

AtkinsRéalis



Gravesend Shaft Piling Risk Assessment

Ferrovial Construction - Bemo Joint Venture

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100116608

TILBURY TO GRAIN TUNNEL

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1. Introduction

1.1 Background

AtkinsRéalis UK Limited (AtkinsRéalis) has been commissioned by Ferrovial Construction and Bemo joint Venture (FBJV) (the client) to provide geo-environmental consultancy support for the proposed Tilbury Shaft (the site) associated with the Tilbury Grain Kingsnorth Upgrade Project (TKRE) (Grain to Tilbury) for National Grid. As part of the design, a piling risk assessment (PRA) is required to assess the potential impact to controlled waters (surface water and groundwater) and human health receptors from proposed piling activities at the Gravesend site. This assessment was undertaken in line with Environment Agency guidance [1] and [2].

The study area for this report is located approximately 150 m south of the Eastcourt Marshes Electricity Substation.

The structure of the report includes:

- Section 2: a summary of the site and proposed piling;
- Section 3: a summary of the environmental baseline conditions;
- Section 4: a description of the proposed piling methodology;
- Section 5: a PRA summarising the potential risk from contaminants, if present in soils, to migrate to surface water and groundwater in the underlying aquifer from piling; and
- Section 6: the conclusion of the PRA.

1.2 Sources of information

The assessment made in this report is primarily based on the following sources of information:

- AECOM, Environmental Statement Volume VI Appendix 13.1 Water Framework, AECOM, 2024 [3];
- Ferrovial construction, RAMS -Shaft sinking with VSM, Ferrovial construction, 2025 [4];
- British Geological Survey (BGS) Geotindex [5];
- Magic Map, DEFRA [6];
- SOCOTEC, Ground Investigation Report (Factual), 2023 [7]; and,
- BakerHicks, Geotechnical Interpretive Report, 2023 [8].

1.3 Assumptions and limitations

This assessment has been carried out under current guidance and legislation, if these are revised in the future, then the assessment contained within this report may also need to be updated. This report does not advise on measures to manage risks associated with asbestos, where present. Detailed advice should be sought from a specialist contractor.

The findings, opinions and recommendations presented in this report are based on information obtained from a variety of third-party sources as detailed within this report. AtkinsRéalis has not independently verified third-party information and for the purposes of this assessment has assumed that such information is accurate and complete. Therefore, whilst this report and the opinions contained herein are accurate to the best of AtkinsRéalis' knowledge and belief, AtkinsRéalis cannot and does not guarantee the completeness, reliability or accuracy of the descriptions or conclusions based on supplied third-party information.

No responsibility can be accepted by AtkinsRéalis for the inaccuracies in the data supplied by any other party.



As with any physical ground investigation involving discrete sampling, test results will only be representative of the point sampled and further investigation and analysis may be required should ground conditions differ from those reported. Therefore, this report cannot guarantee against unexpected ground conditions occurring between the sampling points. If, during any excavation/construction works, visibly contaminated material is encountered in excavations, advice should be sought from a suitably qualified Environmental Scientist and the requirement for additional testing and assessment of the risks agreed.

Constraints relating to geotechnical hazards, ecology, heritage, flooding/drainage, utilities, air quality and noise are beyond the remit of this report.

Ground gas and groundwater conditions are based on observations made at the time of the ground investigations and monitoring programmes, and may be subject to variation due to atmospheric, seasonal or other effects.

The report shall be read as one complete document. Sections (or figures/data/appendices) of the report cannot be used without full reference to other elements of the report and any previous works referenced within the report (and associated limitations).

The opinions given in this report are relevant only for the purpose for which the report was commissioned.



2. Site summary

2.1 Site location and description

The site is located in Gravesend, centred on approximate Ordnance Survey Grid Reference (OSGR) 567436, 174136. The site is part of the TKRE (Grain to Tilbury) Project for National Grid. The site is located to the south of the River Thames and comprises an area of undeveloped land located south of the Eastcourt Marshes Substation and west of Milton Rifle Range.

The site dips with ground elevation across the site decreasing from approximately 6.0 m above ordnance datum (AOD) in the north to 2.0 m AOD in the south. A site layout plan is provided in Figure 2-1, extracted from GRR-FBJ-XX-GRRS4-DA-ZE-000002 (DRAFT), adapted, which presented in Appendix A.

