5-YEAR + 20% CC	NATIONAL HIGHWAYS	N/A	FLOOD RISK ACTIVITY ENVIRONMENTAL PERMIT	EXISTING OUTFALL REFURBISHED
A	OUTFALL	PROPOSED		MAIN RIVER	0.481	HIGHWAY	6	183		5-YEAR + 20% CC	NATIONAL HIGHWAYS	N/A	FLOOD RISK ACTIVITY ENVIRONMENTAL PERMIT	NEW OUTFALL TO RIVER ITCHEN
B	OUTFALL	PROPOSED		MAIN RIVER	10.631	HIGHWAY	29.3	3,389		5-YEAR + 20% CC	NATIONAL HIGHWAYS	N/A	FLOOD RISK ACTIVITY ENVIRONMENTAL PERMIT	NEW OUTFALL TO RIVER ITCHEN
BASIN 1	EXTENDED DETENTION BASIN	PROPOSED			0.813	HIGHWAY					NATIONAL HIGHWAYS	SUDS PLANNING APPROVAL	EXEMPT	BASIN LINED
BASIN 2	EXTENDED DETENTION BASIN	PROPOSED		GROUNDWATER + MAIN RIVER	1.617	HIGHWAY	2	346	237	5-YEAR + 20% CC	NATIONAL HIGHWAYS	SUDS PLANNING APPROVAL	SUBJECT TO ENVIRONMENTAL PERMITTING (ENGLAND & WALES) REGULATIONS 2016, SCHEDULE 22	TBC BY ENVIRONMENT AGENCY
BASIN 3A	EXTENDED DETENTION BASIN	PROPOSED			8.129	HIGHWAY					NATIONAL HIGHWAYS	SUDS PLANNING APPROVAL	EXEMPT	BASIN LINED
BASIN 3B	EXTENDED DETENTION BASIN	PROPOSED		GROUNDWATER	8.973	HIGHWAY			43	5-YEAR + 20% CC	NATIONAL HIGHWAYS	SUDS PLANNING APPROVAL	SUBJECT TO ENVIRONMENTAL PERMITTING (ENGLAND & WALES) REGULATIONS 2016, SCHEDULE 22	TBC BY ENVIRONMENT AGENCY
BASIN 3C	EXTENDED DETENTION BASIN	PROPOSED		GROUNDWATER + MAIN RIVER	10.630	HIGHWAY	29.3	3,389	294	5-YEAR + 20% CC	NATIONAL HIGHWAYS	SUDS PLANNING APPROVAL	SUBJECT TO ENVIRONMENTAL PERMITTING (ENGLAND & WALES) REGULATIONS 2016, SCHEDULE 22	TBC BY ENVIRONMENT AGENCY
BASIN 4	EXTENDED DETENTION BASIN	PROPOSED			6.213	HIGHWAY					NATIONAL HIGHWAYS	SUDS PLANNING APPROVAL	EXEMPT	BASIN LINED
BASIN 5	EXTENDED DETENTION BASIN	PROPOSED		GROUNDWATER	77.681	HIGHWAY + OVERLAND			1,249	5-YEAR + 20% CC	NATIONAL HIGHWAYS	SUDS PLANNING APPROVAL	SUBJECT TO ENVIRONMENTAL PERMITTING (ENGLAND & WALES) REGULATIONS 2016, SCHEDULE 22	TBC BY ENVIRONMENT AGENCY
BASIN 6	EXTENDED DETENTION BASIN	PROPOSED		GROUNDWATER	14.000	OVERLAND			120	5-YEAR + 20% CC	NATIONAL HIGHWAYS	SUDS PLANNING APPROVAL	SUBJECT TO ENVIRONMENTAL PERMITTING (ENGLAND & WALES) REGULATIONS 2016, SCHEDULE 22	TBC BY ENVIRONMENT AGENCY
BASIN 7 (GEOCELL)	GEOCELLULAR TANK	PROPOSED		MAIN RIVER	0.481	HIGHWAY	6	183		5-YEAR + 20% CC	NATIONAL HIGHWAYS	SUDS PLANNING APPROVAL	SUBJECT TO ENVIRONMENTAL PERMITTING (ENGLAND & WALES) REGULATIONS 2016, SCHEDULE 23	TBC BY ENVIRONMENT AGENCY
100	SOAKAWAY TRENCH	EXISTING	ABANDONED	GROUNDWATER		HIGHWAY					NATIONAL HIGHWAYS	N/A	ENVIRONMENTAL PERMIT N/A IF HYDROGEOLOGICAL RISK ASSESSMENT CONCLUDES NO RISK TO GROUNDWATER (EA G12)	TBC WHERE DISCHARGE OF WASTE WATER TO SURFACE OR GROUNDWATERS
101	SOAKAWAY CHAMBER	EXISTING	ABANDONED	GROUNDWATER		HIGHWAY					NATIONAL HIGHWAYS	N/A	ENVIRONMENTAL PERMIT N/A IF HYDROGEOLOGICAL RISK ASSESSMENT CONCLUDES NO RISK TO GROUNDWATER (EA G12)	TBC WHERE DISCHARGE OF WASTE WATER TO SURFACE OR GROUNDWATERS
102	SOAKAWAY TRENCH	EXISTING	ABANDONED	GROUNDWATER		HIGHWAY					NATIONAL HIGHWAYS	N/A	ENVIRONMENTAL PERMIT N/A IF HYDROGEOLOGICAL RISK ASSESSMENT CONCLUDES NO RISK TO GROUNDWATER (EA G12)	TBC WHERE DISCHARGE OF WASTE WATER TO SURFACE OR GROUNDWATERS
103	SOAKAWAY TRENCH	EXISTING	ABANDONED	GROUNDWATER		HIGHWAY					NATIONAL HIGHWAYS	N/A	ENVIRONMENTAL PERMIT N/A IF HYDROGEOLOGICAL RISK ASSESSMENT CONCLUDES NO RISK TO GROUNDWATER (EA G12)	TBC WHERE DISCHARGE OF WASTE WATER TO SURFACE OR GROUNDWATERS
104	SOAKAWAY TRENCH	EXISTING	ABANDONED	GROUNDWATER		HIGHWAY					NATIONAL HIGHWAYS	N/A	ENVIRONMENTAL PERMIT N/A IF HYDROGEOLOGICAL RISK ASSESSMENT CONCLUDES NO RISK TO GROUNDWATER (EA G12)	TBC WHERE DISCHARGE OF WASTE WATER TO SURFACE OR GROUNDWATERS
105	SOAKAWAY CHAMBER	EXISTING	ABANDONED	GROUNDWATER		HIGHWAY					NATIONAL HIGHWAYS	N/A	ENVIRONMENTAL PERMIT N/A IF HYDROGEOLOGICAL RISK ASSESSMENT CONCLUDES NO RISK TO GROUNDWATER (EA G12)	TBC WHERE DISCHARGE OF WASTE WATER TO SURFACE OR GROUNDWATERS
106	2 x SOAKAWAY CHAMBERS + TRENCH	EXISTING	RETAINED	GROUNDWATER		NATIONAL HIGHWAYS DEPOT			EXISTING		NATIONAL HIGHWAYS	N/A	N/A	EXISTING RETAINED IN DEPOT
107	SOAKAWAY CHAMBER	EXISTING	RETAINED	GROUNDWATER		NATIONAL HIGHWAYS DEPOT			EXISTING		NATIONAL HIGHWAYS	N/A	N/A	EXISTING RETAINED IN DEPOT
108	SOAKAWAY CHAMBER	EXISTING	ABANDONED	GROUNDWATER		HIGHWAY					NATIONAL HIGHWAYS	N/A	ENVIRONMENTAL PERMIT N/A IF HYDROGEOLOGICAL RISK ASSESSMENT CONCLUDES NO RISK TO GROUNDWATER (EA G12)	TBC WHERE DISCHARGE OF WASTE WATER TO SURFACE OR GROUNDWATERS
109	SOAKAWAY CHAMBER	EXISTING	ABANDONED	GROUNDWATER		HIGHWAY					NATIONAL HIGHWAYS	N/A	ENVIRONMENTAL PERMIT N/A IF HYDROGEOLOGICAL RISK ASSESSMENT CONCLUDES NO RISK TO GROUNDWATER (EA G12)	TBC WHERE DISCHARGE OF WASTE WATER TO SURFACE OR GROUNDWATERS
110	SOAKAWAY TRENCH	EXISTING	ABANDONED	GROUNDWATER		HIGHWAY					NATIONAL HIGHWAYS	N/A	ENVIRONMENTAL PERMIT N/A IF HYDROGEOLOGICAL RISK ASSESSMENT CONCLUDES NO RISK TO GROUNDWATER (EA G12)	TBC WHERE DISCHARGE OF WASTE WATER TO SURFACE OR GROUNDWATERS
111	SOAKAWAY CHAMBER	EXISTING	ABANDONED	GROUNDWATER		HIGHWAY					NATIONAL HIGHWAYS	N/A	ENVIRONMENTAL PERMIT N/A IF HYDROGEOLOGICAL RISK ASSESSMENT CONCLUDES NO RISK TO GROUNDWATER (EA G12)	TBC WHERE DISCHARGE OF WASTE WATER TO SURFACE OR GROUNDWATERS
112	SOAKAWAY CHAMBER	EXISTING	ABANDONED	GROUNDWATER		HIGHWAY					NATIONAL HIGHWAYS	N/A	ENVIRONMENTAL PERMIT N/A IF HYDROGEOLOGICAL RISK ASSESSMENT CONCLUDES NO RISK TO GROUNDWATER (EA G12)	TBC WHERE DISCHARGE OF WASTE WATER TO SURFACE OR GROUNDWATERS
113	SOAKAWAY TRENCH	EXISTING	ABANDONED	GROUNDWATER		HIGHWAY					NATIONAL HIGHWAYS	N/A	ENVIRONMENTAL PERMIT N/A IF HYDROGEOLOGICAL RISK ASSESSMENT CONCLUDES NO RISK TO GROUNDWATER (EA G12)	TBC WHERE DISCHARGE OF WASTE WATER TO SURFACE OR GROUNDWATERS
114	SOAKAWAY CHAMBER	EXISTING	ABANDONED	GROUNDWATER		HIGHWAY					NATIONAL HIGHWAYS	N/A	ENVIRONMENTAL PERMIT N/A IF HYDROGEOLOGICAL RISK ASSESSMENT CONCLUDES NO RISK TO GROUNDWATER (EA G12)	TBC WHERE DISCHARGE OF WASTE WATER TO SURFACE OR GROUNDWATERS
18	SOAKAWAY CHAMBER	EXISTING	RETAINED	GROUNDWATER	0.038	HIGHWAY			14	5-YEAR + 20% CC	NATIONAL HIGHWAYS	N/A	N/A	EXISTING RETAINED IN HIGHWAY
19	SOAKAWAY CHAMBER	EXISTING	RETAINED	GROUNDWATER	0.033	HIGHWAY			13	5-YEAR + 20% CC	HAMPSHIRE CC	N/A	N/A	EXISTING RETAINED IN HIGHWAY
20	SOAKAWAY CHAMBER	EXISTING	RETAINED	GROUNDWATER	0.022	HIGHWAY			8	5-YEAR + 20% CC	HAMPSHIRE CC	N/A	N/A	EXISTING RETAINED IN HIGHWAY
21	SOAKAWAY CHAMBER	EXISTING	RETAINED	GROUNDWATER	0.026	HIGHWAY			10	5-YEAR + 20% CC	HAMPSHIRE CC	N/A	N/A	EXISTING RETAINED IN HIGHWAY
22	SOAKAWAY CHAMBER	EXISTING	RETAINED	GROUNDWATER	0.021	HIGHWAY			8	5-YEAR + 20% CC	HAMPSHIRE CC	N/A	N/A	EXISTING RETAINED IN HIGHWAY
23	SOAKAWAY CHAMBER	EXISTING	RETAINED	GROUNDWATER	0.045	HIGHWAY			17	5-YEAR + 20% CC	HAMPSHIRE CC	N/A	N/A	EXISTING RETAINED IN HIGHWAY
24	SOAKAWAY CHAMBER	EXISTING	RETAINED	GROUNDWATER	INCLUDED	HIGHWAY			INCLUDED	5-YEAR + 20% CC	NATIONAL HIGHWAYS	N/A	N/A	EXISTING RETAINED IN HIGHWAY
25	SOAKAWAY TRENCH	EXISTING	RETAINED	GROUNDWATER	0.994	HIGHWAY			655	5-YEAR + 20% CC	NATIONAL HIGHWAYS	N/A	N/A	EXISTING RETAINED IN HIGHWAY
26	NOT USED											N/A	N/A	
27	SOAKAWAY TRENCH	EXISTING	RETAINED	GROUNDWATER	INCLUDED	HIGHWAY			INCLUDED	5-YEAR + 20% CC	NATIONAL HIGHWAYS	N/A	N/A	EXISTING RETAINED IN HIGHWAY
28	SOAKAWAY CHAMBER (IN TRENCH)	EXISTING	RETAINED	GROUNDWATER	0.060	HIGHWAY			38	5-YEAR + 20% CC	NATIONAL HIGHWAYS	N/A	N/A	EXISTING RETAINED IN HIGHWAY
29	SOAKAWAY CHAMBER (IN TRENCH)	EXISTING	RETAINED	GROUNDWATER	0.732	HIGHWAY			278	5-YEAR + 20% CC	NATIONAL HIGHWAYS	N/A	N/A	EXISTING RETAINED IN HIGHWAY
30	SOAKAWAY TRENCH	EXISTING	RETAINED	GROUNDWATER	1.190	HIGHWAY			452	5-YEAR + 20% CC	NATIONAL HIGHWAYS	N/A	N/A	EXISTING RETAINED IN HIGHWAY
31	SOAKAWAY CHAMBER	EXISTING	RETAINED	GROUNDWATER	INCLUDED	HIGHWAY			INCLUDED	5-YEAR + 20% CC	NATIONAL HIGHWAYS	N/A	N/A	EXISTING RETAINED IN HIGHWAY

