Geology, soils, land contamination and hydrogeology

One of a series of background topic papers prepared by db symmetry in support of a public consultation on proposals for a strategic rail freight interchange in Blaby district, to the north-east of Hinckley in Leicestershire.

INTRODUCTION

1. In 2019 db symmetry will apply to the government for a Development Consent Order (DCO) for a proposed strategic rail freight interchange (SRFI) on a site in Blaby District, to the east of Hinckley in Leicestershire. The project is known as the Hinckley National Rail Freight Interchange (HNRFI).

2. A DCO is a special form of planning permission for large infrastructure projects. It can include a range of additional powers required to implement the proposals, such as powers to acquire land, undertake works to streets, trees and hedgerows and divert utility services.

3. This topic paper outlines the background to the ground and groundwater conditions at the proposed HNRFI site and the likely main impacts of the project on them in terms of the environment and groundwater resources. It has been prepared for db symmetry by consultant Hydrock.

4. The geotechnical (engineering) and geo-environmental (land contamination) aspects of the development are closely linked and are considered in conjunction with other topics in this document. The topic paper describes the approach to the assessment and how mitigation measures will be brought in to reduce unacceptable risks and minimise any potentially adverse impacts.

LAW, POLICY AND GUIDANCE

5. The following directives, legislation, policies, guidance and best practice are being used alongside other relevant guidance in the environmental assessment and in the design of the facility.

European Directives

6. EU Water Framework Directive. 2000/60/EC. October 2000 (with subsequent amendments). The Water Framework Directive establishes a framework for protecting and improving the water environment through a river basin planning process.

7. The HNRFI project will be designed and managed to ensure that the cleanliness of rivers, lakes, and groundwater will not be compromised, whether or not the water is used for human consumption, or as an environment for fish, shellfish, or other living organisms. The directive aims to make waters cleaner, with the ultimate goal of achieving "good status" for all waters in terms of ecology and chemical quality by a set deadline. The project will be designed to ensure that this will be the case in the context of management of the river basin in which the site lies. The Directive also aims to get citizens involved in the process of cleaning up waters and this consultation is part of this process.

8. EU Waste Framework Directive. 2008/98/EC. The Waste Framework Directive sets out the basic concepts and definitions related to waste management, recycling and recovery. It explains when waste ceases to be waste and becomes secondary raw material. It requires that waste is managed without endangering human health or harming the environment, in particular without risk to water, air, soil, plants or animals, without nuisance from odours or noise, and without adversely affecting the countryside or places of special interest.

9. This is relevant to the HNRFI project, which will involve significant earthworks, in which materials are excavated and will be used elsewhere on the site as fill. Unless material is unsuitable for use in some way, the site will be managed to ensure that no excavated material will leave the site as waste, and all the materials will be handled in accordance with the Waste Framework Directive.

10. EU Integrated Pollution Prevention and Control (IPPC). 2008/1/EC January 2008. The IPPC Directive applies an integrated environmental approach to the regulation of certain industrial activities. This means that emissions to air, water (including discharges to sewer) and land, plus a range of other environmental effects, must be considered together. It also means that regulators must set permit conditions so as to achieve a high level of protection for the environment as a whole. These conditions are based on the use of the Best Available Techniques, which balances the costs to the operator against the benefits to the environment. IPPC aims to prevent emissions and waste production and where that is not practicable, reduce them to acceptable levels. The IPPC Directive will apply to all activities that will be undertaken in the HNRFI and in its construction.

National Legislation

11. Environment Act. 1995. The Environment Act 1995 set up the Environment Agency which is the body, sponsored by the Department for Environment, Food and Rural Affairs (Defra), responsible for regulating major industry and waste, treatment of contaminated land, water quality and resources, fisheries, inland rivers and estuaries, conservation and ecology. The Environment Agency will be a consultee in the proposed HNRFI project.

12. Environmental Protection Act 1990 (EPA). The EPA defines the fundamental structure and authority for waste management and the control of emissions into the environment. Part 1 established a regime of authorisation and enforcement which in England is in the hands of the Environment Agency. Local authorities also have powers under the Act to control air pollution from a range of prescribed processes. Part II sets out a regime for regulating and licensing the acceptable disposal of controlled waste on land. Part IIA of the EPA concerns land which is 'any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that':

    - 'Significant harm is being caused or there is a significant possibility of such harm being caused; or

    - 'Significant pollution of the water environment is being caused or there is a significant possibility of such pollution being caused.'

13. None of the land the HNRFI project is believed to fall within the EPA Part 2A definition of Contaminated Land. However, this is to be confirmed by the site investigations which are being carried out.

14. Contaminated Land Regulations (England) Defra 2006. These regulations set out provisions relating to the identifications and remediation of contaminated land under Part IIA of the EPA 1990. These regulations will only apply to the proposed HNRFI project if any of the land on the site which is found to be defined as contaminated land under the EPA Part 2A definition.

15. Water Environment (Water Framework Directive) Regulations 2017. These regulations transpose the Water Framework Directive 2000/60/EC into UK legislation and will be taken into account in the contamination assessment of the proposed HNRFI project.

16. Water Resources Act, 1991 (amendment) (England and Wales) Regulations. The Water Resources Act regulates water resources, water quality and pollution and flood defence. Under this Act, "causing or knowingly permitting" poisonous or noxious matter to enter controlled waters is a criminal offence. More recently, the concept of 'significance' has been introduced into the application of legislation relating land contamination to the pollution of controlled waters.

