Lower Thames Crossing

9.89 Responses to the Examining Authority's ExQ1 Appendix G – 11. Biodiversity (Part 2 of 6)

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Lower Thames Crossing

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Annexes

Annex A Coalhouse Point Mitigation Water Supply Structure

Lower Thames Crossing

Coalhouse Point Mitigation Water Supply Structure

Document Number: HE540039-LTC-EWE-S07-REP-ENV-00001

Aims of the paper

- To confirm the assumed construction method for the installation of a self regulating tidal gate or equivalent structure at west of Coalhouse Point to secure a water supply for the HRA and ecology mitigation. Including:
    - Construction footprint
    - Operational footprint
    - Method of works
    - Timing of works
    - Design requirements
- Confirm Order Limit changes required for the additional structure

Introduction

LTC's proposed Habitats Regulations Assessment (HRA) and invertebrate mitigation at Coalhouse Point requires a secure water supply. Hydrology studies indicate there is insufficient water in the natural catchment to sustain the water demand. Plate 1 presents the location and indicative design of the proposed mitigation area in the context of the LTC alignment.

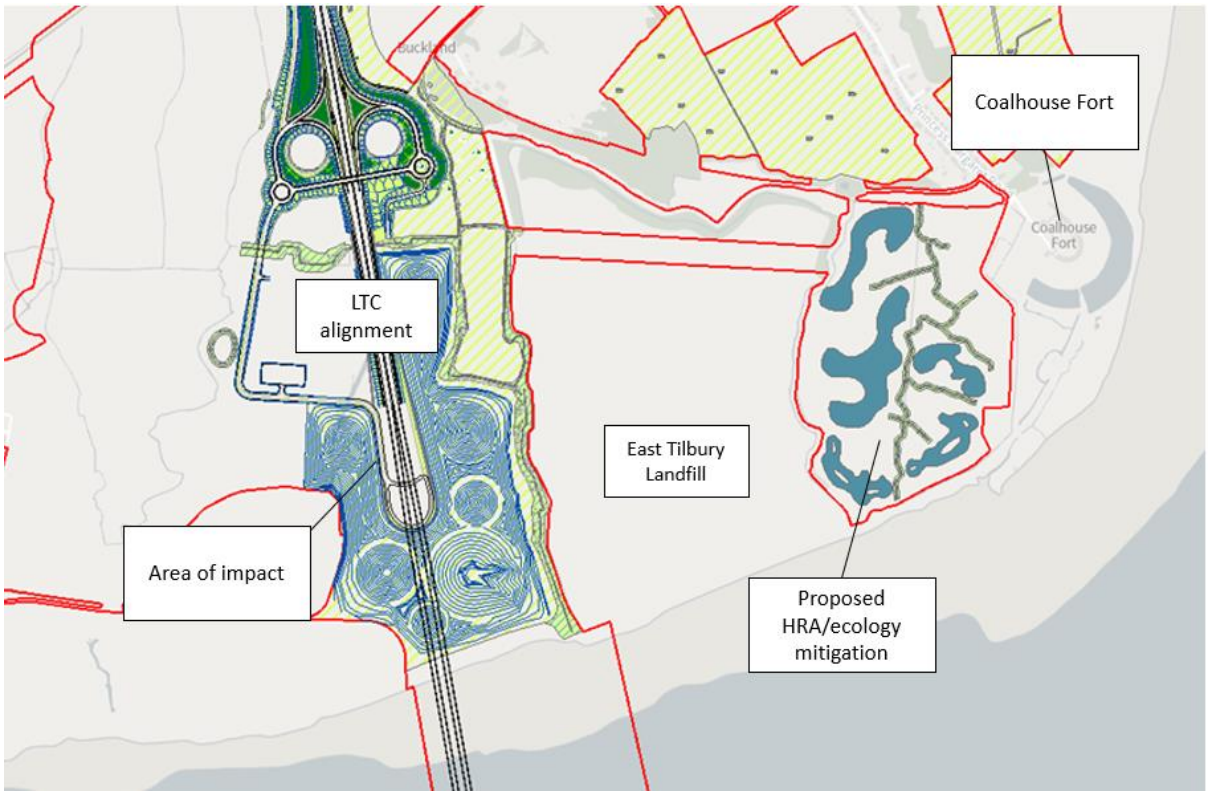

Plate 1: Proposed location of HRA and ecology mitigation

- The HRA and EIA require evidence that proposed mitigation is feasible. Natural England have advised that feasibility of the mitigation will need to be presented before they would be able to agree the sufficiency of the mitigation in the SoCG, which is a DCO acceptance risk and DCO consenting risk.

- A water supply solution is required by the HRA to demonstrate the feasibility of the measures in the DCO application, but also to inform engagement with Natural England in June/July 2022 so that the SoCG submitted at the application will have Natural England agreement on the conclusions of the HRA.
- Uncertainty on long-term condition and ownership of Coalhouse Point flood defences is an ongoing issue, however, does not influence the requirement of demonstrating the feasibility of a self regulating tidal gate or equivalent structure.

A choose by advantage workshop was carried out by the LTC Project team to achieve the following:

- Selection of preferred option/solution using Choosing by Advantage
- Identify next steps and risks
- Present update on a preferred option to DDG

The preferred option selected was to include provision for a structure to provide a direct supply from the River Thames within the DCO Order Limits and works plans. In parallel, the Project would seek to gain a legal agreement with Thurrock to supply water from the existing infrastructure within the Coalhouse Fort moat, however, this cannot be relied upon within the timescales required for the HRA consultation or DCO submission.

A review of alternative sites for the HRA and ecology mitigation has been carried out. No alternatives were identified.

The commitments in the HRA to include this structure reads:

HR010 – The habitat creation at the land adjacent to Coalhouse Point, indicated on the Environmental Masterplan (Figure 2.4, Application Document 6.2) and described in Clause S9.13 of the Design Principles (Application Document 7.5) will be carried out prior to the commencement of works at the Northern tunnel entrance compound. The water required to maintain a range of depths within the habitat consistent with the guidance in “Manage lowland wet grassland for birds” (DEFRA 2021) will be secured prior to completion of the habitat creation works and will, unless otherwise agreed with the Secretary of State, be sourced from the River Thames via a self-regulating tide gate or equivalent structure, passable by eels, constructed (in accordance with HR011) in the sea wall, at approximately TQ686761, to allow regulated tidal exchange (Work No. [TBC]).
HR011 –Works to construct a self-regulating tide gate or equivalent structure (HR010 Option 2) would be undertaken with the following constraints:

- In line with best practice, the works to construct the self regulating tidal gate or equivalent structure should be programmed for April – August (to avoid disturbance to passage and overwintering birds associated with European designated sites) where this would not delay the completion of the habitat creation works at the earliest date.
- All works requiring access to the inter-tidal zone would be completed to suit tidal cycle and at periods of low water.
- All piling works would be completed during periods of low water to avoid transmission of underwater noise.
- All piling works would utilise soft start piling and other best practice techniques, as per the JNCC 2010 guidance (Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise), to help avoid noise and vibration impacts.
- Excavated arisings would be retained within the coffer dam or stored on a support barge.
- No tracking on the upper foreshore area would be carried out.

Change to the Order Limits

To include provision of a new structure within the existing flood defence at Coalhouse Point, an amendment to the Order Limits would be required.

The location of the proposed structure, noted on Plate 2, has been determined by the following constraints:

- 50m offset from the western buried high pressure gas pipeline that crosses beneath the River Thames and the flood defence before taking an easterly alignment towards the National Grid AGI.
- An area which minimises the temporary disturbance of intertidal / mudflat habitat between the flood defence and mean high water level.
- Maintaining a distance of 100m from the boundary of East Tilbury Landfill.

To allow for the construction of the new structure, a temporary working area of 50m (longitudinally to the flood defence) by 20m to 35m (extending into the Thames) would be required. This would allow sufficient space during construction. This is presented as the orange area in Plate 2. The construction works would result in the temporary loss of inter-tidal habitat, however, given the scale of the proposed works and the dynamic nature of the tidal regime, any loss would naturally re-establish within a short-term timescale.