NOTES

1. THE LAYOUT SHOWN IS PRELIMINARY AND SUBJECT TO DETAILED DESIGN.
2. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL OTHER SGAR 3 SUBMISSION DRAWINGS AND DOCUMENTS.
3. FOR DRAINAGE SCHEMATIC LAYOUT REFER TO DRAWING NUMBER HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512.
4. FOR WATER RESOURCES AND GROUNDWATER CONSENTING LAYOUT REFER TO DRAWING NUMBER HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0517.
5. THE DESIGN EVENT CONSIDERED IS IN ACCORDANCE WITH DMRB DESIGN GUIDE CG 501 - DESIGN OF HIGHWAY DRAINAGE SYSTEMS.
6. WHERE SOAKAWAY MATERIALS AND SURROUNDING CONTAMINATED GROUND ARE TO BE REMOVED, ALL WORKS TO BE IN ACCORDANCE WITH HAZARDOUS WASTE CONVEYANCE AND DISPOSAL REGULATIONS (NOT SHOWN IN ABOVE TABLE).

Rev.	Date	Description	Drawn	Chk'd	App'd
P02	23.11.21	ISSUED FOR S3 SUBMISSION	ljj	AC	TRA
P01	11.10.21	FIRST ISSUE	PR	AC	TRA

Drawing Status: S3 - FOR REVIEW & COMMENT

VolkerFitzpatrick

Client: national highways

Project Title: M3 JUNCTION 9 IMPROVEMENT

Drawing Title: SGAR 3 PRELIMINARY DESIGN
WATER RESOURCES
LAND DRAINAGE AND GROUNDWATER CONSENTING TABLE

Scale	Designed	Drawn	Checked	Approved
NOT TO SCALE	PR	AC	AC	TRA
Original Size: A1	Date: 11.10.21	Date: 11.10.21	Date: 11.10.21	Date: 11.10.21

Drawing Number: HE551511 - VFK -HDG- X_XXXX_XX - DR - CD - 0522
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Project Ref. No.: 48176

Revision: P02

Appendix P – Technical Note: Proposed Drainage Amendments Following the Omission of the Managed Motorway Scheme

HE551511-VFK-HGN-W_XXXX_XX-TN-CH-0014 Proposed Drainage Amendments Technical Note

TECHNICAL NOTE

Job Name:	M3 Junction 9 Improvement Scheme
Job No:	48176/2000
Note No:	HE551511-VFK-HGN-W_XXXX_XX-TN-CH-0014
Date:	10th June 2022
Prepared By:	J. Harvey
Checked by:	L. Cuddington
Subject:	**M3 JUNCTION 9 - PROPOSED DRAINAGE AMENDMENTS FOLLOWING THE OMISSION OF THE MANAGED MOTORWAY SCHEME**

1. Introduction

1.1. The purpose of this Technical Note is to summarise the proposed drainage amendments to the approved SGAR 3 Preliminary M3 Junction 9 Improvement Scheme.

1.2. Following the ministerial statement on 12th January 2022, the government paused the roll out of all new all lane running (ALR) schemes. As the M3 Junction 9 Improvement Scheme tied-in to a new ALR scheme referred to as the Managed Motorway Scheme within this Technical Note; minor design development has been undertaken.

1.3. Although the Managed Motorway Scheme is formally paused, National Highways are planning to upgrade the existing central reservation barrier to concrete, to deliver safety benefits. These works will be known as the M3 Junction 9 to 14 Safety Barrier Improvement Scheme, which will be implemented prior to construction of the M3 Junction 9 Improvement Scheme.

1.4. The proposed amendments to the M3 Junction 9 Improvement Scheme are shown on the following drawings (contained within **Appendix A** of this Technical Note):

- HE551511-VFK-HML-X_XXXX_XX-DR-CH-0023 – General Arrangement Plan – Sheet 3.
- HE551511-VFK-HML-X_XXXX_XX-DR-CH-0023 – General Arrangement Plan – Sheet 6.
- HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512 P03 – Proposed Surface Water Drainage Schematic Plan.
- HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512 P04 – Proposed Surface Water Drainage Schematic Plan.

1.5. The proposed design of the M3 Junction 9 Improvement Scheme drainage amendments is based upon incorporating sections of the M3 Junction 9 to 14 Safety Barrier Improvement Scheme drainage, which is currently still being designed by others. The drainage assumptions are therefore based upon the following M3 Junction 9 to 14 Safety Barrier Improvement Scheme drainage drawings (contained within **Appendix B** of this Technical Note):

- HE549338-JAC-HDG-WHL-DN-MAINL-DR-CD-0001 – Legend and General Notes.
- HE549338-JAC-HDG-S1_DN_MAINL-DR-CD-0001 – Proposed Drainage Layout.
- HE549338-JAC-HDG-S1_DN_MAINL-DR-CD-0002 – Proposed Drainage Layout.
- HE549338-JAC-HDG-S1_DN_MAINL-DR-CD-0003 – Proposed Drainage Layout.

1.6. **It should be noted that the revised drainage network proposed as part of the M3 Junction 9 Improvement Scheme assumes that works undertaken as part of the M3 Junction 9 to 14 Safety Barrier Improvement Scheme, includes provision for attenuation features (as per the previous Managed Motorway Scheme design). Therefore, it is assumed that no additional flow (above existing) will enter the M3 Junction 9 Improvement Scheme drainage network. Should there be any significant amendments to the finalised M3 Junction 9 to 14 Safety Barrier Improvement Scheme, the design of the M3 Junction 9 Improvement Scheme drainage covered by this Technical Note will need to be reviewed. It should also be noted that the M3 Junction 9 Improvement Scheme takes no account of any future proofing for the ALR scheme which is currently paused.**

1.7. As stated in paragraph 1.3, the proposed M3 Junction 9 to 14 Safety Barrier Improvement Scheme is happening before construction of the M3 Junction 9 Improvement Scheme and could be part of any barrier upgrade programme regardless of the ALR pause. If the M3 Junction 9 Improvement Scheme did not proceed, then the drainage flow from the M3 Junction 9 to 14 Safety Barrier Improvement Scheme would enter the drainage system north of Junction 9, so therefore the drainage design is independent from the M3 Junction 9 Improvement Scheme. The assumed design principle is that the M3 J9 to 14 Safety Barrier Improvement Scheme drainage does not increase the flow into the existing M3 Junction 9 drainage system beyond its current capacity.

2. Catchments

2.1. To facilitate the tie into the existing M3 highway alignment following the omission of the Managed Motorway Scheme, the extent of the M3 Junction Improvement 9 Scheme has been increased. Details regarding the design of the tie in are contained within Technical Note reference: HE551511-VFK-HGN-W_XXXX_XX-TN-CH-0013, contained within PCF Product 23.

2.2. The overall length of the southbound tie-in has increased by approx. 310m further south whilst the northbound tie-in has increased by approx. 60m.

2.3. Locally, the cross section of the southbound carriageway differs to the existing. Where the proposed carriageway is narrower than the existing, hatched markings are to be provided (i.e., there is no reduction in hard paved surfacing). Where there is an increase in width, the extent of the carriageway's hard paved surfacing is to be increased (widening).

2.4. The impermeable areas associated with the increased scheme extents are defined in the Table 1 below.

Table 1. Impermeable Areas for M3 Junction 9 tie in.

Location	Hard Paved Areas (taken as 100% impermeable)	Soft / Landscaped Areas (taken as 20% Impermeable)
Southbound carriageway	0.599 ha	0.03 ha
Northbound carriageway	0.088 ha	-

3. Current Drainage Design (Managed Motorway Scheme Tie In)

3.1. The current approved Stage 3 M3 Junction 9 Improvement Scheme preliminary drainage design is shown on drawing number HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512 Rev P03.

3.2. The Scheme consists of a number of independent networks which either convey and discharge surface water runoff to ground, the River Itchen and / or a combination of the two.

Northbound Mainline

3.3. The highpoint of the M3 is located approximately 950m south of the proposed Junction 9 roundabout.

3.4. Surface water runoff associated with the first 410m approx. of the M3 mainline are collected and conveyed via drainage associated with the Managed Motorway Scheme. This network predominantly consists of filter trenches within the nearside verge along with concrete 'V' channels and linear drainage channels within the central reserve; the existing filter trenches / French drains present within the central reserve are either to remain and / or improved but will simply convey surface water flows following hardening of the reserve.

3.5. Attenuated flows associated with the Managed Motorway Scheme are accommodated by the M3 Junction 9 Improvement Scheme for the northbound mainline and central reserve. The flows are conveyed north through the scheme predominantly via a piped network situated beneath the central reserve and nearside verge and are attenuated within the extended detention basins prior to discharging into the River Itchen. Along this route, a proportion of the combined surface water flows (M3 Junction 9 Improvement & Managed Motorway Scheme) are to discharge to ground via existing infiltration trenches and soakaways located west of the mainline embankment.