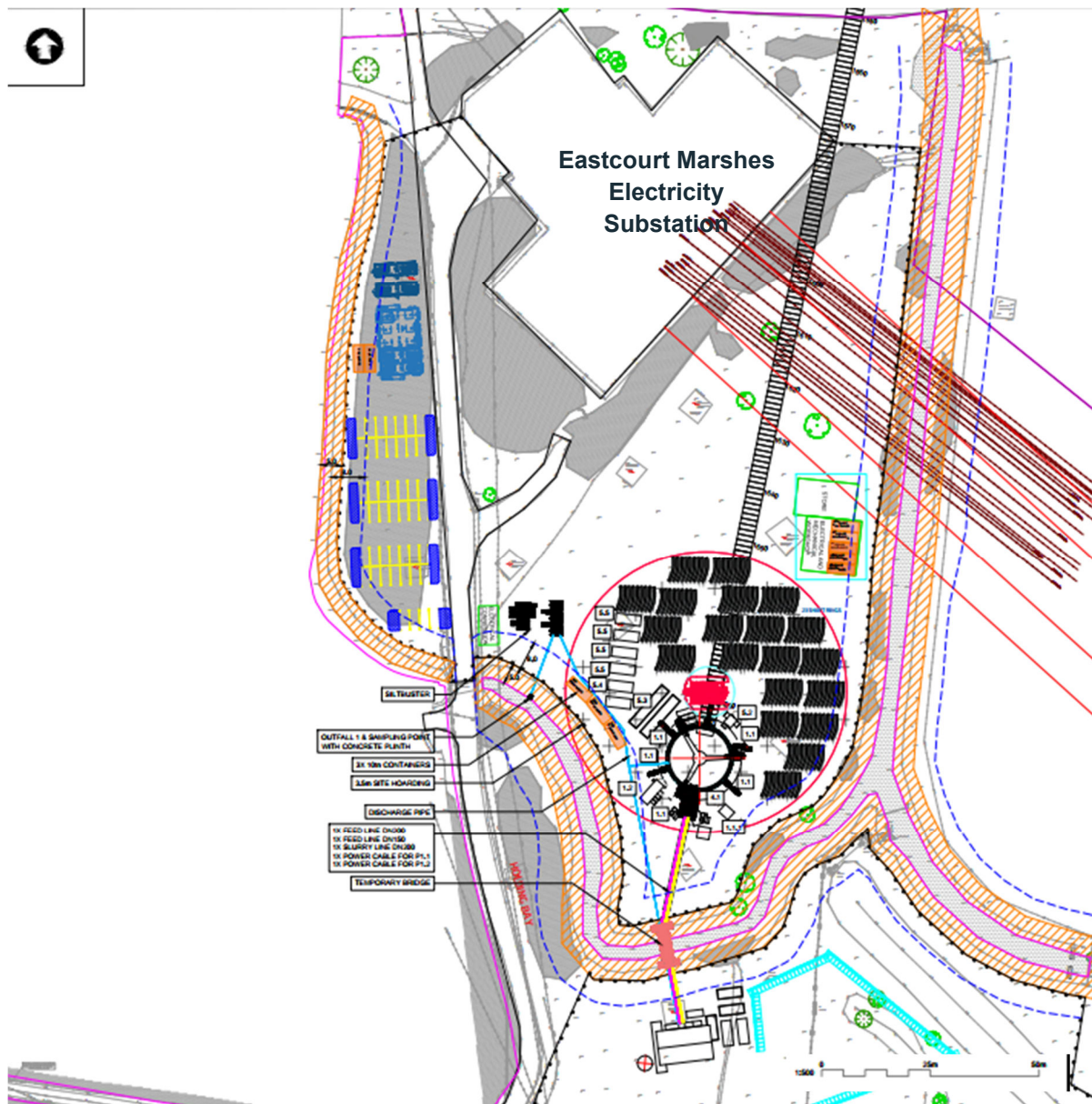


Figure 2-1 – Site layout plan Environmental setting

2.2 Introduction

The information presented in this section has been collated from the environmental information, ground investigations, and other sources listed in the sources of information, unless otherwise specifically cited.

2.3 Ground conditions

2.3.1 Published geology

British Geological Survey (BGS) mapping [9] indicates that the site is underlain by superficial deposits of Alluvium. The Alluvium is reported as consisting of soft to firm consolidated silty clay, which may contain layers of silt, sand, peat and gravel. River Terrace Deposits (RTD) are mapped in the vicinity, and likely beneath the Alluvium, reported as sand and gravel. The bedrock underlying the site is mapped as chalk of the Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation. Made Ground is not mapped at the site but may be present, related to historical development at the site and adjacent sites. Made Ground is mapped to the north and south of the site.

2.3.2 Ground investigation

Ground investigation (GI) at the site was completed by SOCOTEC in 2023 [7]. The GI comprised 3 boreholes, 10 trial pits, and 7 Cone Penetration Tests (CPT). The maximum depth of the investigation was 72.00 m bgl. A borehole location plan is presented in Figure 2-2. Following the GI, BakerHicks completed an interpretive report [8] based on the SOCOTEC data as well as available historical data for the site.