Once operational, it is assumed that the footprint of the proposed structure would not extend beyond the existing footprint of the flood bund and therefore the Project would not result in any permanent loss of inter-tidal habitat.

It was proposed to amend the Order Limits to incorporate the existing flood defence that is currently owned by the landowner, Mr Mott. This change was proposed irrespective of the requirement of a structure and is show as the red area in Plate 2. Given the new structure would be limited to the footprint of the flood defence, this change would also incorporate the new structure.

Plate 2: Proposed amendments to the DCO Order Limits to provide the 50mx20-35m working space for the construction of the sluice structure. Approximate amendments to Order Limits to incorporate flood defence also highlighted.

Key commitments/constraints to works

The works to construct the structure would be required in the early part of the construction programme. The HRA mitigation will need to be established prior to the northern tunnel entrance construction compound.

Works will be delivered in line with the constrains set out below.

- In line with best practice, the works to construct the self-regulating tidal gate or equivalent structure should be programmed for April – August (to minimise disturbance to birds) where this would not delay the completion of the habitat creation works at the earliest date (HR011).
- All works requiring access to the inter-tidal zone would be completed to suit tidal cycle and at periods of low water (HR011).
- All piling works would be completed during periods of low water to avoid transmission of underwater noise (HR011).
- All piling works would utilise soft start piling and other best practice techniques, as per the JNCC guidance, to help avoid noise and vibration impacts (HR011).
- Excavated arisings would be retained within the coffer dam or stored on a support barge (HR011).
- No tracking on the upper foreshore area would be carried out (HR011).
- The proposed final structure arrangement would be passable by eel, potentially opening up the proposed mitigation as new eel habitat, in line with HR010.
- The new structure would include a self-regulating arrangement to ensure water levels entering the mitigation can be controlled and water ingress can be stopped when the desired level within the created ditches and scrapes is achieved.
- Water level control would be established at the exit of the HRA mitigation to control flows leaving the site.

Structure design assumptions

The existing ground levels and tidal regime has informed the potential location and size of the structure, relative to the existing flood bund. The crest of the flood bund sits at approximately 4.0m AoD, whilst its base on the river side is around 1.0m AoD. The existing ditch directly to the north of the flood defence is at 0.0m AoD. Plate 3 provides a cross section of the existing flood defence.

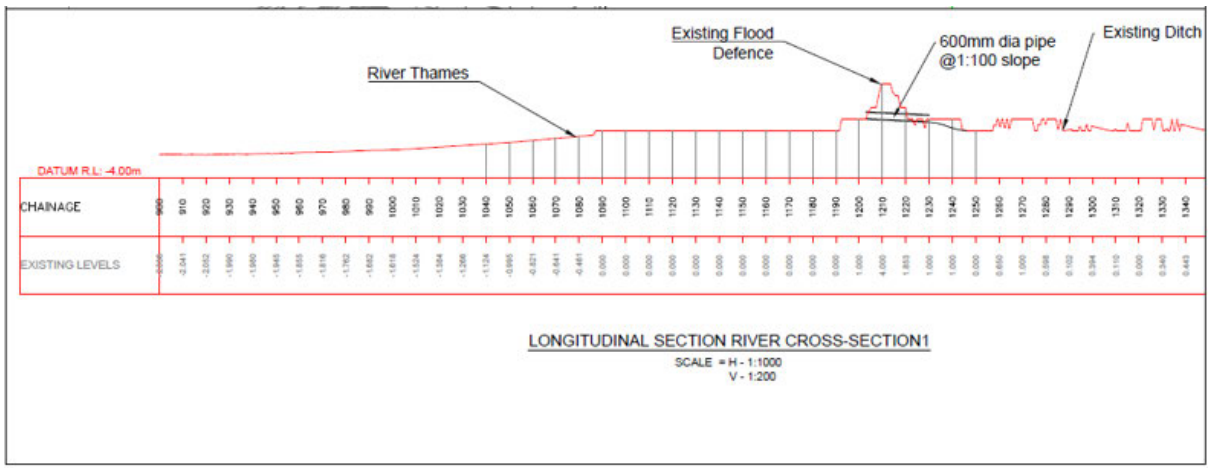

Plate 3: Cross section of the existing Coalhouse Point flood defence

An estimate of the Mean High Water Spring tidal cycle over a three-day period was developed using TE2100 model node at East Tilbury Marshes (Plate 4). It was determined