17. The assessment of land contamination for the proposed HNRFI project takes groundwater and surface water resources into account and the design of the HNRFI project will ensure that water resources are not compromised.

Policy

18. National Policy Statement for National Networks 2014. (NPS). The NPS sets out the need and government policies for nationally significant infrastructure rail and road projects for England. It provides planning guidance for promoters of nationally significant infrastructure projects on the road and rail networks. Evidence is being prepared on the proposed HNRFI project which will form the basis for the examination by the Examining

Authority and decisions by the Secretary of State.

19. National Planning Policy Framework July 2018. (NPPF). The NPPF sets out planning policies for England and how these are expected to be applied. It requires that development plans should minimise pollution and other adverse effects on the local and natural environment.

20. Policies for nationally significant infrastructure projects (NSIPs) are determined in accordance with the decision-making framework in the Planning Act 2008 (as amended) and may include the NPPF.

Guidance

21. Environment Agency, Guiding principles for land contamination. March 2010. This guidance document is followed to ensure that land owners and developers comply with regulatory requirements. It is taken into account in the assessment of current land contamination and in the design of the proposed development to ensure that regulatory requirements are met.

22. Model procedures for the management of land contamination, (CLR11), Defra / Environment Agency. CLR 11 provides guidance which forms the basis of how land contamination is investigated and assessed, and how remediation strategies should be put in place to ensure that there are no unacceptable contamination risks to human health, controlled waters, ecology or the environment during construction or in the final development. Preliminary site investigations have been carried out in accordance with these documents and further more detailed investigations will be carried out before construction begins. The reports are subject to review and consultation with local authorities and the Environment Agency.

23. Protect groundwater and prevent groundwater pollution. Environment Agency guidance. March 2017. This guidance is aimed at any activity which could affect the quantity or quality of groundwater. It provides advice on what groundwater is and how activities might affect it.

24. Design Manual for Roads and Bridges (DMRB), Highways England and forbears, incorporating Volume 4 Section 1 Geotechnics and Drainage – Earthworks Part 2 (HD22/08 – Managing geotechnical risk). 2008. The DMRB contains current standards and specifications relating to the design, assessment and operation of trunk roads, including motorways. to enable them to be built and operated safely and effectively. The HD2/08 standard sets out the procedures to be followed and certificates to be used during the process of planning and reporting of all Geotechnical Works carried out on highways under the jurisdiction of the relevant Overseeing Organisation to ensure that the Geotechnical Risk is correctly managed.

25. The proposed HNRFI project involves the construction of new slip roads from and to the M69, and the DMRB forms the basis for the safe and effective design and construction of these elements.

26. Specification for Highway Works (SHW). Highways England. 2018. (SHW). The SHW defines how site won soils can be used to construct embankments supporting the roads such as those planned to link to the M69. In addition, the SHW also forms the basis of defining how site-won materials will be used and placed to raise any parts of the site that require levelling as part of the construction.

Standards

27. The main Standards relevant to the geotechnical design of the proposed HNRFI are as follows:

28. Eurocode 7:Geotechnical Design BS EN ISO 1997 (EC7). The Eurocodes are a series of European Standards which are the basis for British Standards in the design of construction works for buildings, civil engineering works and other construction projects. EC7 is the code used to ensure that the design of geotechnical structures satisfies their long term safety and performance, known as the Limit State design philosophy.

29. BS5930:2015. Code of practice for ground investigations.

30. BS10175:2011 + A2:2017. Investigation of potentially contaminated sites – Code of practice.

31. BS5930 and BS10175 are the British Standards under which the site investigations activities are being undertaken for geotechnical and land contamination assessment purposes. Compliance with these ensures that the works are undertaken according to best practice. The results of the investigation are used to identify the ground conditions that are present, to define a conceptual site model for identifying any risks from contamination, designing remediation to clean up contamination where it is found, and for designing foundations, earthworks and any other ground related works for the project.

32. BS6031:2009. Code of practice for earthworks. BS6031, in conjunction with the SHW, defines how materials excavated from the site can be used elsewhere in the site for the construction of earthworks for roads, and any areas where ground levels need to be raised or levelled.

33. BS8004:2015 Code of practice for foundations. BS8004 gives recommendations for the design and construction of foundations for the normal range of buildings and engineering structures. It provides information for use in conjunction with Eurocodes.

County and local policy

34. Leicestershire County Council Minerals Development Framework. Core Strategy and Development Control Policies up to 2021. 2018. This document sets out the County Council's vision, objectives and strategy for mineral land-use planning in Leicestershire and provides a detailed policy framework for determining mineral planning applications. Its purpose is to guide decisions about planning applications and to provide a ‘spatial plan’ or 'geographic blueprint’ to help shape the future of their area.

35. Leicestershire and Leicester Waste Development Framework. Core Strategy and Development Control Policies up to 2021. 2018.