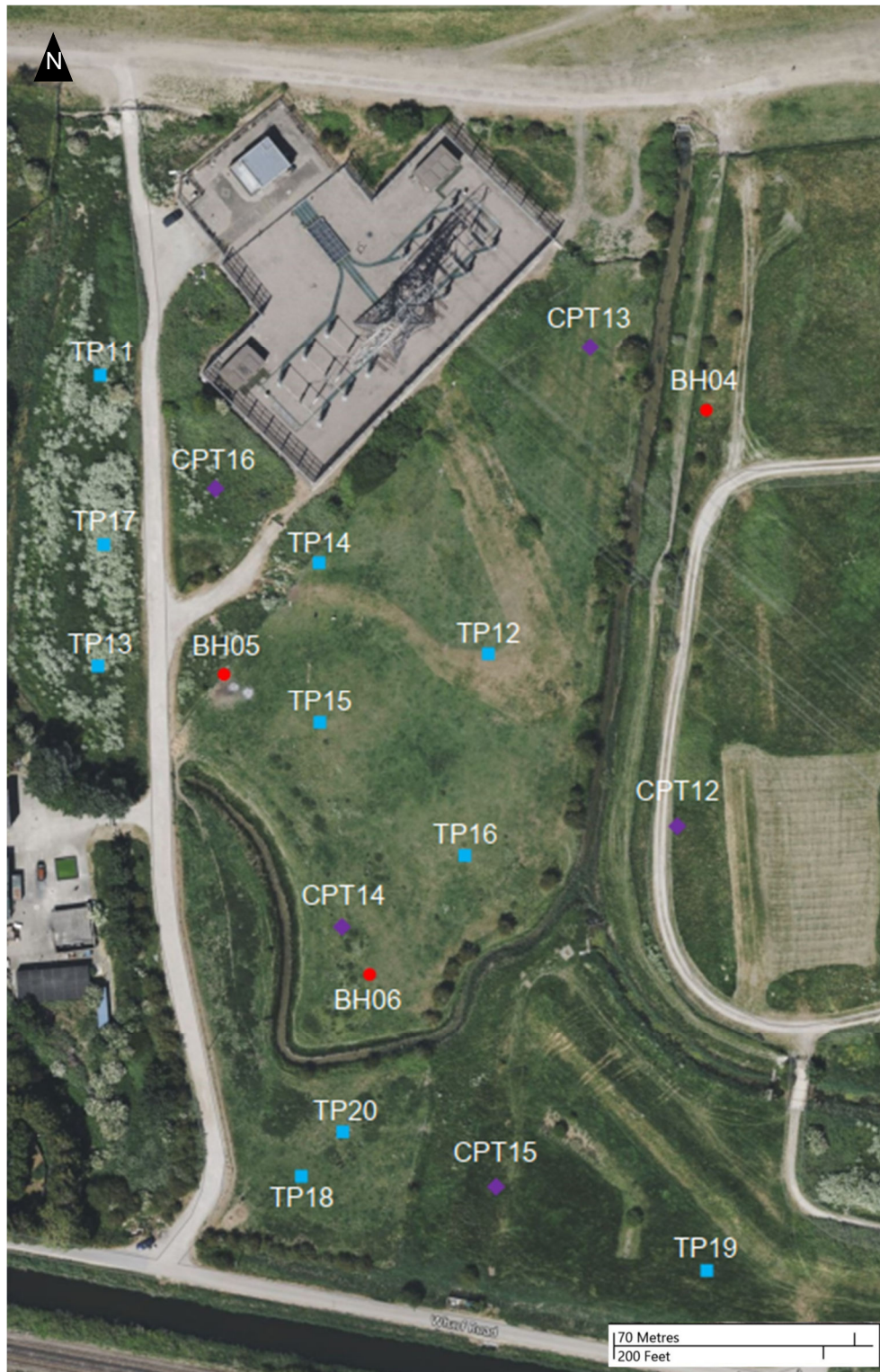


Figure 2-2 – SOCOTEC trail pit and borehole locations, extracted from SOCOTEC factual report [7].

The ground conditions identified during the SOCOTEC GI at the site as summarised in Table 2-1, below.

Table 2-1 – SOCOTEC GI encountered ground conditions

Geology	Strata	Elevation Range Encountered (mAOD)	Maximum Thickness (m)
-	Topsoil	2.49 to 1.63	0.50
-	Made Ground	2.42 to -0.22	2.30
Superficial	Alluvium	2.10 to -14.40	15.00
	River Terrace Deposits	-11.10 to -17.72	6.00
Bedrock	Seaford Chalk Formation	-16.71 to -68.41	51.70
	Lewes Nodular Chalk Formation	-42.15, base unproven	Unproven

Topsoil was identified as soft to firm, slightly sandy to gravelly clay with grass and occasional rootlets. Topsoil was identified at most locations across the site - BH04, BH06, CPT13, CPT14, CPT16 and all trial pits (TP11 to TP20).

Made Ground was identified in all SOCOTEC boreholes and was identified as orange, grey and bluish soft to firm, slightly sandy to gravelly sandy silt or clay. Alluvium was reported as soft to firm slightly sandy clayey silts with some fine to medium sand towards the base. Sand towards the base was described as brownish grey silt and dark orangish brown gravelly fine to medium sand with occasional sandy silty clay. Peat was reported in BH04 with a thickness of 0.98 m and was identified as plastic dark brown amorphous peat. River Terrace Deposits were identified below the Alluvium in the three deep boreholes, reported as brown speckled black or brownish grey fine to coarse sand and subangular to subrounded fine to coarse gravel of flint.

Bedrock of Seaford Chalk Formation was identified in the three deep boreholes, reported as between 1.30 m and 3.00 m of structureless chalk, recovered as sandy gravelly clay or sandy silty gravel, over 27.9 m to 48.7 m of CIRIA grade B4 to A1 structured chalk described as extremely weak to weak medium density chalk. Some fracture sets were reported in the structured chalk. Bedrock of Lewes Nodular Chalk Formation was identified below the Seaford Chalk Formation in boreholes BH04, BH05 and BH06. The Lewes Nodular Chalk Formation was reported as very weak to weak medium density white chalk, CIRIA grade A2 to fractureless with frequent black nodular flint. No notable layers of flint were reported.

2.4 Hydrogeology

The superficial Alluvium is classified as a secondary (undifferentiated) aquifer. The RTD are classified as a secondary A aquifer. The Seaford Chalk Formation and Lewes Nodular Chalk Formation are classified by the Environment Agency as principal aquifers.

Online information [6] indicates that there are no groundwater source protection zones (SPZ) on or within 500 m of the site.

The SOCOTEC 2023 investigation installed monitoring boreholes at locations BH04, BH05 and BH06. The boreholes were installed with dual installs in superficial and bedrock geology. No groundwater strikes were reported due to the use of water flush during drilling.

The reported groundwater monitoring results from the SOCOTEC GI at the site as summarised in Table 2-2, below.



Table 2-2 – SOCOTEC GI encountered groundwater levels

Borehole ID	Base of borehole (m bgl)	Response zone depth range (m bgl)	Response zone strata	Groundwater level range (m bgl / m AOD)
BH04	48.00	15.00 to 16.00	Alluvium	1.33 to 2.07 / 0.87 to 0.13
		42.00 to 44.00	Seaford Chalk Formation	1.76 to 2.18 / 0.44 to 0.02
BH05	68.02	16.00 to 19.00	River Terrace Deposits	0.81 to 1.87 / 1.67 to 0.61
		50.00 to 53.00	Seaford Chalk Formation	0.80 to 1.96 / 1.68 to 0.52
BH06	69.51	5.00 to 7.50	Alluvium	1.05 to 1.30 / 1.44 to 1.19
		34.50 to 27.50	Seaford Chalk Formation	1.09 to 1.66 / 1.40 to 0.83

The groundwater elevation data suggests that the superficial and bedrock aquifers are in hydraulic continuity.

2.5 Hydrology

The estuarine River Thames is located approximately 50 metres (m) to the north, flowing in an easterly direction. A number of drainage ditches are present adjacent and in the vicinity of the site however these are understood not to directly connect to the River Thames [10].