that the Thames' water level would be greater than 2.0m AoD for 24.75 hours over the three-day period. Assuming that a 600mm diameter pipe is installed, this would be sufficient to convey water through the flood defence to meet the required water demand of the proposed mitigation area and would avoid any permanent works within the inter-tidal area. Due to the elevated position of the structure within the flood defence and its relative position in terms of overall tidal frame, it has been assumed that the risk of the structure becoming silted up is low.

The final siting and form of the structure would be subject to detailed design.

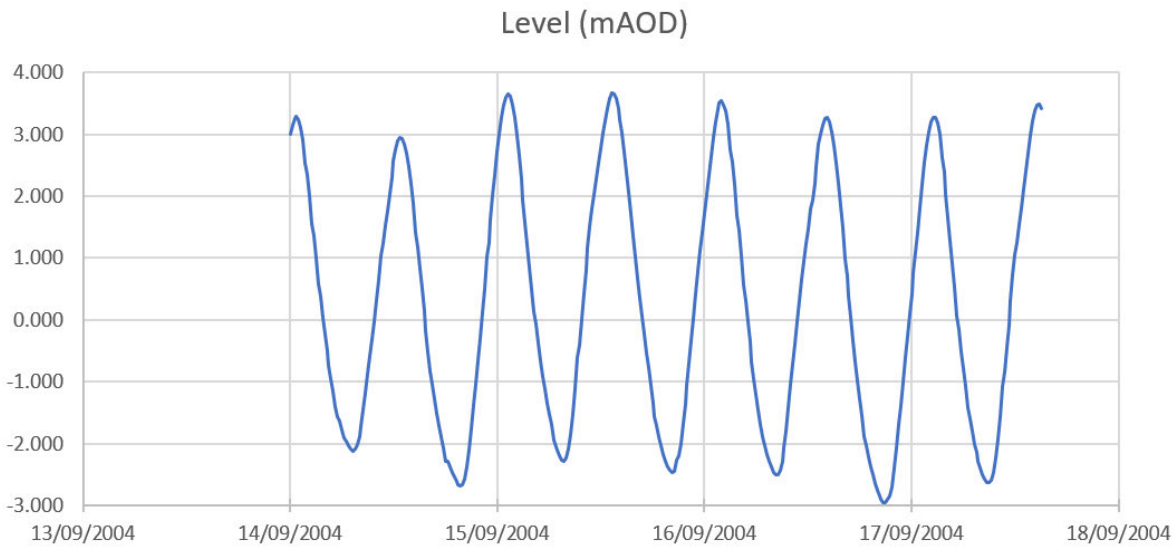

Plate 4: Mean high water spring tidal cycle at Coalhouse Point

To prevent unacceptable inundation of the land behind the flood defence, a mechanism would be required to control and/or stop water inflow once the mitigation features are filled to the required water level (HR010). Plate 5 illustrates a self-regulating tidal gate structure that has been used in similar situations and would likely be used on this proposal.

Plate 5 Self regulating tide gate at Seaton in Devon (Figure 3.6 in https://assets.publishing.service.gov.uk/media/6033a8f5e90e076607c1bf0e/Self-regulating_tide-gate_a_new_design_for_habitat_creation_technical_report.pdf)

Construction Method

The following sections describe the envisaged construction method required for the installation of the structure within the footprint of the existing flood defence. It is envisaged that in total construction would be up to 12 weeks in duration.

It is assumed that all works within the intertidal area would be restricted to periods of low water.