Southbound Mainline

3.6. Similarly, to the northbound, surface water runoff associated with the first 410m approx. of the M3 mainline is to be collected and conveyed via an existing filter trench / french drain network located within the nearside verge.

3.7. Unlike the northbound, this section of highway is to drain entirely to existing infiltration trenches and soakaways located to the east of the A272 Spitfire Link. There is no current connection between this drainage network and the proposed M3 Junction 9 Improvement scheme; surface water flows do however merge with those attributed with the A272 prior to infiltrating to ground.

3.8. To ensure the system operates as intended, despite the increase in impermeable catchment, the existing drainage network is to be improved with flows controlled to that of the existing network and attenuated online within oversized pipes.

4. Amended Drainage Design (No Managed Motorway - Tie into Existing Highway)

4.1. The amended Stage 3 M3 Junction 9 Improvement Scheme preliminary drainage design is shown on drawing number HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512 Rev P04.

Northbound Mainline

4.2. It is understood that whilst the Managed Motorway Scheme is paused (subject to review by the Government), the drainage improvements associated with the scheme are to proceed as planned (forming part of the M3 Junction 9 to 14 Safety Barrier Improvement Scheme). On this basis there is little to no change required to facilitate surface water runoff associated with the northbound mainline and central reserve.

4.3. It should be noted that there are differences regarding the application of climate change in accordance with DMRB for the two schemes. At the time of writing, the climate change factors applied to the M3 Junction 9 to 14 Safety Barrier Improvement Scheme have not been confirmed by the schemes Design Consultant although it has been confirmed the scheme has been designed in accordance with IAN 161/15. It is understood the requirements of IAN 161/15 are less onerous than GC 501 therefore a review of the scheme will need to be undertaken following receipt of this information.

Southbound Mainline

4.4. The increased cross-sectional width of the southbound carriageway required to facilitate the tie into the existing highway will marginally increase the peak surface water runoff to the nearside drainage network. Accounting for the change in climate change factors between the two schemes (the tie will now form part of the M3 Junction 9 Improvement Scheme) it is likely that this will result in further improvements to the existing network beyond those proposed by the M3 Junction 9 to 14 Safety Barrier Improvement Scheme.

4.5. It is worth noting that at the time of writing this section of the southbound carriageway still forms part of the M3 Junction 9 to 14 Safety Barrier Improvement Scheme. As a result, there is a conflict as to the extent of accommodation and collaboration between the schemes & the Design Consultants. Current programmes are likely to result in the construction of the southbound drainage as part of the M3 Junction 9 to 14 Safety Barrier Improvement Scheme with further improvements and/or abortive construction works required later to facilitate the M3 J9 scheme. Early engagement with National Highways and the Safety Barrier Improvement Scheme Design Consultants is recommended to mitigate against this.

4.6. An initial review of the proposed southbound drainage identified this to be sub-standard in complying with the requirements of DMRB CG 501 with the additional proposed highway catchments of the M3 Junction 9 Improvement Scheme incorporated into the drainage model. Due to existing and proposed site constraints, there is little scope to improve on the proposed drainage design. Limiting the proposed amendments to this existing (improved) filter trench network also minimises abortive work should this be provided as part of the M3 Junction 9 to 14 Safety Barrier Improvement Scheme.

4.7. Although flood exceedance modelling has not been undertaken, a review of the proposed vertical alignment of the scheme indicates the exceedance would likely flow across the southbound carriageway just south of the proposed M3 Junction 9 southbound merge.

4.8. Given the significance of this location and the risk to road users during flood events, a solid carrier pipe and manhole network is to be provided within the southbound verge downstream of MH 261 to act as an overflow system for the existing (improved) highway drainage network. This drainage system will run northwards within the southbound verge for 162m prior to crossing the proposed M3 Junction 9 merge slip, connecting into the proposed drainage network within the southbound verge further to the north.

4.9. The initial 162m section of this proposed overflow network is to consist of oversized pipes with a flow control device within the downstream manhole MH 47. The controlling of flows limits the extent of improvements required to the approved Stage 3 proposed drainage network, although localised improvements are required to the southbound network located beneath the Junction 9 roundabout.

4.10. To facilitate the proposed overflow network, the flow control chamber MH 261 is to be reconstructed as a complex flow control chamber. The exact construction of the proposed complex flow control chamber is to be developed during Stage 5 (Detailed Design). It is envisioned this will comprise of an oversized chamber incorporating a weir wall, orifice plate and two outgoing pipes. The orifice plate is to be fixed to the outgoing pipe which conveys surface water flows towards the existing soakaway features located adjacent to the A272 Spitfire Link. This will control the flow rate to that of the existing highway as per the current M3 Junction 9 to 14 Safety Barrier Improvement Scheme drainage design. The internal weir wall will proceed to divert surface water flows towards the orifice plate and associated outgoing pipe until water levels within the network reach a defined level, it is at this point flows will cascade over the weir to be conveyed north into the wider M3 Junction 9 Improvement Scheme drainage network.

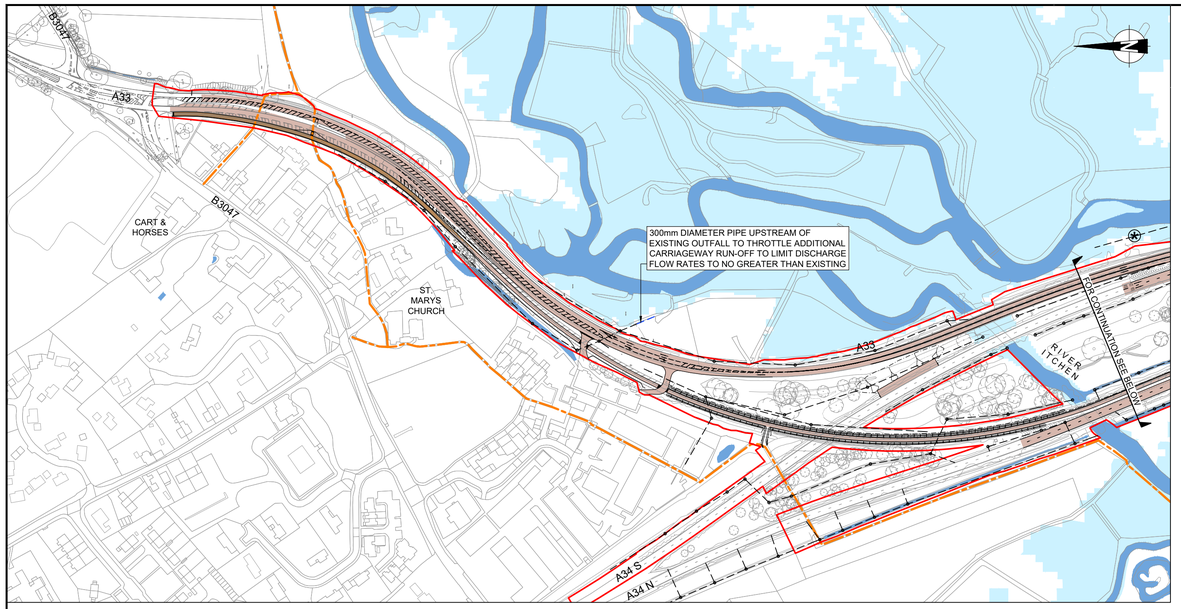
4.11. Surface water runoff which is conveyed into the southern drainage network further north, via the overflow system, is to be attenuated within the extended detention basins to the north of the scheme prior to discharging into the River Itchen.

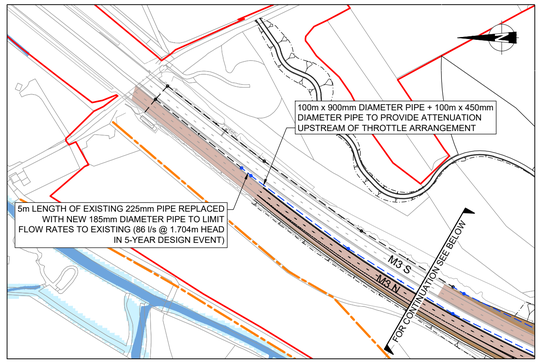
5. Next Steps

5.1. It is understood that the areas associated with the revised M3 Junction 9 Improvement Scheme tie into existing highway were not incorporated with the approved Stage 3 preliminary drainage design as these were covered by the then Managed Motorway Scheme. It is therefore recommended the additional areas are assessed and the National Highways Water Risk Assessment Tool (HEWRAT) & Hydrological / Hydrogeological Risk Assessment (HgRA) assessments are updated as required.

5.2. Drainage associated with the northbound carriageway associated with the Managed Motorway Scheme and subsequently the M3 Junction 9 to 14 Safety Barrier Improvement Scheme which drain into the M3 Junction 9 Improvement Scheme have already been incorporated within the Stage 3 drainage model. At the time of writing, elements of the proposed M3 Junction 9 to 14 Safety Barrier Improvement Scheme (north and southbound verge drainage) are still to be progressed. Whilst it is anticipated there will be limited change to the total impermeable catchments, discharge rates and/or the proposed drainage layouts as outlined in Paragraph 1.5, the proposed M3 Junction 9 Improvements Scheme drainage design will need to be assessed and updated accordingly; this is to be undertaken at Stage 5.

APPENDIX A

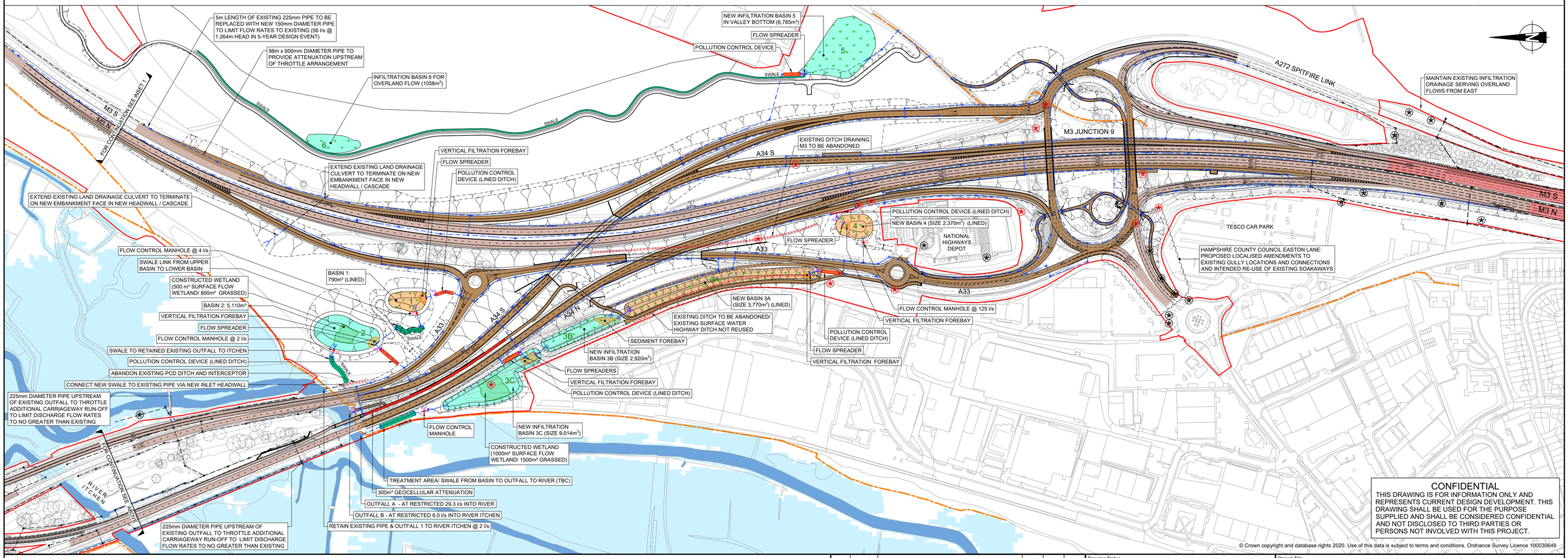




INSET 1: M3 NORTHBOUND CONTINUATION EXTRACT

KEY:

- DEVELOPMENT CONSENT ORDER BOUNDARY
- EXISTING FOOTPATH / PUBLIC RIGHT OF WAY
- PROPOSED HIGHWAY DRAINAGE NETWORK
- RETAINED EXISTING HIGHWAY DRAINAGE
- RIVER ITCHEN
- ENVIRONMENT AGENCY FLOOD ZONE 3 EXTENT
- PROPOSED GEOCELLULAR ATTENUATION
- PROPOSED INFILTRATION BASIN AND REFERENCE NUMBER
- PROPOSED LINED BASIN AND REFERENCE NUMBER
- PROPOSED GRASSED BASIN (ALL GRASSED EXCEPT BASIN 2 AND 3C)
- PROPOSED SWALE
- EXISTING CARRIAGEWAY AND DRAINAGE FEATURES TO BE RETAINED
- PROPOSED NEW CARRIAGEWAY / FOOTWAY / CYCLEWAY AREAS
- PROPOSED MOTORWAY UPGRADE SCHEME TO BE CONSTRUCTED PRIOR TO JUNCTION 9 IMPROVEMENT SCHEME
- PROPOSED PENSTOCK
- PROPOSED SEDIMENT FOREBAY
- PROPOSED FLOW CONTROL MANHOLE
- EXISTING SOAKAWAY FEATURE REFURBISHED AND REUSED



CONFIDENTIAL

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NOTES:

1. THIS DRAWING SHOULD BE PRINTED IN COLOUR.
2. DO NOT SCALE FROM THIS DRAWING.
3. THE LAYOUT SHOWN IS PRELIMINARY AND SUBJECT TO DETAILED DESIGN.
4. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL OTHER SGAR 3 SUBMISSION DRAWINGS AND DOCUMENTS.
5. FOR PROPOSED AND EXISTING HIGHWAY CATCHMENTS REFER TO DRAWING NUMBERS HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0513 AND 0515 AND STANDARD NOTES.
6. FOR DETAIL OF M3 JUNCTION 9-14 MOTORWAY UPGRADE DRAINAGE DESIGN REFER TO MOTORWAY UPGRADE SCHEME DRAWING NUMBERS HE549338-MMSJV-HDG-000-DR-CD-31001 TO 31007.
7. PROPOSED DRAINAGE SCHEMATIC SHOWN IS SUBJECT TO REVIEW BY THE RESPECTIVE HIGHWAY AUTHORITIES, LEAD LOCAL FLOOD AUTHORITY AND THE ENVIRONMENT AGENCY.
8. PROPOSED RE-USE OF EXISTING DRAINAGE ASSETS IS SUBJECT TO REVIEW OF SURVEY DATA, ASSET RECORDS AND SITE VERIFICATION. THIS IS TO BE UNDERTAKEN DURING SGAR 5 (DETAILED DESIGN).
9. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH:
   - DRAINAGE STRATEGY REPORT REF: HE551511-VFK-HDG-X_XXXX_XX-RP-CD-0001
   - POLLUTION PREVENTION TECHNICAL NOTE REF: HE551511-VFK-HGN-X_XXXX_XX-TN-CH-0003
10. FIN DRAINS ARE NOT SHOWN ON THIS DRAWING. THESE SHALL BE DETAILED DURING SGAR 5 (DETAILED DESIGN).
11. CONTROL OF RUN-OFF AND SEDIMENT DURING CONSTRUCTION IS TO BE STRICTLY IN ACCORDANCE WITH THE CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN, WHICH MAY INCLUDE PIPES, SWALES AND BASINS NOT SHOWN ON THIS DRAWING. THIS IS TO BE DEVELOPED DURING SGAR 5 (DETAILED DESIGN).
12. PROPOSED FORM OF DRAINAGE SYSTEM REQUIRED TO COLLECT THE SURFACE WATER RUN-OFF FROM THE CARRIAGEWAY SURFACE (eg. GULLIES, FILTER DRAINS ETC.) IS TO BE DETERMINED DURING SGAR 5 (DETAILED DESIGN).

SEDIMENT FOREBAY AREA SCHEDULE

BASIN	FOREBAY AREA (m²)	FOREBAY DEPTH OF FREEBOARD (mm)
1	10	150
2	40	300
3A	40	300
3B	40	300
3C	135	300
4	36	300
5	36	300

0 50 100 150 200 250m

SCALE 1:2500

Rev.	Date	Description	Drawn	Chk'd	App'd
P03	24.11.21	ISSUED FOR S3 SUBMISSION	ljj	AC	TRA
P02	15.10.21	UPDATES TO SUIT DESIGN DEVELOPMENT	RG	AC	TRA
P01	28.05.21	FIRST ISSUE	ME	AC	TRA

Drawing Status: S3 - FOR REVIEW & COMMENT

VolkerFitzpatrick

Client: national highways

Project Title: M3 JUNCTION 9 IMPROVEMENT

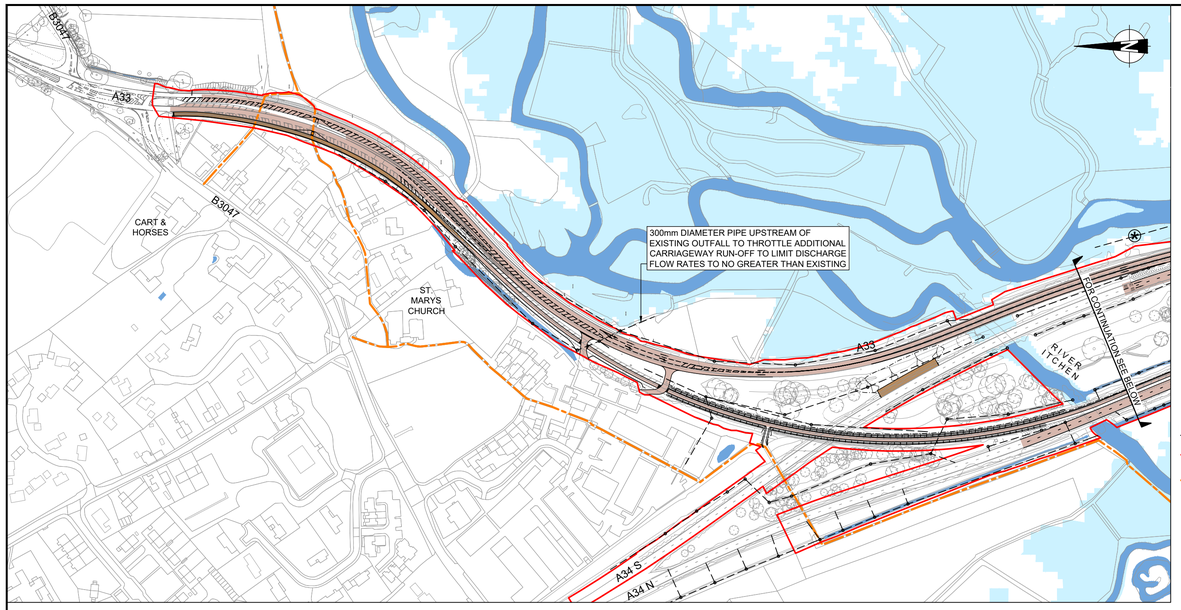
Drawing Title: SGAR 3 PRELIMINARY DESIGN PROPOSED SURFACE WATER DRAINAGE SCHEMATIC PLAN

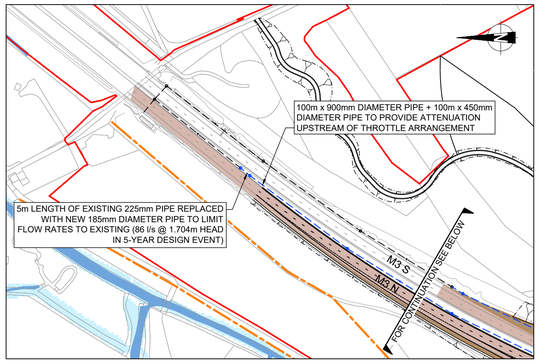
Scale	Designed	Drawn	Checked	Approved
1:2500	PR	ME	AC	TRA
Original Size: Size	Date: 28.05.21	Date: 28.05.21	Date: 28.05.21	Date: 28.05.21

Drawing Number: HE551511 - VFK - HDG - X_XXXX_XX - DR - CD - 0512 (HE PIN | Originator | Volume | Location | Type | Role | Number)

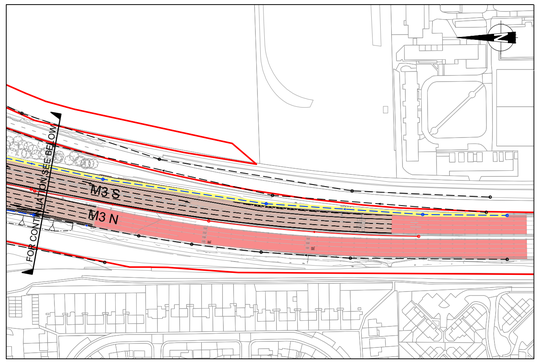
Project Ref. No.: 48176

Revision: P03





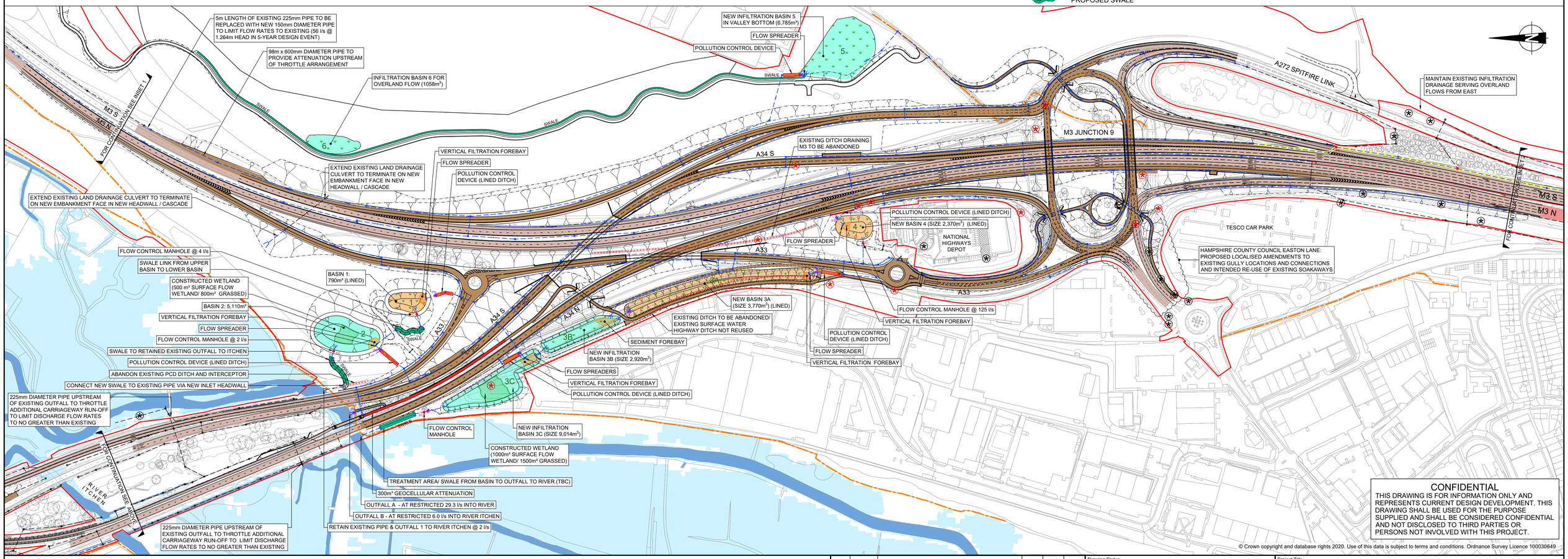
INSET 1: M3 NORTHBOUND CONTINUATION EXTRACT