2.6 Environmental sensitivity

Online information [6] indicates presence of RAMSAR sites and Sites of Special Scientific Interest (SSSI) approximately 50 m to the south of the site and 450 m to the east of the site. There is also a Special Protection Areas (SPA) located approximately 600 m to the north-east of the site. There are no Special Areas of Conservation (SAC), or Local Nature Reserves (LNR) present within 1 km of the site.

2.7 Land contamination

Data from the 2023 SOCOTEC GI was assessed by BakerHicks and reported in their Interpretive Report [8]. The report presented human health, ground gas and controlled waters risk assessments on available data from the 2023 GI at the site.

2.7.1 PID monitoring

Photoionisation detector (PID) headspace testing for concentrations of volatile compounds was undertaken on 64no. samples across the site. All reported values were between <0.1 to 0.3 parts per million (ppm). No visual or olfactory evidence of contamination were reported at the site.



2.7.2 Geo-environmental Sampling

SOCOTEC completed geo-environmental sampling which included 12 soil samples and three groundwater samples [7].

2.7.3 Human health risk assessment

The BakerHicks report completed a human health assessment on available site data (34 samples). No exceedances of selected screening criteria were reported.

2.7.4 Ground gas risk assessment

The BakerHicks report discussed ground gas at the site and reported that monitoring identified elevated ground gas levels for methane, carbon monoxide and carbon dioxide. It was also noted that the data collected did not represent an assessment of the Made Ground materials. A theoretical high risk was reported and it was noted that migration of ground gas off-site through preferential pathways (underground services, trenches, pipelines) is possible and appropriate mitigation measures for asphyxiation or explosion in below ground excavations should be implemented. The reported high risk was specifically associated with the data gap and lack of representative data from Made Ground.

2.7.5 Groundwater risk assessment

The BakerHicks report completed a controlled waters risk assessment on the three groundwater samples collected during the GI. Samples were screened against Environmental Quality Standards (EQS) and Drinking Water Standards (DWS). Screening of the available data reported exceeding concentrations of chloride (3,200 mg/l, DWS+EQS 250 mg/l), boron (1.99 mg/l, DWS of 1.99 mg/l) and arsenic (0.014 mg/l, DWS of 0.01 mg/l) above DWS. Additionally, chromium (0.002 mg/l, EQS of 0.0006 mg/l), zinc (0.017 mg/l, EQS of 0.0079 mg/l) and fluoranthene (0.01 ug/l, EQS of 0.0063) was detected above EQS. The identified exceedances of chloride, maximum concentration 3,200 mg/l, was inferred to be related to the proximity of the site to the estuarine River Thames. The majority of the rest of the concentrations were marginal exceedances above the criteria.

The BakerHicks report states that no soil-leachate laboratory analysis was completed during the GI and so no soil-leachate data was available for screening.

The BakerHicks report concluded that the potential leaching and downward migration of contaminants represented an active pollutant linkage at the site. Based on the screening undertaken, BakerHicks reported that the superficial deposits and chalk were likely to be in hydraulic continuity. Overall, BakerHicks assessed the risk from leaching of contaminants into groundwater as moderate/low. Recommendations comprised monitoring of groundwater during the works to ensure no deterioration of quality, appropriate treatment and/or disposal of any water derived from dewatering activities along-side an environmental watching brief during the works.

2.7.6 Ground aggressivity

Ground aggressivity was also assessed in the 2023 BakerHicks report, reported as design sulphate (DS) class 2 and ACEC (AC) class 2 for the Alluvium, and DS-1 and AC-1 for Made Ground, River Terrace Deposits, Seaford Chalk Formation and Lewes Nodular Chalk Formation.



3. Proposed piling locations and technique

The development plans and pile design information are provided in Figure B-1 included in Appendix B. The methodology for the vertical shaft machine (VSM) are presented in the VSM Risk Assessment Method Statement (RAMS) [4]. A high-level summary of the methodology is presented below.

The design comprises 35 cast in-situ concrete Continuous Flight Auger (CFA) piles of 750 millimetre (mm). The proposed lengths of the piles are 15.3 m, which would likely terminate within the superficial deposit, based on the geology outlined in Section 3.2.1. These piles will be completed in a ring around the location of the shaft.

During the groundwater monitoring carried out as part of the 2023 GI, groundwater was encountered between 0.80 m bgl to 2.18 m bgl [7]. The piling operation is therefore assumed to intercept the groundwater table during installation and the completed piles will interact with groundwater.

The proposed bored, CFA piles are individual piles which do not interlock and are therefore unlikely to form a barrier to groundwater flow. CFA piles are cast in-situ piles, where an auger is drilled into the ground at controlled speed to a desired depth and then placing concrete through the tip of the auger as it is extracted from the ground. After the auger is pulled out from the drilling hole, a reinforcement cage is placed in the concrete to strengthen the pile. CFA piles are non-displacement piling methods and result in small amount of soil arisings which minimises the risk of groundwater contamination and reducing high moisture content in the surface arisings. The proposed technique means that soils are unlikely to be displaced vertically or laterally, therefore preventing potential contamination to the deeper strata.



4. PRA

4.1 Methodology

This PRA has been completed according to the methodology and framework set out in the Environment Agency guidance for piling on land potentially affected by contamination [1] and [2].

This guidance sets out the following six pollution scenarios (PS) that may occur during piling operations on potentially contaminated sites. An eighth scenario has been added, considering the possibility of impeding groundwater flow by the proposed piling outlined in Section 3.