Construction and excavation of coffer dam

A sheet-piled coffer dam would be constructed to isolate the section of the flood defence in which the structure is to be installed. Isolation via the coffer dam allows the flood defence to be "breached" for the installation of the structure.

Piling works for the coffer dam would be undertaken from a dumb barge with spud legs or anchors on winches, with a 30 to 50 tonne 360 excavator and a multi cat that has a 5 tonne lifting capacity to set anchors as required.

The main piling barge may be serviced by a second dumb feeder barge carrying sheet piles. Alternatively, depending on the final siting of the sluice structure, servicing could be achieved via crane access from the landward side of the defence.

The short sheet piles would be vibro-piled into place (circa 6m "driven" in 4m below trench base) with small vibrating hammer (https://www.omsvibro.com/products/vibratory-hammers/excavator-mounted/). Sheet piling would be installed along either side of the proposed working area forming the coffer dam. Indicatively, the coffer dam would be approximately 10m x 15m, and would not extend beyond the maximum working area defined for the construction works. Excavation of the section of flood defence would take place within the coffer dam to the required depth.

Excavated arisings would be retained within the coffer dam or stored on a support barge or on land. Arisings would not be side cast within the inter-tidal area.

Assumed plant required for construction:

- Dumb barge/Jack up barge/pontoon
- Vibrating Hammer attachment on an excavator, or similar
- Crane – if servicing from land
- Excavator
- Multi Cat with lifting capacity
- Supply barge (for sheetpiles)

Installation of structure

The proposed structure selected to convey the water flow would be installed in the location of the flood defence "breach". Due to uncertainty over ground conditions, this may require additional foundation works and therefore piling has been assumed.

Assumed plant required for construction:

- Dumb barge/Jack up barge/pontoon
- Mini piling rig – on the barge
- Supply barge for precast piles and other materials
- Crane
- Excavator
- Compressor and small tools

Reinstatement

Following the installation of the structure the flood defence would be reinstated / back filled to maintain continuity of the defence around the new structure and maintain the existing public right of way. The sheet piled coffer dam would be removed and any areas excavated back filled as required.

Assumed plant required for construction:

- Dumb barge/Jack up barge/pontoon
- Supply barge
- Excavator
- Multi Cat with lifting capacity

Decommissioning

It is assumed that the structure would be permanent, due to its role in supporting HRA and ecology mitigation. Therefore, decommissioning of the asset would not be assessed.

Secondary Consents and Stakeholder Engagement

Secondary consents

- Deemed Marine Licence
- Preliminary Navigational risk assessment
- River works licence
- Abstraction licence
- Flood Risk Activity Permit

Stakeholders

- Port of London Authority
- Environment Agency
- Marine Management Organisation
- Thurrock Council (as other flood defence owner)
- Natural England
- National Highways
- Landowner

Annex B LTC technical note considerations of in combination development within traffic modelling

LTC Technical Note: Consideration of in combination development within traffic modelling

1. Introduction

1.1. During engagement on the assessment of air quality effects of LTC on ecological receptors, Natural England has asked for confirmation that LTC's traffic model has included all of the growth proposed in the relevant local plans which will use the affected road network?

1.2. Following discussion on this, part of the answer to that question is that the same growth factors have been used by LTC and local plans to generate their understanding of development and so LTC has effectively considered the same level of growth that would use the road network as have the LPAs. Natural England has further asked that if the same growth factors have been used as the local plans, why are there significant differences in the findings of LTC and the LPAs (in particular Maidstone)?

1.3. We have set out below a summary of the engagement so far; a summary of how the methodology has included growth; an explanation of the apparent inconsistences between LTC and LPA HRAs; and a concluding statement confirming that LTC has included all the growth proposed in the relevant local plans.