INSET 2: M3 SOUTHBOUND CONTINUATION EXTRACT

KEY:

- DEVELOPMENT CONSENT ORDER BOUNDARY
- EXISTING FOOTPATH / PUBLIC RIGHT OF WAY
- PROPOSED HIGHWAY DRAINAGE NETWORK
- PROPOSED HIGHWAY DRAINAGE (INSTALLED AS PART OF M3 JUNCTION 9 TO 14 SAFETY BARRIER IMPROVEMENT SCHEME WORKS)
- PROPOSED ADDITIONAL DRAINAGE TO BE INSTALLED AS PART OF THE M3 JUNCTION 9 IMPROVEMENT SCHEME (FOLLOWING THE MANAGED MOTORWAY GOVERNMENT PAUSE)
- RETAINED EXISTING HIGHWAY DRAINAGE
- RIVER ITCHEN
- ENVIRONMENT AGENCY FLOOD ZONE 3 EXTENT
- PROPOSED GEOCELLULAR ATTENUATION
- 1 PROPOSED INFILTRATION BASIN AND REFERENCE NUMBER
- 4 PROPOSED LINED BASIN AND REFERENCE NUMBER
- PROPOSED GRASSED BASIN (ALL GRASSED EXCEPT BASIN 2 AND 3C)
- PROPOSED SWALE
- EXISTING CARRIAGEWAY AND DRAINAGE FEATURES TO BE RETAINED
- PROPOSED NEW CARRIAGEWAY / FOOTWAY / CYCLEWAY AREAS
- PS PROPOSED PENSTOCK
- PROPOSED SEDIMENT FOREBAY
- FC PROPOSED FLOW CONTROL MANHOLE
- EXISTING SOAKAWAY FEATURE REFURBISHED AND REUSED



NOTES:

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5. FOR PROPOSED AND EXISTING HIGHWAY CATCHMENTS REFER TO DRAWING NUMBERS HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0513 AND 0515 AND STANDARD NOTES.
6. FOR DETAIL OF M3 JUNCTION 9-14 MOTORWAY UPGRADE DRAINAGE DESIGN REFER TO MOTORWAY UPGRADE SCHEME DRAWING NUMBERS HE549338-JAC-HDG-S1-DN-MAINL-DR-CD-0002 TO 003.
7. PROPOSED DRAINAGE SCHEMATIC SHOWN IS SUBJECT TO REVIEW BY THE RESPECTIVE HIGHWAY AUTHORITIES, LEAD LOCAL FLOOD AUTHORITY AND THE ENVIRONMENT AGENCY.
8. PROPOSED RE-USE OF EXISTING DRAINAGE ASSETS IS SUBJECT TO REVIEW OF SURVEY DATA, ASSET RECORDS AND SITE VERIFICATION. THIS IS TO BE UNDERTAKEN DURING SGAR 5 (DETAILED DESIGN).
9. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH:
   - DRAINAGE STRATEGY REPORT REF: HE551511-VFK-HDG-X_XXXX_XX-RP-CD-0001
   - POLLUTION PREVENTION TECHNICAL NOTE REF: HE551511-VFK-HGN-X_XXXX_XX-TN-CH-0003
10. FIN DRAINS ARE NOT SHOWN ON THIS DRAWING. THESE SHALL BE DETAILED DURING SGAR 5 (DETAILED DESIGN).
11. CONTROL OF RUN-OFF AND SEDIMENT DURING CONSTRUCTION IS TO BE STRICTLY IN ACCORDANCE WITH THE CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN, WHICH MAY INCLUDE PIPES, SWALES AND BASINS NOT SHOWN ON THIS DRAWING. THIS IS TO BE DEVELOPED DURING SGAR 5 (DETAILED DESIGN).
12. PROPOSED FORM OF DRAINAGE SYSTEM REQUIRED TO COLLECT THE SURFACE WATER RUN-OFF FROM THE CARRIAGEWAY SURFACE (eg. GULLIES, FILTER DRAINS ETC.) IS TO BE DETERMINED DURING SGAR 5 (DETAILED DESIGN).

SEDIMENT FOREBAY AREA SCHEDULE

BASIN	FOREBAY AREA (m^2)	FOREBAY DEPTH OF FREEBOARD (mm)
1	10	150
2	40	300
3A	40	300
3B	40	300
3C	135	300
4	36	300
5	36	300

0 50 100 150 200 250m

SCALE 1:2500

Rev.	Date	Description	Drawn	Chk'd	App'd
P04	28.06.22	UPDATED TO SUIT OMISSION OF MANAGED MOTORWAY SCHEME	JH	LC	TRA
P03	24.11.21	ISSUED FOR S3 SUBMISSION	ljj	AC	TRA
P02	15.10.21	UPDATES TO SUIT DESIGN DEVELOPMENT	RG	AC	TRA
P01	28.05.21	FIRST ISSUE	ME	AC	TRA

Drawing Status: S3 - FOR REVIEW & COMMENT

VolkerFitzpatrick

Client: national highways

Project Title: M3 JUNCTION 9 IMPROVEMENT

Drawing Title: SGAR 3 PRELIMINARY DESIGN PROPOSED SURFACE WATER DRAINAGE SCHEMATIC PLAN

Scale	Designed	Drawn	Checked	Approved
1:2500	PR	ME	AC	TRA
Original Size: Size	Date: 28.05.21	Date: 28.05.21	Date: 28.05.21	Date: 28.05.21

Drawing Number: HE PIN HE551511 - Originator VFK - Volume HDG - Location X_XXXX_XX - Type DR - Role CD - Number 0512

Project Ref. No.: 48176

Revision: P04

EXISTING SUBWAY TO BE DECOMMISSIONED

PROPOSED GYRATORY SUBWAY (NORTH EAST)
NOTE: SUBWAY TO BE LIT (FULL LIGHTING DESIGN TO BE CARRIED OUT DURING STAGE 5)

PROPOSED REALIGNED A272 CARRIAGEWAY

PROPOSED RETAINING WALL

PROPOSED TIE-IN TO EXISTING A272

SOUTH DOWNS NATIONAL PARK

PROPOSED RETAINING WALL

PROPOSED JUNCTION 9 GYRATORY

ROUTE WIDENED TO PROVIDE TURNING FACILITY FOR HORSE RIDERS

PROPOSED M3 J9 GYRATORY SOUTH BRIDGE ACCOMMODATING FOOTWAY / CYCLEWAY

PROPOSED M3 SOUTHBOUND ON-SLIP

PROPOSED RETAINING WALL

PROPOSED REALIGNED AND WIDENED M3 CARRIAGEWAYS

PROPOSED A272 TEMPORARY CONSTRUCTION COMPOUND ENTRANCE / EXIT
REFER TO DRAWING NUMBERS:
- HE551511-VFK-HML-E_A272_XX-DR-CH-0101
- HE551511-VFK-HML-E_A272_XX-DR-CH-0102
- HE551511-VFK-HML-E_A272_XX-DR-CH-0103

FOR DETAILS

PROPOSED HIGH CONTAINMENT (CONCRETE) CENTRAL RESERVE VEHICLE RESTRAINT SYSTEM. EXACT EXTENTS SOUTH OF M3 J9 GYRATORY TO BE DETERMINED DURING SGAR 5 (DETAILED DESIGN) BASED UPON PROPOSED WORKS BEING CONSTRUCTED BY OTHERS (M3 J9 TO 14 SAFETY BARRIER IMPROVEMENT SCHEME)

PROPOSED AUXILIARY LANE MERGE ARRANGEMENT FROM M3 J9 GYRATORY TO M3 SOUTHBOUND CARRIAGEWAY

PROPOSED RETAINING WALL

PROPOSED RETAINING WALL

ERT

W_M3NB_XX

ERT

W_M3NB_DV

W_M3NB_DV

E_RNBT_01

E_RNBT_01

W_NMUX_04

PROPOSED VARIABLE MESSAGE SIGN (REF. VMS007)

PROPOSED RETAINING WALL

PROPOSED M3 NORTHBOUND OFF-SLIP

PROPOSED GANTRY (REF. STANTEC_GADS_0004) - EXTERNALLY ILLUMINATED

PROPOSED GYRATORY SUBWAY (SOUTH WEST)
NOTE: SUBWAY TO BE LIT (FULL LIGHTING DESIGN TO BE CARRIED OUT DURING STAGE 5)

PROPOSED PEDESTRIAN STEPS

PROPOSED 3m WIDE WALKING AND CYCLING ROUTE

PROPOSED REALIGNED EASTON LANE CARRIAGEWAYS

PROPOSED TIE-IN TO EASTON LANE

W_A33X_S3

W_A33X_S3

W_ESTW_XX

W_ESTW_XX

TESCO CAR PARK

PROPOSED TIE-IN TO EXISTING M3 NORTHBOUND CARRIAGEWAY

PROPOSED GANTRY (REF. STANTEC_GADS_0003) - EXTERNALLY ILLUMINATED

PROPOSED GYRATORY SUBWAY (NORTH WEST)
NOTE: SUBWAY TO BE LIT (FULL LIGHTING DESIGN TO BE CARRIED OUT DURING STAGE 5)

PROPOSED DEDICATED LEFT TURN LANE FROM EASTON LANE TO A33

EASTON LANE

HOMEBASE

W_M3NB_XX

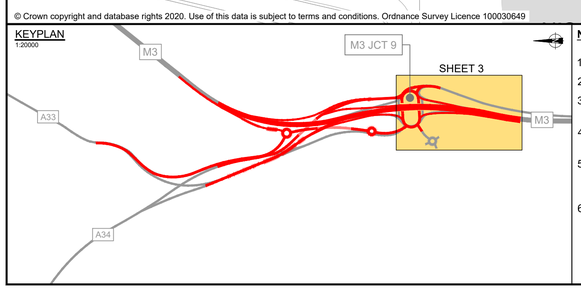
FOR CONTINUATION SEE HE551511-VFK-HGN-X_XXXX_XX-DR-CH-0022

FOR CONTINUATION SEE HE551511-VFK-HGN-X_XXXX_XX-DR-CH-0026

KEY:

- DEVELOPMENT CONSENT ORDER BOUNDARY
- EXISTING HAMPSHIRE COUNTY COUNCIL FOOTPATH
- EXISTING NON-MOTORISED USER ROUTE
- EXISTING NATIONAL CYCLE NETWORK (NCN 23)
- PROPOSED CARRIAGEWAY
- PROPOSED TRAFFIC ISLAND / CENTRAL RESERVE
- PROPOSED FOOTWAY AND CYCLING ROUTE
- PROPOSED FOOTWAY, CYCLEWAY AND HORSE RIDING ROUTE
- PROPOSED FOOTPATH LINK
- PROPOSED VERGE
- PROPOSED EMBANKMENT / CUTTING
- PROPOSED CHALK / GRASS BUND OR AREA
- PROPOSED INFILTRATION & ATTENUATION BASIN
- PROPOSED ATTENUATION BASIN
- PROPOSED BASIN MAINTENANCE TRACK
- PROPOSED BLISTER TACTILE PAVING SLABS
- PROPOSED BLISTER / CORDUROY TACTILE PAVING SLABS
- PROPOSED VEHICLE RESTRAINT SYSTEM
- PROPOSED HIGH CONTAINMENT (CONCRETE) CENTRAL RESERVE VEHICLE RESTRAINT SYSTEM
- PROPOSED SIGN(S)
- PROPOSED GANTRY
- PROPOSED VARIABLE MESSAGE SIGN
- RELOCATED VARIABLE MESSAGE SIGN
- PROPOSED VARIABLE MESSAGE SIGN MAINTENANCE BAY
- PROPOSED EMERGENCY ROADSIDE TELEPHONE (ERT)
- PROPOSED RETAINING WALL / STRUCTURE. CONSTRUCTION SUBJECT TO DETAILED DESIGN
- PROPOSED MOTORWAY COMMUNICATION CHAMBER LOCATION (SEE NOTE 6)

KEYPLAN
1:20000



NOTES:

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5. PROPOSED BOUNDARY FENCING IS OMITTED FOR CLARITY. REFER TO DRAWING NUMBERS: HE551511-VFK-HFE-X_XXXX_XX-DR-CH-0301 TO 0305 FOR DETAILS.
6. REFER TO DRAWING NUMBERS HE551511-VFK-GEN-X_XXXX-DR-EC-0001 TO 0006 FOR FURTHER DETAILS OF PROPOSED MOTORWAY COMMUNICATIONS EQUIPMENT. **NOTE:** EXACT INTERFACE WITH PROPOSED EARTHWORKS / VERGES / CHAMBERS, ETC. TO BE ESTABLISHED DURING SGAR 5 DETAILED DESIGN.

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0 20 40 60 80 100m
SCALE 1:1000

Rev.	Date	Description	Drawn	Chk'd	App'd
P08	13.05.22	UPDATED TO SUIT OMISSION OF MANAGED MOTORWAY SCHEME	MP	LC	TRA
P07	07.11.21	ISSUED FOR S3 SUBMISSION	RR	LC	TRA
P06	24.09.21	TECHNOLOGY ASSETS AMENDED	RR	LC	TRA
P05	07.09.21	ERA & GANTRY AMENDED TO SUIT MANAGED MOTORWAY SCHEME LAYOUT	MP	LC	TRA
P04	23.08.21	WESTERN NMU ROUTE UPDATED & LAYBY ADDED ON M3NB OFF-SLIP TO GYRATORY	RR	LC	TRA
P03	11.06.21	UPDATED GANTRY & VMS LAYOUT	RR	LC	TRA
P02	28.05.21	LAYOUT AND HATCHING UPDATED. LIGHTING NOTES ADDED TO SUBWAY LABELS	ljj	LC	TRA
P01	12.02.21	FIRST ISSUE	RR	LC	TRA

Drawing Status: S3 - FOR REVIEW & COMMENT

VolkerFitzpatrick

Client: national highways

Project Title: M3 JUNCTION 9 IMPROVEMENT

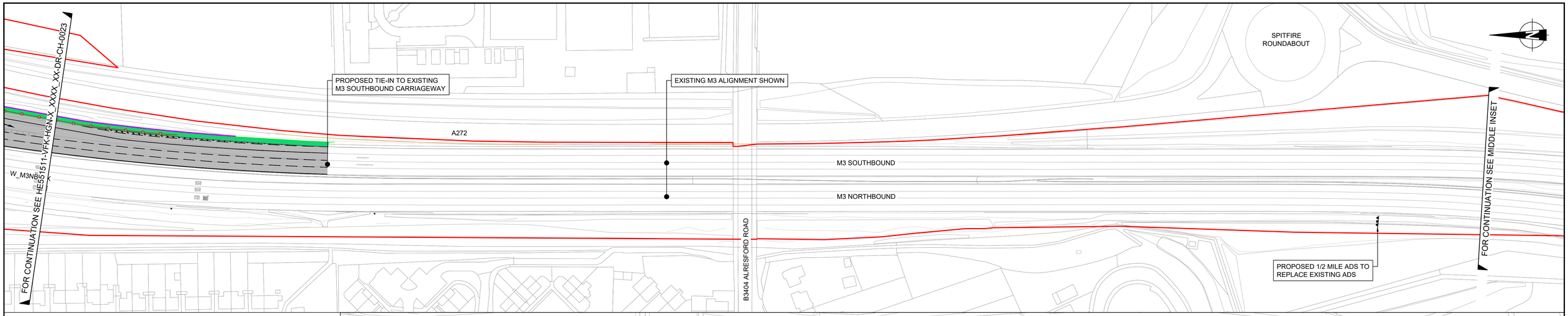
Drawing Title: SGAR 3 PRELIMINARY DESIGN
SITE WIDE HIGHWAY
GENERAL ARRANGEMENT PLAN
SHEET 3 OF 6

Scale	Designed	Drawn	Checked	Approved
1:1000	LC	ATC	TRA	MF
Original Size: Size	Date: 12.02.21	Date: 12.02.21	Date: 12.02.21	Date: 12.02.21

Drawing Number: HE PIN | Originator | Volume | Location | Type | Role | Number
HE551511 | VFK | HGN | X_XXXX_XX | DR | CH | 0023

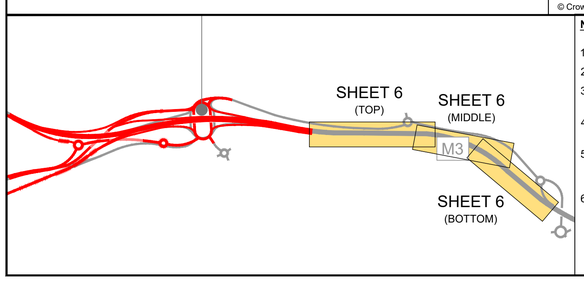
Project Ref. No.: 48176

Revision: P08



KEY:

- DEVELOPMENT CONSENT ORDER BOUNDARY
- EXISTING HAMPSHIRE COUNTY COUNCIL FOOTPATH
- EXISTING NON-MOTORISED USER ROUTE
- EXISTING NATIONAL CYCLE NETWORK (NCN 23)
- PROPOSED CARRIAGEWAY
- PROPOSED TRAFFIC ISLAND / CENTRAL RESERVE
- PROPOSED FOOTWAY AND CYCLING ROUTE
- PROPOSED FOOTWAY, CYCLEWAY AND HORSE RIDING ROUTE
- PROPOSED FOOTPATH LINK
- PROPOSED VERGE
- PROPOSED EMBANKMENT / CUTTING
- PROPOSED CHALK / GRASS BUND OR AREA
- PROPOSED INFILTRATION & ATTENUATION BASIN
- PROPOSED ATTENUATION BASIN
- PROPOSED BASIN MAINTENANCE TRACK
- PROPOSED BLISTER TACTILE PAVING SLABS
- PROPOSED BLISTER / CORDUROY TACTILE PAVING SLABS
- PROPOSED VEHICLE RESTRAINT SYSTEM
- PROPOSED HIGH CONTAINMENT (CONCRETE) CENTRAL RESERVE VEHICLE RESTRAINT SYSTEM
- PROPOSED SIGN(S)
- PROPOSED GANTRY
- PROPOSED VARIABLE MESSAGE SIGN
- RELOCATED VARIABLE MESSAGE SIGN
- PROPOSED VARIABLE MESSAGE SIGN MAINTENANCE BAY
- PROPOSED EMERGENCY ROADSIDE TELEPHONE (ERT)
- PROPOSED RETAINING WALL / STRUCTURE. CONSTRUCTION SUBJECT TO DETAILED DESIGN
- PROPOSED MOTORWAY COMMUNICATION CHAMBER LOCATION (SEE NOTE 6)



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6. REFER TO DRAWING NUMBERS HE551511-VFK-GEN-X_XXXX-DR-EC-0001 TO 0006 FOR FURTHER DETAILS OF PROPOSED MOTORWAY COMMUNICATIONS EQUIPMENT. **NOTE:** EXACT INTERFACE WITH PROPOSED EARTHWORKS / VERGES / CHAMBERS, ETC. TO BE ESTABLISHED DURING SGAR 5 DETAILED DESIGN.

0 20 40 60 80 100m

SCALE 1:1000

Rev.	Date	Description	Drawn	Chk'd	App'd
P06	13.05.22	UPDATED TO SUIT OMISSION OF MANAGED MOTORWAY SCHEME	MP	LC	TRA
P05	07.11.21	ISSUED FOR S3 SUBMISSION	RR	LC	TRA
P04	24.09.21	TECHNOLOGY ASSETS AMENDED	RR	LC	TRA
P03	07.09.21	RELOCATION OF MANAGED MOTORWAY GANTRIES	RR	LC	TRA
P02	23.08.21	UPDATED GANTRY & VMS POSITIONS	RR	LC	TRA
P01	11.06.21	FIRST ISSUE	RR	LC	TRA

Drawing Status: S3 - FOR REVIEW & COMMENT

VolkerFitzpatrick

Client: national highways

Project Title: M3 JUNCTION 9 IMPROVEMENT

Drawing Title: SGAR 3 PRELIMINARY DESIGN
SITE WIDE HIGHWAY
GENERAL ARRANGEMENT PLAN
SHEET 6 OF 6

Scale	Designed	Drawn	Checked	Approved
1:1000	LC	RR	TRA	MF
Original Size	**Date**	**Date**	**Date**	**Date**
A1	10.06..21	10.06.21	10.06.21	10.06.21

Drawing Number: HE551511 | VFK (Originator) | HGN (Volume) | X_XXXX_XX (Location) | DR (Type) | CH (Role) | 0026 (Number)

Project Ref. No.: 48176

Revision: P06

APPENDIX B

NO DESIGN CHANGE
RETAIN EXISTING

N

N20-8.004-300

N20-ECP/RA/0020

102125.417

000

050

100

150

N20-ECP-8.005-300

102200

N20-6.001-150

N20-ECP/
RA/0019

N20-6.002-300

FOR CONTINUATION SEE BELOW

Cutline

NOT DESIGNED YET

NOT DESIGNED YET

CDM 016
(details as per SHE box)

CDM 005, CDM 007, CDM 0034
(Chainage details as per SHE box)

1A

N

Cutline

FOR CONTINUATION SEE ABOVE

100

150

200

250

300

344.507

NOT DESIGNED YET

N20-6.001-150

N20-ECP/
RA/0019

N20-6.002-300

102300

N20-ECP/RA/0018

N20-4.000-225

N20-4.001-225

N20-ECP/RA/0017

N20-3.000

102400

102500

NOT DESIGNED YET

FOR CONTINUATION REFER TO SHEET 2

Cutline

Cutline

CDM 016
(details as per SHE box)

CDM 005, CDM 007, CDM 0034
(Chainage details as per SHE box)

0 10 20 30 40 50

SCALE 1:500 METRES

1B

C:\dms\01094\HE549338-JAC-HDG-S1_DN_MAINL-DR-CD-0001.dwg - 6/29/2022 11:42:16 AM - A1Frame - SZPYRAP

NOTES:

1. ALL DIMENSIONS ARE IN METRES.
2. FOR GENERAL NOTES AND LEGENDS REFER TO DRAWING NO. HE549338-JAC-HDG-WHL_DN_MAINL-DR-CD-0001.