36. Blaby District Local Plan (Core Strategy) 2013

37. Blaby District Local Plan (Saved Policies) 1999

38. Hinckley and Bosworth Borough Council Local Plan 2006 to 2026.

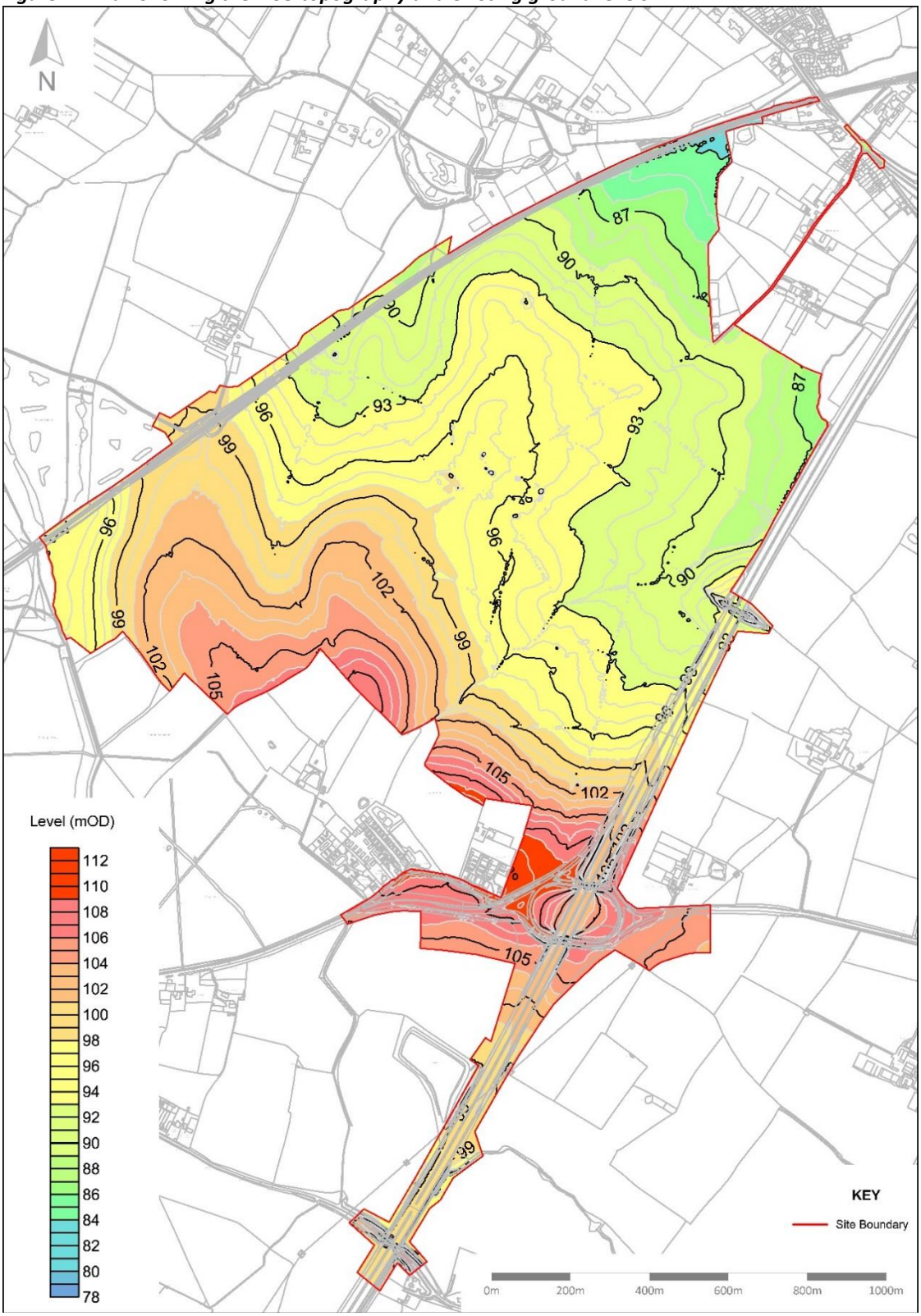
39. The areas covered by the DCO for the proposed HNRFI project falls within the area covered by Blaby District Council. However, a section of the boundary in the southwest borders an area covered by Hinckley and Bosworth Borough. Therefore, for completeness the consultation is being undertaken with Hinckley and Bosworth Borough Council and their Local Plan is included in this section as a reference.

THE SITE

40. This section describes the current site conditions and the geology that underlie the site and surrounding areas. The information is based on data published by the British Geological Survey (BGS), primarily 1:50,000 Sheet 169 (Solid and Drift Geology) which forms the basis of a preliminary conceptual ground model for the site. Site investigations are being undertaken to confirm the ground conditions under all parts of the site to determine how the groundworks for the development should be designed and to determine whether there is any land contamination that needs to be dealt with.

41. The Draft DCO Boundary and the topography of the site are shown on the plan in Figure 1. The site lies within a triangle formed by the Hinckley to Leicester railway line to the north, the M69 to the east, and an irregular series of boundaries to the south-west. The DCO area extends a short way across the railway line on the northwest boundary and incudes land around the proposed new access roads to Junction 2 of the M69 in the south of the site.

Figure 1 – Plan showing the DCO topography and existing ground levels



42. The land within the Draft DCO Boundary covers a total area of approximately 225ha and measures approximately 2km (south-west – north-east) by 1.5km (west-east). The land is used primarily for agricultural purposes, with crops or pasture for stock or horses, along with farm premises (barns, yards and farmhouses) and associated residential cottages and houses, and infrastructure associated with the Hinckley to Leicester railway line on the western site boundary and the M69 on the eastern site boundary.

43. Historically, the majority of the site has been in various forms of agricultural use since the late 19th century and probably for indefinite periods before that.

44. Currently and historically there are and have been no industrial activities or any other land uses likely to have resulted in significant amounts of land contamination at any location on the site. However, there are minor localised sources of potential contamination arising from agricultural works across the site such as; heating oil tanks, stockpiles of agricultural materials and localised uncontrolled waste which will be taken into account in the land contamination stage of the development.