- PS 1 – Creation of preferential pathways through a low permeability layer (an aquitard) to cause contamination of groundwater in an aquifer;
- PS 2 – The driving of solid contaminants down into an aquifer during pile driving;
- PS 3 – Contamination of groundwater and subsequently surface waters by turbidity, support fluids, concrete, cement paste or grout. For piling works, risks to environmental receptors are likely to be greater when:
 - Contaminants are present on the site and ground works could allow them to migrate;
 - Piling would breach a low permeability layer or connect two previously discrete aquifers;
 - The site overlies a principal or secondary A aquifer;
 - The site is located within a groundwater SPZ;
 - The groundwater table is shallow or likely to be intersected by piles;
 - The geological strata are fractured or fissured; and,
 - Works are close to a surface water body and run-off from arisings could pollute those waters.
- PS4 – Direct contact with contaminated soil or leachate causing degradation of pile materials;
- PS5 – Creation of preferential pathways to allow migration of landfill gas or contaminant vapours to surface;
- PS6 – Causing off site migration of ground gas or increased vertical emissions as a result of vibration or other effects from the pile installation process; and,
- PS7 – Direct contact with contaminated soil arisings that have been brought to the surface.
- PS8 – Impeding groundwater flow resulting in groundwater embankment or reduced baseflow adjacent water courses.

The following section provides a summary of the potential risks associated with the proposed bored cast-in-place piling methodology against the PS identified above. As part of this assessment, the client has confirmed that identified mitigation measures will be implemented during piling. This includes good working practices and adherence to design guidance in the piling design and construction process.

Based on the outline proposed piling approaches, the likelihood and magnitude of risk associated with each of the above PS has been presented in Table 5-1.



4.2 Piling scenario assessment

Table 5-1 presents site-specific considerations, an overall (pre-mitigation) risk and possible mitigation measures for each of the PS for the identified method using bored cast-in-situ CFA piles at the site.

Table 4-1 – Summary of pollution scenarios for piling activities

PS	Applicable	Piling scenario risk rating	Mitigation measures
PS 1 – Creation of preferential pathways through a low permeability layer (an aquitard) to cause contamination of groundwater in an aquifer	Based on the available GI information the ground conditions underlying the site comprise Topsoil and Made Ground of clayey sand, sandy gravel underlain by superficial deposits of Alluvium and RTD. Bedrock of chalk was identified from - 16.71 m AOD. The 2023 GI reported groundwater in superficial deposits between 0.81 m bgl and 2.07 m bgl and 0.80 m bgl and 2.18 m bgl in bedrock. No visual or olfactory evidence of contamination was reported in 2023 and maximum PID readings reported were 0.3 ppm. The Alluvium is considered to be of variable permeability due to clay content. The groundwater elevation data suggests superficial deposits and bedrock are in hydraulic continuity. Based on available data the CFA piles will terminate within the superficial deposits. However, the RAMS for piling suggests that the piles will aim to reach the chalk and so we have conservatively assumed that the CFA piles will fully penetrate the Alluvium and RTD.	Low	A 'watching brief' approach will be implemented. Monitor composition of arising. Seek advice if gross contamination identified. All holes will implement temporary casing when drilling through the Alluvium, this casing is to only be removed as the holes are grouted up. The ground improvement boreholes will be backfilled with grout rather than backfilled with gravel as the temporary casing is removed to ensure no pathways are created. Use of aquifer protection measures (e.g. telescopic drilling/casing) through alluvium when piling or advancing boreholes.
PS 2 – The driving of solid contaminants down into an aquifer during pile driving	Made Ground is present across the site to a depth of 2.3 m bgl, -0.22 m AOD.	Low	Ensure no under-rotation of augers.



PS	Applicable	Piling scenario risk rating	Mitigation measures
	CFA piling technique is non-displacement, meaning no material should be pushed downwards. Non-displacement piles will remove soil to the surface and therefore do not result in contaminated soils being pushed either laterally or downward into the underlying geology. Displacement piling methodology is not proposed to be used and therefore the displacement of soils deeper into the aquifer is likely to be limited.		
PS 3 – Contamination of groundwater and subsequently surface waters by turbidity, support fluids, concrete, cement paste or grout	The proposed CFA pile methodology will require the injection of grout or concrete, however the toe of these piles will be either in the superficial deposits or weathered chalk and as such the risk of contamination to groundwater (or any other waters) is considered low. The piles will encounter groundwater which was recorded in superficial deposits between 0.81 m bgl and 2.07 m bgl and 0.80 m bgl and 2.18 m bgl in bedrock. The River Thames is located approximately 50 m north of the site. Drainage ditches adjacent to the site are not in direct continuity with the River Thames.	Low	A low slump grout or concrete mix is to be utilised within the bore reducing the risk of potentially contaminating the groundwater. Implement accurate recording of concrete or grout volumes to identify if abnormal losses occur. Maintain a watching brief during the injection process to ensure no signs of migration in groundwater or unidentified voids. If identified, stop work and carry out a review of the design to mitigate further migration. Consider the use of monitoring wells to confirm the absence of impact outside the treatment zone. Mitigation measures above and implemented within design will reduce the risk to the groundwater aquifer.
PS4 – Direct contact with contaminated soil or leachate causing degradation of pile materials;	The proposed CFA piling will penetrate Made Ground and is assumed to terminate within the underlying bedrock deposits. Groundwater was encountered in 2023 in superficial and bedrock deposits between 0.81 m bgl and 2.07 m bgl. As	Low to moderate	Contractors will be made aware of potential for aggressive ground conditions and groundwater. Appropriate material grade for piles is to be selected by the designers based on the ground