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

The significant residual risks detailed on this drawing are linked to the referencing system within the Hazard Elimination and Risk Reduction Register (HE549338-JAC-GHS-WHL_AL_SCHME-HS-ZS-0004). Each risk is given a unique number followed by a letter that corresponds to one of the six stages affected.

Stages
S - Survey
C - Construction
M - Maintenance
O - Operation
U - Road User
D - Demolition

Significant Residual Risks

CDM 016 - C/M/D - No known utilities at this time

CDM 005 - C/M/D - Noxious fumes/gas for works at chambers and trenches (scheme wide, refer to drainage schedules for specific locations)

CDM 007 - C - Potential structural failure of existing drainage assets due to construction works causing sinkholes and flooding (Central Reserve / Verge)

CDM 034 - C - Construction work requires reworking or causes flooding of road due to design being in error as a consequence of errors in survey data (Central Reserve / Verge)

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	29/09/21	ISSUED FOR TECHNICAL ASSURANCE	SSA	GMI	ROS	JAN
P02	20/10/21	ISSUED FOR STAGED APPROVAL	SSA	GMI	ROS	SST
C01	04/11/21	For Construction	SSA	GMI	ROS	SST
P03	19/05/22	For Construction	APA	GMI	JAN	SST
C02	02/06/22	For Construction	APA	GMI	JAN	SST

Designer: Jacobs

Client: highways england | smp alliance

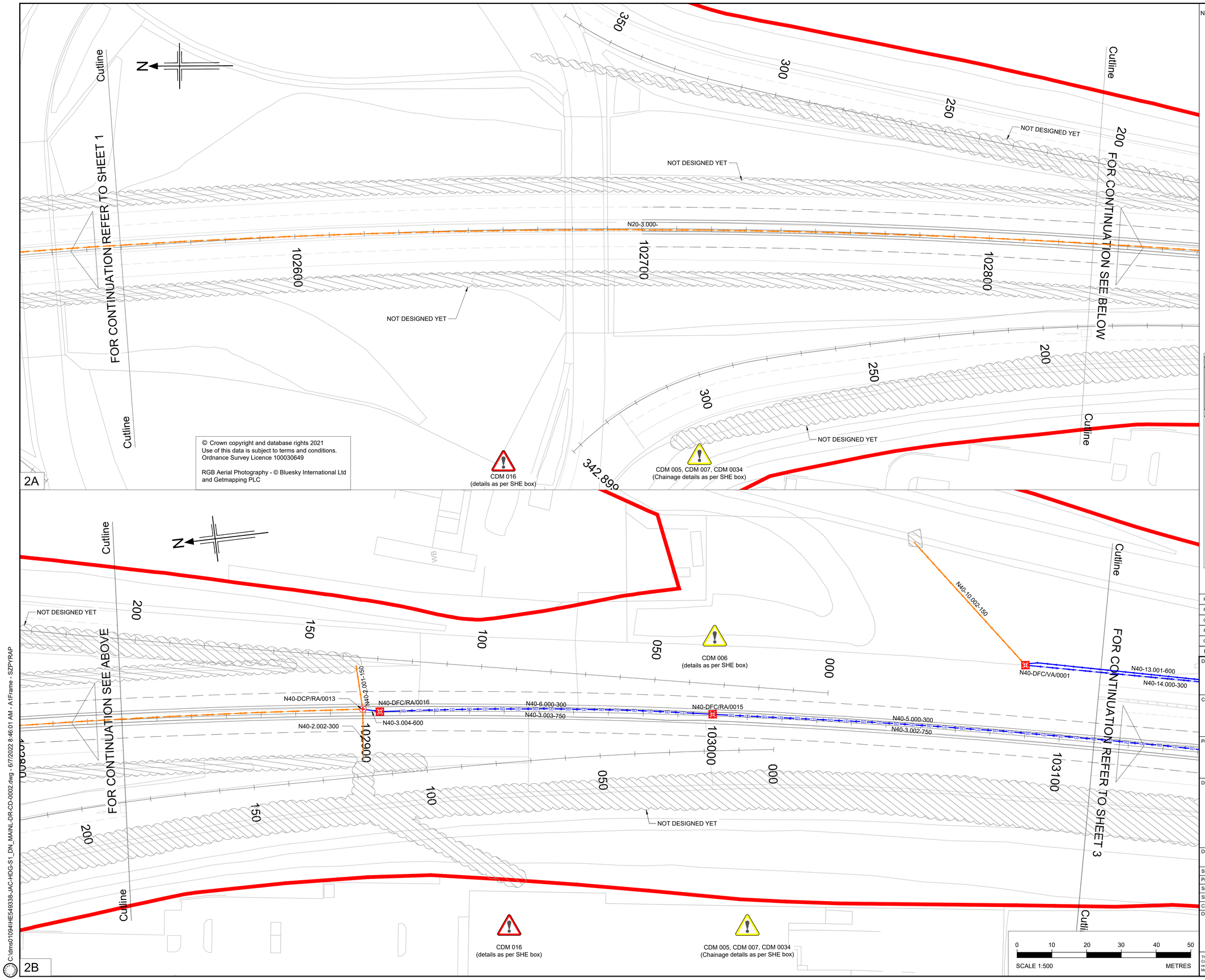
Project
M3
J9-14
Smart Motorway

Drawing title
PROPOSED DRAINAGE LAYOUT
SHEET 01 TO 38
FROM CH. 102125 TO CH. 102550

Drawing status
A5 - ACCEPTED - CONSTRUCTION

State Code	Construction		
Project Stage	Stage 5		
Scale	1:500	DO NOT SCALE	
Sheet Size	A1	Rev	C02
Client no.	HE549338		

Drawing number
PIN | Originator | Volume | Location | Type | Role | Number
HE549338 - JAC - HDG - S1_-DN_-MAINL -DR-CD-0001



NOTES:

1. ALL DIMENSIONS ARE IN METRES.
2. FOR GENERAL NOTES AND LEGENDS REFER TO DRAWING NO. HE549338-JAC-HDG-WHL_DN_MAINL-DR-CD-0001.

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

The significant residual risks detailed on this drawing are linked to the referencing system within the Hazard Elimination and Risk Reduction Register (HE549338-JAC-GHS-WHL_AL_SCHME-HS-ZS-0004). Each risk is given a unique number followed by a letter that corresponds to one of the six stages affected.

Stages
S - Survey
C - Construction
M - Maintenance
O - Operation
U - Road User
D - Demolition

Significant Residual Risks

CDM 016 - C/M/D - No known utilities at this time

CDM 006 - C - Structural instability of chamber and surrounding ground / trenches for drainage works >3m depth (DFC/RA/0015)

CDM 005 - C/M/D - Noxious fumes/gas for works at chambers and trenches (scheme wide, refer to drainage schedules for specific locations)

CDM 007 - C - Potential structural failure of existing drainage assets due to construction works causing sinkholes and flooding (Central Reserve / Verge)

CDM 034 - C - Construction work requires reworking or causes flooding of road due to design being in error as a consequence of errors in survey data (Central Reserve / Verge)

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Appr'd
P02	29/09/21	ISSUED FOR TECHNICAL ASSURANCE	SSA	GMI	ROS	JAN
P03	20/10/21	ISSUED FOR STAGED APPROVAL	SSA	GMI	ROS	SST
C01	04/11/21	For Construction	SSA	GMI	ROS	SST
P04	19/05/22	For Construction	APA	GMI	JAN	SST
C02	02/06/22	For Construction	APA	GMI	JAN	SST

Designer: Jacobs

Client: highways england | smp alliance

Project
M3
J9-14
Smart Motorway

Drawing title
PROPOSED DRAINAGE LAYOUT
SHEET 2 OF 38
FROM CH. 102550 TO CH. 103110

Drawing status: A5 - ACCEPTED - CONSTRUCTION

State Code	Construction		
Project Stage	Stage 5		
Scale	1:500	DO NOT SCALE	
Sheet Size	A1	Rev	C02
Client no.	HE549338		

Drawing number
PIN | Originator | Volume
HE549338 - JAC - HDG -
Location | Type | Role | Number
S1_-DN_-MAINL -DR-CD-0002

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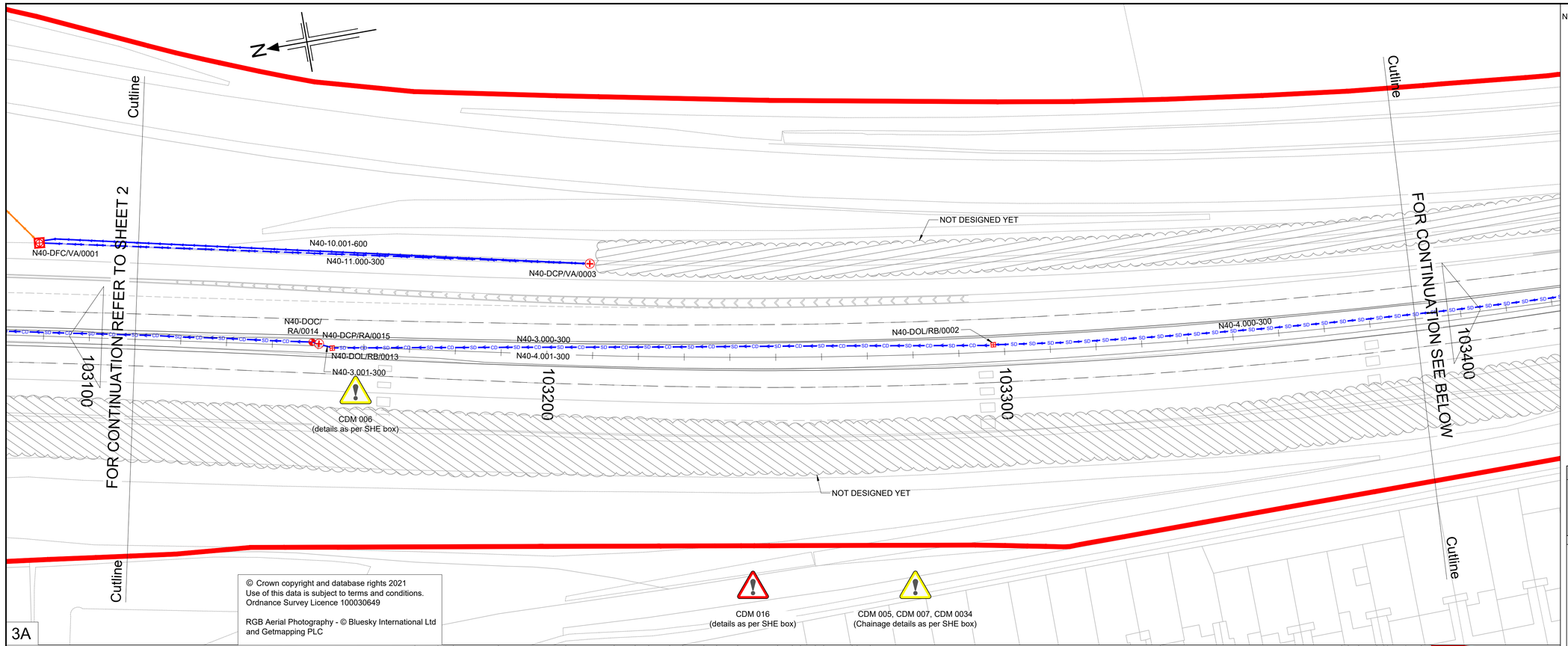

NOTES:

1. ALL DIMENSIONS ARE IN METRES.
2. FOR GENERAL NOTES AND LEGENDS REFER TO DRAWING NO. HE549338-JAC-HDG-WHL_DN_MAINL-DR-CD-0001.