Landform

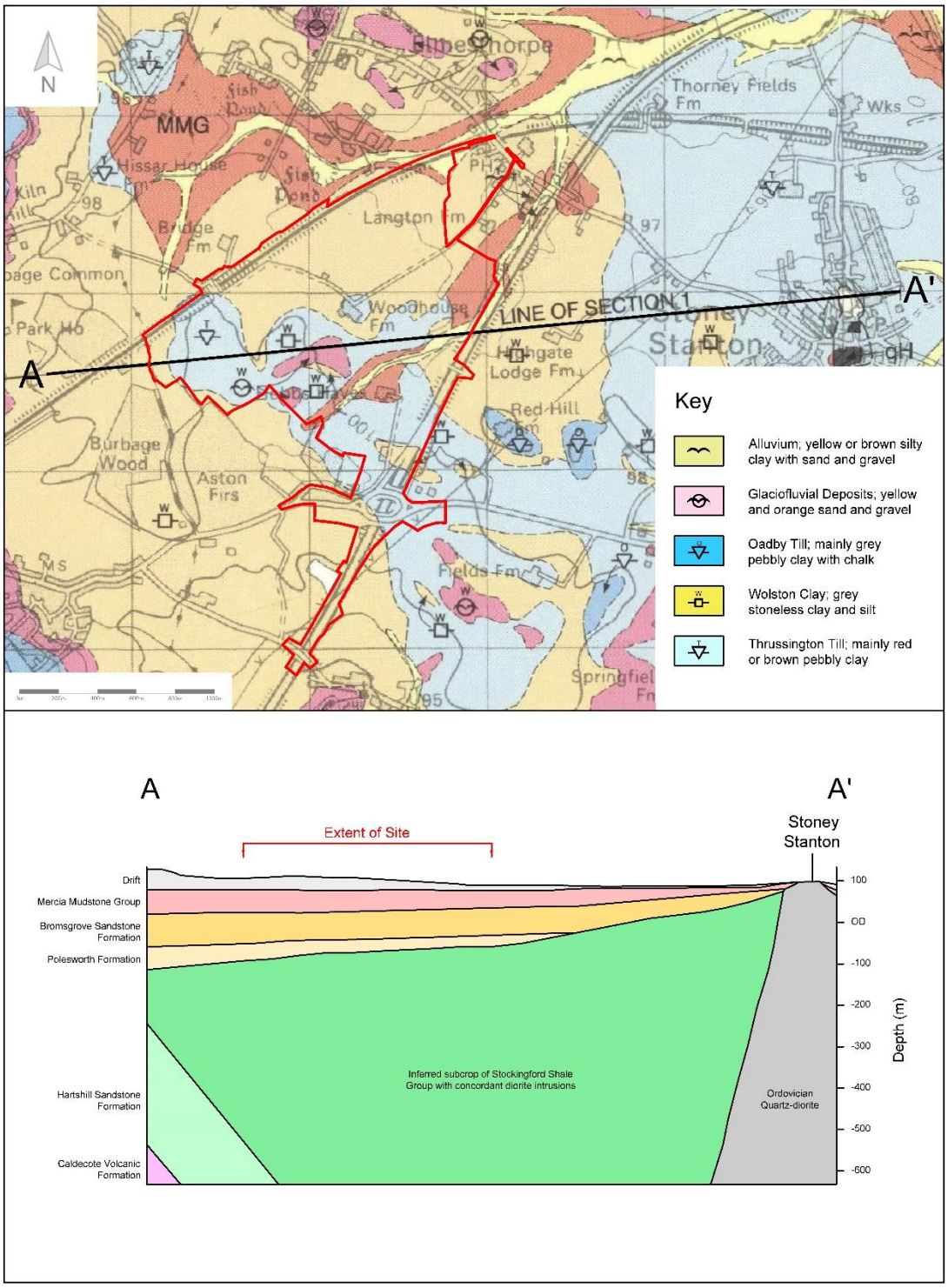
45. The land within the Draft DCO Boundary comprising the proposed HNRFI site has a gently rolling character forming a ridge running from the south-west boundary down to the apex in the north-east, and sloping down to streams to the north of the railway line and to other brooks draining the land to the south and east. The difference in level between the highest and lowest parts of the site is approximately 25m.

Geology

46. The geology of the site shown on the BGS map, combined with the defined site boundary is shown in Figure 2. The term 'superficial deposits' refer to soil deposits placed during the Ice Age and subsequently by rivers, and recent natural soil movements. The Ice Age (known as the Pleistocene Epoch) lasted from about 2.5 million years to 12,000 years ago.

47. The terms 'bedrock' and 'solid geology' refer to strata dating back to before the Ice Age, and include Triassic strata (200-250 million years old) and, at considerable depth, Cambrian and Precambrian strata (between 485 and 540 million years old).

Figure 2 – Plan and cross section showing the geology at the HNRFI site.



48. The solid (bedrock) geology under the entire site is Mercia Mudstone of Triassic age which was laid down in shallow salty water in hot desert-like conditions. The rock comprises red (in parts grey-green) mudstone and siltstone and contains crystalline gypsum and anhydrite and some rock salt. The top of the Mercia Mudstone is thought to be at depths

generally between approximately 5m and 20m below ground level and it is believed to be of the order of 100m thick, although this is subject to the results of intrusive investigation by drilling boreholes.

49. Below the Mercia Mudstone is the Sherwood Sandstone Group, also of Triassic age and formed of mainly sandstone with thin mudstone beds. This is thought to extend from about 100m to approximately 200m depth below existing ground level.