PS	Applicable	Piling scenario risk rating	Mitigation measures
	such the piles will intercept groundwater and contact between piles and the ground improvement groundwater will occur. BakerHicks undertook ground aggressivity evaluation in 2023 and reported DC-2 and AC-2 for Alluvium (superficial) and DC-1 and AC-1 in bedrock, Made Ground and River Terrace Deposits (superficial)		conditions and aggressivity following appropriate guidance/legislation.
PS5 – Creation of preferential pathways to allow migration of landfill gas or contaminant vapours to surface	Made Ground was encountered in the GI across the site, recorded to depths of 2.42 m bgl on-site. The 2023 ground gas monitoring and risk assessment identified ground gas above the instrument detection level. BakerHicks undertook a risk assessment and it was noted that migration of gas off-site through preferential pathways (underground services, trenches, pipelines) is possible and appropriate mitigation measures for asphyxiation or explosion in below ground excavations should be implemented. The BakerHicks report stated that ground gas posed a high risk, however this was associated with the data gap for ground gas in Made Ground and so is considered a theoretical risk only. The piling is unlikely to create a long-term preferential pathway as there is no shallow low permeable barrier to create a pathway. In addition, the holes would only be open for a short time before being sealed via grout or concrete.	Moderate	Piling contractors to be made aware of the potential contamination in the Made Ground which may pose a vapour risk. Collate and assess existing information on gas management on the wider site and associated historic and current landfills. Completion of a detailed gas risk assessment to inform the detailed design and ensure no preferential pathway is created for landfill / ground gas to migrate off-site. Contractors to provide mitigation for employees during construction if necessary. The ground improvement boreholes will be backfilled with grout to ensure no pathways are created. Contractors to provide mitigation for employees as required, e.g. use of gas alarms.
PS6 – Causing off site migration of ground gas or increased vertical emissions as a result of vibration or other	In addition to the above, ground conditions within the Alluvium it is likely to be low permeability and so migration of ground gas is unlikely. Groundwater is shallow and so there is limited space for migration.	Low to moderate	As above

PS	Applicable	Piling scenario risk rating	Mitigation measures
effects from the pile installation process	The closest structure is approximately 80 m from the site and ground cover is generally permeable. The likelihood of migrating gases travelling to off-site receptors is low.		
PS7 – Direct contact with contaminated soil arisings that have been brought to the surface.	The proposed bored cast-in-situ piling methods will result in generation of arisings which will be brought to surface, requiring storage and off-site disposal. Made Ground was recorded at the site to a depth of 2.42 m bgl and as such any proposed boring is likely to bring Made Ground to the surface. The 2023 BakerHicks human health risk assessment did not report any exceedances of screening criteria were reported.	Low	A 'watching brief' approach is to be undertaken. Monitor the composition of arisings. Seek advice if contaminated material or potential asbestos is encountered. Implement appropriate health and safety measures (e.g. use of personal protection equipment). All arisings shall be removed from the site. The arisings shall be appropriately classified and treated/ disposed off-site at a suitable waste management facility under an appropriate duty of care. If arisings are to be re-used on site, then they must be assessed appropriately, and re-use done under a relevant materials management plan or permit. Precautions to be taken to ensure pile arisings are stored safely and correctly and to avoid contact and contaminants becoming airborne. Asbestos has not been identified in Made Ground on-site. However, as a precaution any personnel working with the Made Ground material are to have appropriate training and work under applicable risk assessments.
PS 8 – Impeding groundwater flow resulting in groundwater embankment or reduced	Proposed spacing between the CFA piles means that they are unlikely to impact groundwater flow, with sufficient space between piles to allow for groundwater to continue to flow.	Low	No specific mitigation measures required.

PS			Applicable	Piling scenario risk rating	Mitigation measures
baseflow courses.	adjacent	water	The shallowest groundwater level encountered at to the site is 0.81 m bgl. As such, significant groundwater mounding is not expected, with any potential impact minimal.		



5. Summary and recommendations

5.1 Summary

This PRA has been undertaken for the proposed Gravesend Shaft (the site) associated with the Tilbury Grain Kingsnorth Upgrade Project (TKRE) (Grain to Tilbury) for National Grid. The assessment has reviewed the potential risk from the use of the proposed CFA bored cast-in-situ piling technique. The piles are expected to intersect groundwater, which was reported between 0.81 m bgl and 2.07 m bgl in superficial and 0.80 m bgl and 2.18 m bgl in bedrock in 2023.

5.2 Recommendations

The piling/ground treatment options discussed above are subject to appropriate workmanship, mitigation and ensuring quality assurance/ quality control (QA/QC) measures are adopted. The works will also be subject to appropriate oversight and method statements. Should the proposed depths or techniques of piling or ground treatment be changed then this assessment must be reviewed.

The pre-mitigation risks associated with the identified piling scenario activities range from Low to Moderate. Selected mitigation has been summarised below. The client has confirmed that identified mitigation measures will be implemented.

PS1

- Implementation of a 'watching brief';
- Monitor composition of arising. Seek advice if gross contamination identified.
- Installation of temporary casing when drilling through the Alluvium, this casing will only be removed as the holes are grouted up.
- Use of aquifer protection measures (e.g. telescopic drilling/casing) through Alluvium when piling or advancing boreholes.
- The ground improvement boreholes are to be backfilled with grout rather than backfilled with gravel as the temporary casing is removed to ensure no pathways are created.

PS2

- Ensure no under-rotation of augers.

PS3

- A low slump concrete mix is to be utilised within the bore reducing the risk of potentially contaminating the groundwater.
- Implement accurate recording of grout volumes to identify if abnormal losses occur.
- Maintain a watching brief during the injection process to ensure no signs of migration in groundwater or unidentified voids. If identified, stop work and carry out a review of the design to mitigate further migration.
- Consider the use of monitoring wells to confirm the absence of impact outside the treatment zone.

PS4

- Contractors to be made aware of potential for aggressive ground conditions and groundwater - DC-2 and AC-2 for Alluvium and DC-1 and AC-1 in Made Ground, RTD and bedrock.
- Appropriate material grade for piles is to be selected by the designers based on the ground conditions and aggressivity following appropriate guidance/legislation.



PS 5 and 6

- Piling contractors to be made aware of the potential contamination in the Made Ground which may pose a vapour risk.
- Collate and assess existing information on gas management on the wider site and associated historic and current landfills.
- Completion of a detailed gas risk assessment to inform the detailed design and ensure no preferential pathway is created for landfill / ground gas to migrate off-site. Contractors to provide mitigation for employees during construction if necessary.
- The ground improvement boreholes are to be backfilled with grout rather than backfilled with gravel as the temporary casing is removed to ensure no preferential pathways are created.
- Contractors to provide mitigation for employees as required, e.g. use of gas alarms.