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

The significant residual risks detailed on this drawing are linked to the referencing system within the Hazard Elimination and Risk Reduction Register (HE549338-JAC-GHS-WHL_AL_SCHME-HS-ZS-0004). Each risk is given a unique number followed by a letter that corresponds to one of the six stages affected.

Stages
S - Survey
C - Construction
M - Maintenance
O - Operation
U - Road User
D - Demolition

Significant Residual Risks

CDM 016 - C/M/D - No known utilities at this time

CDM 006 - C - Structural instability of chamber and surrounding ground / trenches for drainage works >3m depth (DOL/RB/0013)

CDM 005 - C/M/D - Noxious fumes/gas for works at chambers and trenches (scheme wide, refer to drainage schedules for specific locations)

CDM 007 - C - Potential structural failure of existing drainage assets due to construction works causing sinkholes and flooding (Central Reserve / Verge)

CDM 034 - C - Construction work requires reworking or causes flooding of road due to design being in error as a consequence of errors in survey data (Central Reserve / Verge)

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Appr'd
P02	29/09/21	ISSUED FOR TECHNICAL ASSURANCE	SDU	GMI	ROS	JAN
P03	20/10/21	ISSUED FOR STAGED APPROVAL	SSA	GMI	ROS	SST
C01	04/11/21	For Construction	SSA	GMI	ROS	SST
P04	19/05/22	For Construction	APA	GMI	JAN	SST
C02	02/06/22	For Construction	APA	GMI	JAN	SST

Designer: Jacobs

Client: highways england | smp alliance

Project
M3
J9-14
Smart Motorway

Drawing title
PROPOSED DRAINAGE LAYOUT
SHEET 3 OF 38
FROM CH. 103110 TO CH. 103670

Drawing status
A5 - ACCEPTED - CONSTRUCTION

State Code	Construction		
Project Stage	Stage 5		
Scale	1:500	DO NOT SCALE	
Sheet Size	A1	Rev	C02
Client no.	HE549338		

Drawing number
PIN | Originator | Volume
HE549338 - JAC - HDG-
Location | Type | Role | Number
S1_-DN_-MAINL -DR-CD-0003

LINEAR ASSETS

DITCHES AND CHANNELS

ASSET NAME	PROPOSED	EXISTING
Combined Drainage Kerb	CDK CDK CDK	CDK CDK CDK
Bridge Deck Drainage Kerb	BDK BDK BDK	BDK BDK BDK
Combined Pipe and Concrete Channel	SWC CD SWC	SWC CD SWC
Combined Pipe and Grass Channel	SWC FD SWC	SWC FD SWC
Combined Pipe and Slot Drain	SD CD	SD CD
Ditch	DITCH	DITCH
Drainage channel Block	DCB DCB DCB	DCB DCB DCB
Linear Drainage Channel	LDC LDC LDC	LDC LDC LDC
Slot Drainage Channel	SD SD SD SD	SD SD SD SD
Concrete Surface Water Channel	SWC SWC	SWC SWC
Grassed Surface Water Channel	SWC SWC	SWC SWC

FILTER DRAINS

ASSET NAME	PROPOSED	EXISTING
Combined Surface and Sub Surface	Not Used	
Counterfort Drain		
Filter Drain		
Narrow Filter / Fin Drain		
Soakaway Trench		

PIPES

ASSET NAME	PROPOSED	EXISTING
Carrier Drain		
Carrier and Filter in same Trench		
Land Drainage		
Rising Main		
Culvert		

NETWORK MODELLING

ASSET NAME	PROPOSED	EXISTING
Phantom Connector		
Region Connector		

LINEAR NAMING CONVENTION

1. Linear features where appropriate will be labelled with the following convention
   1.1. C-#.###-DIA
2. C is the catchment reference
3. #.### is the reference as based on the hydraulic model
4. DIA is the diameter this will depending on the linear feature mean;
   4.1. Ditches - this will be the base width of the ditch
   4.2. Channels - this will be the total width of the channel
   4.3. Drainage Kerb - this will be reference to hydraulic capacity
   4.4. Filter Drains - this will be the pipe diameter
   4.5. Pipes - this will be the pipe diameter
   4.6. Slot Drains - this shall refer to nominal bore

HIGHWAY BOUNDARY

POINT ASSETS

CHAMBERS

ASSET NAME	ADMM v11	PROPOSED	EXISTING	
Bifurcation or Storm Overflow	DGBI			
Catchpit	DGCP			
Gully	DGGU			
Inspection Chamber	DGIC			
Lamphole	DGLH			
Manhole	DGMH			
Other Special Chamber	DGOC			For further details refer to chamber schedule
Rodding Eye	DGRE			
Soakaway Borehole	DGSB	S	S	
Soakaway Chamber	DGSO			

ANCILLARIES

ASSET NAME		PROPOSED	EXISTING	
Flow Control Catchpit	DGFC			
Flow Control Manhole	DGFC			
Flow Control Headwall	DGFC			
Interceptor	DGIN			
Oil Separator	DGOS	OS	OS	
Pumping Station	DGPS	P	P	
Vortex Separator	DGVS	VS	VS	

INLETS AND OUTLETS

ASSET NAME		PROPOSED	EXISTING	
Grip inlet	DGGI			
Inlet	DGIT			
Outfall	DGOU			
Outlet	DGOL			Open watercourse / Carriageway Collection System

NETWORK MODELLING

ASSET NAME		PROPOSED	EXISTING	
Connector Node	DGCN			
Ghost Node	DGGN			
Phantom Node	DGPN			
Region Node	DGRN			

NODE NAMING CONVENTION

1. Nodal features where appropriate will be labelled with the following convention
   1.1. C-XYY/L/###

2. C is the catchment reference
3. X is the status code
   3.1. E - Existing
   3.2. R - Replacement
   3.3. D - Proposed
   3.4. A - Assumed

4. YY is the ADMM v11 asset code with the DG prefix removed see table coloumn above for details

5. L is the location
   5.1. R - Central Reserve
   5.2. V - Verge
   5.3. C - Carriageway
   5.4. F - Field

6. ### is a unique number

NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED.
2. ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM.
3. GRID CO-ORDINATES ARE TO HIGHWAYS ENGLAND LOCAL GRID.
4. THE DESIGN IS BASED UPON TOPOGRAPHICAL AND DRAINAGE SURVEYS AS WELL AS HADDMS ASSET INFORMATION.
5. THE CONTRACTOR SHALL VERIFY DETAILS AT INTERFACES BETWEEN PROPOSED AND EXISTING DRAINAGE ASSETS.
6. THE CO-ORDINATES OF PROPOSED CHAMBERS ARE AT THE INTERSECTION OF PROPOSED PIPES (UNLESS OTHERWISE STATED), SITE CONSTRAINTS MAY CAUSE CHAMBER CENTRE POINTS TO VARY. WHERE PROPOSED CHAMBERS ARE CONSTRUCTED ON EXISTING PIPES, DUE TO THE TOLERANCE IN SURVEYS OF THE EXACT POSITION OF THE PIPES, CHAMBER CENTRE POINT MAY VARY TO SUIT THE POSITION OF THE PIPES AND OTHER SITE CONSTRAINTS.
7. THE SURVEYED POSITIONS OF ACCESS COVERS MAY NOT REPRESENT THE CENTRE OF THE CHAMBERS.
8. CHAMBER ACCESS COVERS / GRATINGS AND FRAMES SHALL NOT BE POSITIONED WHOLLY OR PARTIALLY IN RUNNING LANES AND HARD STRIPS.
9. THE CURRENT PROFILES AND LINES OF DITCHES SHALL BE RETAINED UNLESS STATED OTHERWISE ON THE DRAWINGS AND SCHEDULES.
10. SUB-SURFACE DRAINAGE IS SHOWN ON THE TYPICAL CROSS-SECTIONS CENTRAL RESERVE 100 SERIES AND SUB-DRAINAGE SCHEDULE. THEY HAVE BEEN OMITTED FROM THE DRAINAGE LAYOUT DRAWINGS FOR CLARITY.
11. MANHOLE TYPES STATED AS "NODES" ARE POINTS PROVIDED TO ASSIST SETTING OUT.
12. HATCHED SECTIONS ON DRAWINGS ARE CURRENTLY IN ABEYANCE.
13. FOR NARROW FILTER DRAIN OR FIN DRAIN DETAILS REFER TO SCHEDULE NO. HE549338-JAC-HDG-WHL_DN_SCHME-SH-CD-0006 AND HE549338-JAC-HDG-WHL_DN_SCHME-SH-CD-0005.
14. DRAINAGE DESIGN ASSUMPTIONS HAVE BEEN RECORDED IN SCHEDULE HE549338-JAC-HDG-WHL_DN_SCHME-FN-CD-0002. THE DRAINAGE SURVEYS DID NOT PROVIDE FULL COVERAGE OF THE SCHEME EXTENTS AND AS SUCH ASSUMPTIONS FOR SOME EXISTING ASSETS WERE MADE. THE CONTRACTOR SHALL CONSULT THE LOG TO CONFIRM WHICH EXISTING RETAINED ASSETS REQUIRE CONFIRMATION OF LEVEL, CONDITION, AND LOCATION PRIOR TO CONSTRUCTION.
15. FOR EXISTING ABANDONED ASSETS DETAILS REFER TO SCHEDULE: HE549338-JAC-HDG-WHL_DN_SCHME-SH-CD-0004; THIS SCHEDULE SHOULD BE READ IN CONJUNCTION WITH SERIES 200.

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	06/08/21	FOR INFORMATION	SSA	GMI	GMI	ROS
P02	20/10/21	ISSUED FOR STAGED APPROVAL	KLA	SDU	ROS	SST
C01	04/11/21	For Construction	KLA	SDU	ROS	SST
P03	12/05/22	For Construction	WHO	GMI	KHA	SST
C02	02/06/22	For Construction	WHO	GMI	KHA	SST

Designer: Jacobs

Client: highways england | smp alliance

Project: M3 J9-14 Smart Motorway

Drawing title: LEGEND AND GENERAL NOTES DRAINAGE LAYOUT SHEETS

Drawing status: A5 - ACCEPTED - CONSTRUCTION

State Code	Construction	
Project Stage	Stage 5	
Scale	NTS	DO NOT SCALE
Sheet Size	A1	Rev C02
Client no.	HE549338	

Drawing number: HE549338 - JAC - HDG - WHL_-DN_-MAINL -DR-CD-0001
(PIN | Originator | Volume | Location | Type | Role | Number)