50. The Sherwood Sandstone strata were deposited over a land surface underlain by strata of Cambrian and Precambrian age, mostly as massive desert sand dunes but also with a coastal or shallow water depositional environment.

51. Stoney Stanton lake is about 3km to the east of the site, and is a former deep quarry from which roadstone was extracted. The rock in the quarry is formed of hard quartz diorite, an igneous rock which was injected as a molten magma into the Cambrian rocks in the Ordovician period (approximately 440 million years ago). The rock was used as roadstone, railway ballast and aggregate. At Stoney Stanton, the diorite and Cambrian strata outcrop with little or no cover of Triassic strata or glacial deposits, but these thicken steadily towards the west, with the Cambrian strata becoming increasingly deep towards the west, under the site, as can be seen in the cross section in Figure 2.

52. There are no geological faults shown under, or in the vicinity of, the site on the BGS maps, although it is likely that there will be faults, resulting from tectonic movements.

53. In the Ice Age a succession of glaciers wore down and removed much of the bedrock leaving a covering of successive Glacial Till deposits known as the Wolston Glacial Succession, which comprises mainly clay. There are also deposits of sand and gravel which were laid down by water as the glaciers melted and retreated.

54. The clay of the Glacial Till was subjected to very high pressures from the load of the glacial ice and the resulting consolidation resulted in the water in the clay being forced out, making the clay become relatively stiff. However, as the last phase of ice melted, there was a long period of periglacial conditions which caused the clay to be repeatedly thawed and re-frozen, causing it to soften in the top few metres. This can result in the shallow soils being more variable in strength and consistency.

55. In the southern area of the site, where the ground is higher, the ground conditions are slightly more complex, with areas underlain by sand and gravel deposits, resulting from the meltwaters depositing material originally contained in the glacial ice.

56. In the floor of the valleys which drain the site, there are alluvial deposits left by the streams, comprising mixtures of clay, sand and gravel. These were deposited in more recent geological time since the Pleistocene Epoch, and are typically soft, and water bearing alongside the streams.

57. Figure 2 shows a cross section through the site which is taken from the BGS geological map. This shows the general sequence described above, which is also summarised in Table

1:

Table 1 - Summary of Geology

Age	Stratigraphic Name	Detail
Pleistocene/ Recent	Alluvium / alluvial fan deposits	Yellow or brown silty clay with sand and gravel.
Pleistocene	Glacial Till	Wolston Sand and Gravel Wolston Clay Thrussington Till
Triassic	Mercia Mudstone Group	Dominantly red, less commonly green-grey, mudstones and subordinate siltstones with thick halite units and thin beds of gypsum/anhydrite.
	Sherwood Sandstone Group	Sandstones with mudstone layers and conglomerate at the base.
Cambrian	Charnian Group	Volcanic ash deposits (tuffs).

Hydrogeology

58. The Environment Agency has classified strata underlying England and Wales as various grades of aquifer depending on their capability of yielding water for uses such as drinking, irrigation and industrial uses such as cooling and cleaning. An aquifer is an underground layer of rock, sediment (usually sand or gravel) or soil that can yield water. Sandstones, limestones, sand and gravel usually have a high proportion of voids that are filled with water and are interconnected, so that they not only store water but also can transmit water so that it can act as a water resource.

59. Aquifers with a high capacity to store and transmit water storage are classified as Principal Aquifers. These may support water supply and/or river base flow on a strategic scale.

60. Secondary aquifers are those that have a lower level of importance, and are subdivided into Secondary A, Secondary B and Secondary undifferentiated aquifers.

61. Clay strata have a low proportion of voids and are of very low permeability so that water cannot flow through the ground. These are generally classified as 'unproductive' strata from an aquifer perspective and have negligible significance for water supply or river base flow.

62. The aquifer designations of the strata mapped as occurring at the HNRFI site are listed in Table 2 based on the Environment Agency aquifer designations explained above.

Table 2 - Hydraulic Characteristics of Strata

Stratum	Aquifer Designation	Hydraulic Characteristics
Alluvium Deposits (Drift)	Secondary A	Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifer
Wolston Sand and Gravel		
Bosworth Clay Member	Secondary (undifferentiated)	Secondary undifferentiated aquifer is a designation used when it is not possible to attribute fully one of either Secondary A or Secondary B, due to the variable nature of the soils
Thrussington Member		
Mercia Mudstone Group	Secondary B	Unproductive strata are defined as deposits exhibiting low permeability with negligible significance for water supply or river base flow. Unproductive Strata are generally regarded as not containing groundwater in exploitable quantities.
Sherwood Sandstone	Not designated at this site, but elsewhere are often designated as Principal Aquifers.	High intergranular and/or fracture permeability with potential for significant water supply and/or river base flow on a strategic scale. At this site, covered by c100m of strata as listed above, hence it is a confined aquifer.

63. Where there are licenced groundwater abstractions such as wells, boreholes and springs used for public drinking supplies, the Environment Agency defines Source Protection Zones (SPZ) showing the risk of contamination from any activities that might cause pollution in that area. The three main zones are:

- Zone 1, Inner zone. A minimum radius of 50m around the source, and with a 50 day travel time.
- Zone 2, outer zone. 250m or 500m radius, with a 400 day travel time.
- Zone 3, total catchment. Defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source.

64. There are no SPZ defined within the site or within 500m of the site.

65. The development proposals will not cause any adverse impacts on groundwater quality as there is no pathway between any land contamination sources and aquifers with the potential to act as water resources.