PS7

- Use of a 'watching brief' approach. Monitor the composition of arisings. Seek advice if contaminated material or potential asbestos is encountered. Implement appropriate health and safety measures (e.g. use of personal protection equipment).
- All arisings shall be removed from the site. The arisings shall be appropriately classified and treated/ disposed off-site at a suitable waste management facility under an appropriate duty of care. If arisings are to be re-used on site, then they must be assessed appropriately, and re-use done under a relevant materials management plan or permit.
- Precautions to be taken to ensure pile arisings are stored safely and correctly and to avoid contact and contaminants becoming airborne.
- Asbestos has been identified in Made Ground on-site and off-site. Therefore, any personnel working with the Made Ground material are to have appropriate training and work under applicable risk assessments.

PS8

- No specific mitigation measures required.



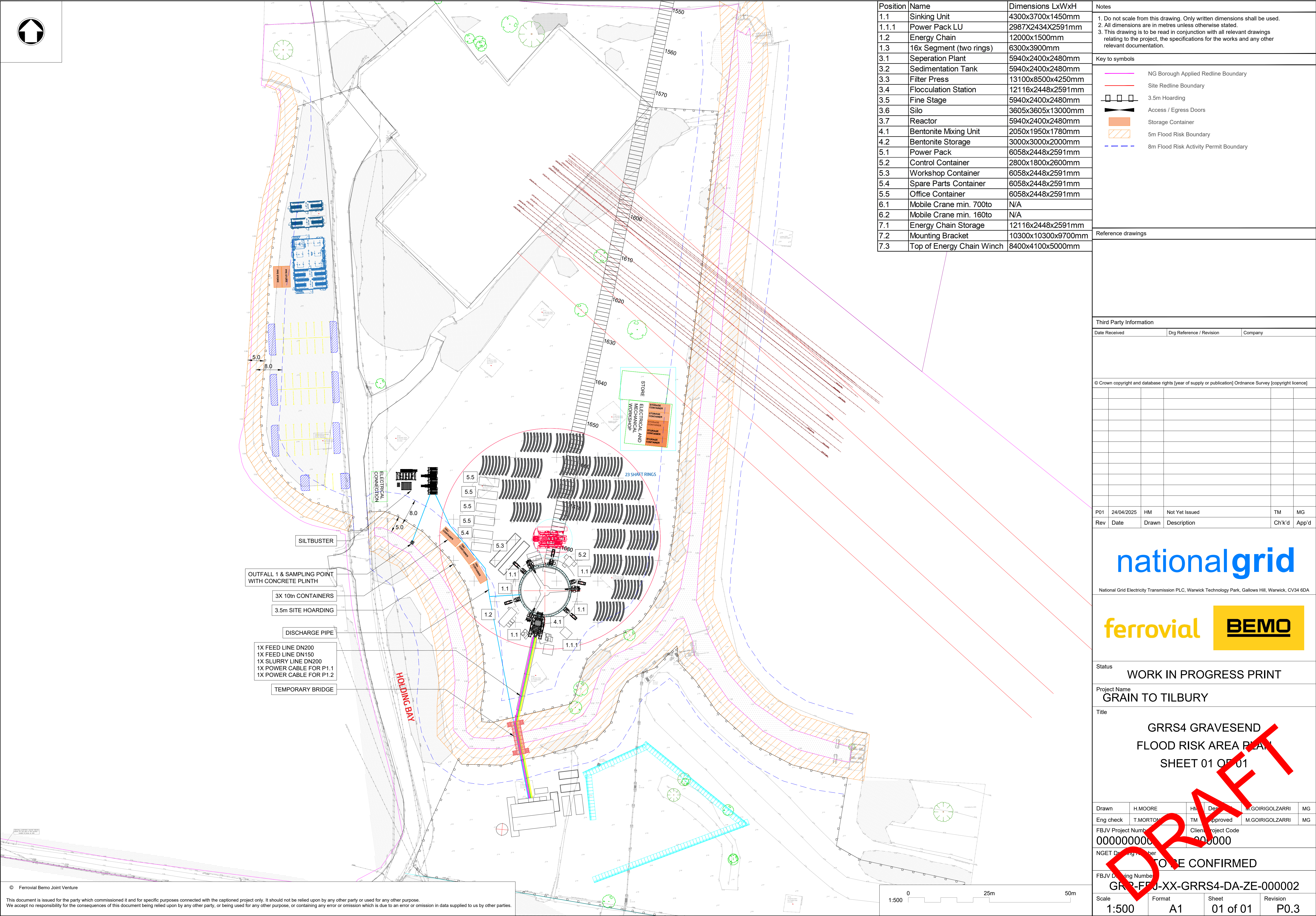
6. References

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APPENDICES

Appendix A. Site Drawing





Position	Name	Dimensions LxWxH
1.1	Sinking Unit	4300x3700x1450mm
1.1.1	Power Pack LU	2987X2434X2591mm
1.2	Energy Chain	12000x1500mm
1.3	16x Segment (two rings)	6300x3900mm
3.1	Seperation Plant	5940x2400x2480mm
3.2	Sedimentation Tank	5940x2400x2480mm
3.3	Filter Press	13100x8500x4250mm
3.4	Flocculation Station	12116x2448x2591mm
3.5	Fine Stage	5940x2400x2480mm
3.6	Silo	3605x3605x13000mm
3.7	Reactor	5940x2400x2480mm
4.1	Bentonite Mixing Unit	2050x1950x1780mm
4.2	Bentonite Storage	3000x3000x2000mm
5.1	Power Pack	6058x2448x2591mm
5.2	Control Container	2800x1800x2600mm
5.3	Workshop Container	6058x2448x2591mm
5.4	Spare Parts Container	6058x2448x2591mm
5.5	Office Container	6058x2448x2591mm
6.1	Mobile Crane min. 700to	N/A
6.2	Mobile Crane min. 160to	N/A
7.1	Energy Chain Storage	12116x2448x2591mm
7.2	Mounting Bracket	10300x10300x9700mm
7.3	Top of Energy Chain Winch	8400x4100x5000mm

Notes

1. Do not scale from this drawing. Only written dimensions shall be used.
2. All dimensions are in metres unless otherwise stated.
3. This drawing is to be read in conjunction with all relevant drawings relating to the project, the specifications for the works and any other relevant documentation.