66. The Sherwood Sandstone Principal Aquifer is overlain by considerable thicknesses of low

permeability clay strata which restrict recharge of water in the aquifer from rainfall. Therefore although the development proposals will cover much of the site with buildings and hardstanding which will reduce infiltration of rainwater to the ground, it will have negligible effect in reducing the recharge of the Sherwood Sandstone aquifer.

67. The development will incorporate Sustainable Drainage Systems (SuDS) which will mitigate reduction of water infiltration by introducing water directly to the ground.

Soils – agricultural

68. The term 'soils' is used in this section with regard to the soil covering across the site used as a growing medium for agricultural and landscaping / garden purposes and soil that has been affected by ploughing and similar agricultural activity. Consideration of 'soil' in an engineering sense is covered separately.

69. The thickness of agricultural topsoil across the site varies between 100mm and 400mm. The variation in thickness and soil quality depends on a wide range of factors, including the history of the site activities, methods of agricultural working including depth of ploughing and tilling, slope effects, erosion and other effects.

70. The proposed development will entail the removal of most of the topsoil across the site prior to the proposed earthworks. Careful controls will be employed to ensure that most, if not all the excavated soil will be employed in the final development. The assessment of this will form part of the detailed site investigation to be carried out at a later stage, and incorporated into the design and specification.

71. The proposed layout includes landscaping where it will be possible to incorporate site-won growing medium soil. This will apply particularly in the areas surrounding warehouse units and access areas, and around the access routes around the rail freight terminal and the feeder slip roads including to and from the M69.

72. The re-use of site-won material will be maximised through appropriate design and specification to mitigate and limit off-site disposal. Based on current outline design there is no anticipated need for off-site disposal except for any hazardous materials which might be present but have not been recorded as yet.

Engineering soils

73. The proposed development will involve the construction of level platforms for each building unit, and the surrounding access areas need to be at levels which enable vehicles to move around without excessive gradients.

74. As previously described, the topography of the site varies in level by approximately 25m between the highest and lowest points on the site. There are also significant slopes across the footprints of each of the proposed units.

75. In order to create level platforms accommodating the existing levels and proposed levels,

there will be a requirement to reduce levels to the proposed platform levels by excavation (cut), and also to raise levels by placement of fill material. Some units may involve both cut and fill, others may require a predominance of either cut or fill. There will be a very large volume of soil involved in the cut to fill exercise, but most of this will be remain within the site.

76. In addition to the platform levels for the buildings, the access roads and vehicular access areas, including the access roads to the M69 and the rail freight areas will need to be designed to specific levels and these will involve both cut and fill earthworks.

77. Overall across the development, taking into account the proposed design formation levels the design will aim to achieve as close as possible a balance of material such that the volume of material excavated from areas of cut will be equal to the volume of fill required to achieve the required levels.

78. It is envisaged that most of the material arising from the excavations will comprise Glacial Till which in the main will comprise clay. However, depending on the actual ground conditions encountered, there may be glacial sands and gravels and other soils. The Mercia Mudstone which underlies the Glacial Till is only likely to be encountered in the deepest of cut excavations, although this depends on the thickness of superficial deposits covering the Mercia Mudstone and the depth of excavation in areas of cut that will be required. It is also anticipated that other soil types, including Made Ground, may be encountered locally and these will be dealt with as, and when, they are encountered.

79. Geotechnical design in accordance with British Standards incorporating Eurocode 7 (BS EN 1997(EC7)) will be undertaken following the geotechnical investigations. The Geotechnical Design Report will include an earthworks specification. Excavated material will be assessed for re-use against the engineering specification including general landscaping fill and selected fill. If required, soils will be modified and/or stabilised to make them suitable for re-use. This will maximise the re-use of soils and minimise the need to import soil to the site.

Land contamination

80. The methodology adopted to assess land contamination aims first to establish whether there are any sources of contamination on the site, and second to assess whether there is a plausible pathway that can link the sources with the receptors.

81. Where it is established that a pollutant linkage exists (i.e. that there is a source, a receptor and a pathway linking them), a remedial strategy will be put in place to ensure that any risks that there might be are mitigated and are not unacceptable.

82. In the context of the proposed site end use, the main receptors that have been identified and will be included in the assessment are as follows.

- Humans (site end users– commercial/industrial end use scenario, and users of land and property remaining adjacent to the site, assuming long term lifetime

exposure).

- Development end use (buildings, utilities and landscaping).
- Groundwater: Secondary A aquifer status of the Alluvium and Alluvial Fan Deposits.
- Surface water: ponds and streams on the site, ponds recorded off site.
- Risks to construction workers and others during construction are assessed using short term exposure criteria and are usually dealt with using site based control measures, but this assessment will be undertaken and any measures taken as necessary to avoid unacceptable risks.

83. There are relatively few potential sources of contamination that have been identified on the site so far resulting from historical and recent site uses. Those that have been identified on site and off site with the potential to affect the site include the following:

84. Potential on site sources of contamination:

- Chemicals from agricultural use and maintenance of land around railway lines and motorways: fertilisers, pesticides and herbicides.
- Asbestos from demolition of buildings, in existing Made Ground and from future Made Ground.
- Metals and polyaromatic hydrocarbons from general Made Ground.
- Petroleum hydrocarbons and fuel oils from leaks from storage tanks and general spillage.
- Volatile organic carbons (VOC) and semi-volatile organic carbons (SVOC) from leaks from stored chemicals and accidental spillage.
- Permanent ground gases, predominantly carbon dioxide and methane from the Alluvial deposits and made ground from biodegradable organic content in soils including backfilled ponds and as yet undetected burial pits etc.
- Bacteriological sources in animal waste, slurry etc.

85. Potential off-site sources of contamination:

- Former brickworks recorded adjacent to Junction 2 of the M69.
- Permanent ground gases (carbon dioxide and methane) from the landfill located 246m south east of site.

86. Preliminary assessment indicates that the risks associated from the identified sources to

the receptors affected are generally low.

87. Furthermore, following the cut and fill earthworks discussed in the previous section, it is likely that on completion of these works the risks will be reduced further. Nevertheless, if unacceptable risks are identified, then mitigation measures will be carried out to reduce the risk to acceptable levels or to reduce it entirely. The magnitude of sources of land contamination can be described qualitatively according to the categories shown in Table 3.

Table 3 Scale for magnitude of potential sources of land contamination and their extent

Magnitude	Definition	Previous Land Use
Very Low	No detectable contamination from site investigation work on the site.	Greenfield Site
Low	Detectable but minor soil contamination less than threshold and unlikely to affect most sensitive receptors. Site investigation data detecting no significant contamination.	Previous or on-going activities with low potential to cause contamination (e.g. residential, retail or offices etc.)
Medium	Detectable localised soil contamination above threshold limits, identified during ground investigation.	Previous or on-going activities with some potential to cause moderate contamination (e.g. railways, collieries, scrap yards etc.)
High	Site investigation data indicating widespread and/or severe localised contamination.	Previous or on-going activity on or near to the Site with high potential to cause land contamination (no land of this nature has been identified in the investigations undertaken to date)

88. The contamination risks at the proposed HNRFI Site overall are currently very low and will remain very low.

89. Users of the proposed HNRFI are being considered in the contamination risk assessment as the human health receptors and in the context of commercial land or public open space in landscaped areas. As the length of time that these people will be on site is limited to working times, the sensitivity as receptors is Low or Very Low.

OUR APPROACH TO THE ASSESSMENT

90. The method for carrying out the assessment of land contamination across the site and for considering whether there will be any need for remediation is set out in BS10175, CLR11 and other guidance documents set out in the section on Guidance earlier in this Topic Paper. This involves a phased approach as follows:

- Desk studies and walkover surveys to gather as much information together as possible from available published sources, databases and historical sources. This

work is currently in progress.

- The initial intrusive investigations using boreholes, trial excavations, in situ testing and monitoring to determine the soil types, their depths, and distribution have been carried out in July and August, 2018.

- The scope of the initial investigation enables the design and construction to be planned and to determine the extent of any contamination or the extent to which contamination could affect the ground and groundwater conditions.

- Testing has been carried out to determine the physical and chemical properties of the soils.

- Initial assessment and modelling has been undertaken to determine whether there are contaminants present likely to require additional mitigation measures such as remediation.

Hydrock Consultants has undertaken the first preliminary stage of site investigation, in the form of a desk study and site walkover reconnaissance.

91. Preliminary site investigation, as described in paragraphs 15.15 to 15.24 of the EIA scoping document has also been carried out in 2018. The objective of this was to determine if the assumptions from the initial desk study phase were correct and to provide some initial information on the basic soil types that are present. It has targeted specific identified potential sources of contamination as an initial overview of their significance in terms of risks and need for remediation.

92. The consultant's report on the preliminary investigation will be included in the submission of the DCO application to provide supportive data. Further phases of investigation will be carried out prior to finalising the designs.

THE LIKELY MAIN EFFECTS OF THE PROPOSALS

93. It is envisaged that the proposed HNRFI will have a negligible effect on the geological and hydrogeological conditions at the site. The likely main effects of the development proposals from the point of view of the geology, soils and hydrogeology and land contamination aspects will be from the earthworks required to construct the proposed development, and from the covering of the land by buildings and hardstanding, which will reduce water infiltration to the ground.

94. An earthworks cut and fill exercise will be undertaken to accommodate the designed platform levels and road formation levels. The earthworks will be designed for an overall balance in cut and fill volumes across the site so by the time the construction has been completed there will be negligible nett excess or shortfall of material. The vast majority of material excavated from cut areas to lower some units will comprise clay (Glacial Till) which will be used to build embankments to raise ground under units which will be raised

above current ground levels.

95. As the proposed earthworks have the potential to create dust the specification will contain clauses requiring active measures to be employed to avoid wind-borne dust being carried off site. Active measures may include dampening down haul roads. Most of the earthworks traffic will be confined to the site so that there will be little need for construction traffic involved in this to travel on roads in the vicinity of the site. Construction traffic leaving the site will go through a wheel-washing process to minimise mud being left on public roads.

96. The earthworks will result in the need to excavate, remove, redirect or infill watercourses and ponds. Mitigation measures will also be put in place to ensure that as much rainwater as possible is allowed to enter the ground by means of various forms of infiltration and attenuation measures rather than being discharged directly to watercourses.

97. The Sherwood Sandstone underlies the site and is a Principal Aquifer. However, it is covered by considerable thicknesses of low permeability clay strata which prevent recharge of water in the aquifer from rainfall. Therefore, although the development proposals will cover much of the site with buildings and hardstanding, which will reduce infiltration of rainwater to the ground, it will have negligible effect in reducing the recharge of the Sherwood Sandstone aquifer.

98. Depending on the final scope of earthworks, small areas of Secondary Aquifers, mainly on higher areas of the site. could be removed in the cut to fill earthworks process. These would be replaced by balancing ponds to benefit the water resources. However, they are likely to be of limited thickness and extent and are not currently utilised as a source from which groundwater is extracted. They may contribute a minor amount of water as base flow to local streams. However, those streams within the site will be diverted/re-profiled as part of the overall design and there will be negligible overall loss of supply of water as baseflow to streams.