Key to symbols

NG Borough Applied Redline Boundary

Site Redline Boundary

3.5m Hoarding

Access / Egress Doors

Storage Container

5m Flood Risk Boundary

8m Flood Risk Activity Permit Boundary

Reference drawings

Third Party Information

Date Received

Drg Reference / Revision

Company

© Crown copyright and database rights [year of supply or publication] Ordnance Survey [copyright licence]

P01

24/04/2025

HM

Not Yet Issued

TM

MG

Rev

Date

Drawn

Description

Ch'k'd

App'd

nationalgrid

National Grid Electricity Transmission PLC, Warwick Technology Park, Gallows Hill, Warwick, CV34 6DA

ferrovial

BEMO

Status

WORK IN PROGRESS PRINT

Project Name

GRAIN TO TILBURY

Title

GRRS4 GRAVESEND
FLOOD RISK AREA PLAN
SHEET 01 OF 01

Drawn

H.MOORE

HM

Des

M.GOIRIGOLZARRI

MG

Eng check

T.MORTON

TM

Approved

M.GOIRIGOLZARRI

MG

FBJV Project Number

000000000

Client Project Code

000000

NGET Drawing Number

000000

CONFIRMED

FBJV Drawing Number

GRR-FBV-XX-GRRS4-DA-ZE-000002

Scale

1:500

Format

A1

Sheet

01 of 01

Revision

P.0.3

Appendix B. Design Drawings

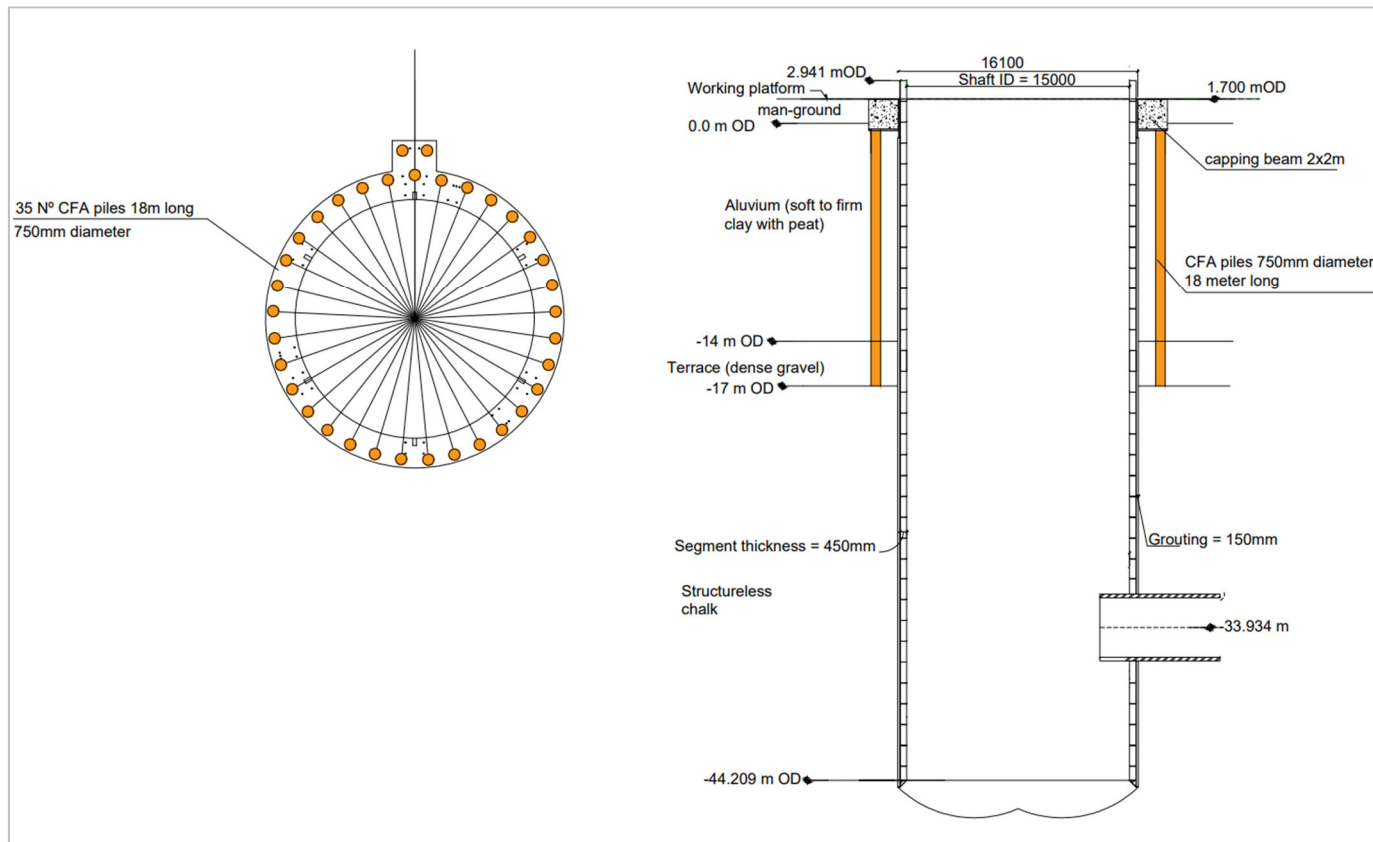


Figure B-1 – Development and pile design drawing

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