99. The development will incorporate Sustainable Drainage Systems (SuDS) which will mitigate reduction of water infiltration by introducing water directly to the ground.

100. In order to accommodate the differences in levels between adjacent warehouse units, access roads, rail sidings, loading bays and other facilities, there will likely be a need for the scheme to include slopes and / or retaining walls. These will need to be designed to ensure adequate stability and to enable site drainage to perform efficiently.

101. Further details of the drainage mitigation measures are discussed in the Topic Paper on Surface water and flood risk.

102. The proposed development will have negligible adverse impact on the hydrology and hydrogeology of the site in terms of groundwater quality, surface water quality and water resources.

PROPOSED APPROACH TO MITIGATION

103. The potential effects of any contamination that is found to be present at the site will be mitigated either during initial enabling works prior to construction, or during construction as the earthworks are undertaken. How this will be undertaken will be detailed in a Remediation Method Statement (RMS) which will take into account the results of the contamination risk assessment and will be approved by the relevant regulators prior to implementation.

104. The works will be validated on completion to ensure that the contamination risks are suitably mitigated, and the results recorded in a verification report, which will also be certified by the relevant regulators.

105. The likelihood of any contamination being caused by the construction works will be mitigated through the use of a Construction Environmental Management Plan (CEMP), in which the measures to control potentially contaminative activities will be detailed. All contractors involved in the construction will be required to comply strictly with the CEMP.

106. All activities undertaken in the operation of the HNRFI will be strictly controlled to ensure that there is no risk that contamination risks can be caused to the site users, controlled waters or the general environment. Where necessary, the design of the proposed HNRFI will incorporate appropriate measures to ensure that even if there is an accident or incident which results in release of a contaminative material, such as an oil spillage, this will be controlled. Examples of this include interceptors to prevent oil spillages reaching local watercourses, and attenuation ponds in which any contaminated suspended matter in drained surface water will be trapped before the water discharges into watercourses.

107. On this basis, the proposed development will have no adverse impacts from the point of view of land contamination. Indeed, should there be any land contamination which currently poses risks, these would be mitigated by the proposed works, resulting in an overall betterment.

NEXT STEPS

108. The process of carrying out a detailed site investigation to determine the ground and groundwater conditions at the site has commenced with a Phase 1 Desk Study and site reconnaissance, and a preliminary site investigation, as detailed in the report prepared by Hydrock.

109. The preliminary investigation involves a grid of exploratory holes on a roughly 300m grid together with a limited amount of investigation targeting features identified in the Phase 1 Desk Study Report as being potentially contaminative. The investigation will include the fields as well as around houses and residential properties.

110. The scope of the initial investigation works is outlined as follows:

- Boreholes to up to 5m depth by dynamic sampling techniques ('windowless sampling').
- In situ testing by Standard Penetration Tests (SPT) to determine 'N' values to indicate soil relative density and strength.
- Trial pits up to 4m deep, dug with a JCB type excavator.
- Hand excavated trial pits in areas where machine access is not possible, for instance next to heating oil tanks in farmyards and private houses.
- Taking soil samples for laboratory analysis.
- Localised breaking out of concrete and hardstanding where necessary
- Installation of standpipes in boreholes, to allow groundwater levels to be monitored and for ground gas readings to be taken.
- Taking samples of groundwater and water samples from streams and ponds for laboratory chemical analysis to determine the water quality.
- Laboratory chemical testing for defined suites of chemicals to determine contaminant concentrations in soil samples.
- Laboratory geotechnical testing to determine soil classification characteristics.

111. Preparation of a geotechnical and geoenvironmental interpretive report (GIR), describing the works undertaken, presenting the factual data obtained, and providing an updated conceptual site model, contamination risk assessment, geotechnical interpretation, geotechnical risk register, recommendations for outline foundation design, floor slab design, earthworks, slope stability, design of road pavements, railway infrastructure, and the like.

112. At a later stage, in order to provide more detailed recommendations, assessment and advice, a much more extensive scope of site investigation works will be undertaken, which will then provide adequate data to enable geo-environmental risks to be fully assessed, and mitigation measures designed. This will also provide data sufficient to allow a detailed geotechnical design report to be prepared. The full Geoenvironmental report will form a central part of the Environmental Impact Assessment (EIA) process.

113. Ground investigation and geotechnical design for the new access roads linking to the M69 Junction 2 will comply with the requirements set out by Highways England in the document DMRB Volume 4 Section 1 – HD22/08 – Managing Geotechnical Risk. The design process set out in this document and BS6031:2009 will be followed.

114. Documents required to enable the earthworks to progress will be prepared, to include the following:

- Geotechnical Design Report(s) (GDR) in accordance with BS EN 1997 and the Design Manual for Road and Bridge Works will be prepared.
- Materials Management Plan (MMP) (to enable materials excavated on the site to be re-used in construction without being considered as waste).
- Construction Environmental Management Plan (CEMP) (to ensure that the works undertaken have minimum environmental impact).
- Earthworks Specification in accordance with BS6031:2009 Code of practice for earthworks (designed to allow the most effective and efficient use of materials where they are suitable for use).
- Outline Remediation Strategy (a preliminary version will be included in the GIR).
- Remediation Method Statement.

118. Post construction –

- Remediation verification report (s).
- Geotechnical Feedback Report for all works (in accordance with HD22/08).

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