2. Previous Engagement

2.1. Engagement has included the shared draft documents and calls summarised below:

Table 2.1 Previous Engagement

Engagement	Date	Notes
Consultation	10/10/2018	Statutory Consultation, including Traffic Non-Technical Summary
HRA Meeting	19/12/2019	Discussion on traffic modelling and in combination data used
HRA Meeting	16/01/2020	Discussion on traffic modelling and in combination data used
HRA Meeting	07/02/2020	Update on HRA development including briefing on traffic and air quality.
Methodology	26/02/2020	Air quality assessment methodology
Evidence Base	26/02/2020	HRA Evidence base
Traffic Modelling Meeting	31/03/2020	Overview of traffic model methodology and inclusion of future projects and developments
Consultation	02/04/2020	Supplementary Consultation, including Traffic Modelling Update
HRA Meeting	13/05/2020	Discussion on traffic modelling methodology
Methodology	22/05/2020	In combination methodology briefing
HRA Meeting	27/05/2020	Discussion on traffic modelling methodology

Technical Note	02/06/2020	Construction traffic modelling and air quality effects briefing
Report	13/07/2020	HRA SIAA draft report
Evidence Plan	06/08/2020	Evidence Plan
Report	10/09/2020	HRA Stage 1 Screening- Appendix H- LA 105 NEA001 Comparison
Presentation Slides	18/09/2020	HRA air quality consultation meeting 25/09/20 early sight slides- draft
Presentation Slides	24/09/2020	HRA air quality consultation meeting 25/09/20 early sight slides- final
Air Quality Meeting	25/09/2020	Air quality specialist meeting- discussion on in combination approach
SoCG Workshop 9	04/11/2020	Discussion on traffic model
Technical Note	12/02/2021	Summary of LTC consultation and air quality effects to date
Consultation	14/07/2021	Community Impacts Consultation, including traffic forecasts non-technical summary (Chapter 4 of the Operations Update)
Report	06/08/2021	Draft HRA Report
Evidence Plan	24/08/2021	HRA and EIA Evidence Plan: Air Quality effects from vehicle emissions
Evidence Plan	11/11/2021	HRA and EIA Evidence Plan: Air Quality effects from vehicle emissions
Technical Note	10/02/2022	Note on modelling approach for Designated Sites
SoCG Workshop 44	23/02/2022	Discussion on inconsequential NOx threshold- Maidstone LDP and the LTC traffic model assumptions
SoCG Workshop 46	26/04/2022	Discussion on Maidstone LDP and how it's been considered in LTC traffic model
SoCG Workshop 50	29/06/2022	Discussion on traffic TEMPro model- development and growth factors

3. Inclusion of development / growth in transport models

3.1. LTC's approach follows the DFT guidance on how to deal with traffic growth and future developments.

3.2. The level of traffic growth in each Middle Layer Super Output Area (MSOA) census area is forecast by the DfT using the National Trip End Model. In these forecasts, the main factor that determines the level of traffic growth is the predicted increase in population, as provided by the Office for National Statistics, the future demographic profile of the population, forecasts of GDP growth and levels of car ownership and drivers license holding.

3.3. The DFT provide the forecasts of the growth in traffic levels for each MSOA in software known as TEMPro. When using these forecasts in transport models DfT guidance allows for the inclusion of specific developments in a specific location if there is more specific spatial information about where the growth in an area will occur. A development can be included if there is a high degree of certainty, as shown by its progress through the planning system. However, the overall level of traffic growth in an area must be controlled in the traffic model to the levels of growth provided in the National Trip End model. The transport model is run for the do minimum scenario, i.e. with future growth and known new highway schemes and is then run again with the sole addition of the LTC (the Do Something Scenario).

3.4. This approach has the growth in traffic related to ONS population projections. Minor differences in local-scale location of developments would not significantly change the predictions of traffic on the wider road network that extends over a large area encompassing a number of Local Authorities. The model is therefore appropriate and precautionary for assessing effects on the affected road network.

3.5. In local plan modelling, Local Authorities test a whole range of local sites and usually include sites which do not end up being developed. Local plan modelling has a different purpose, to look at the local implications of growth in very specific locations and is often undertaken to assist in the decision-making process as to where the increasing population in an area might be housed. The modelling undertaken for LTC looks specifically and in detail at the difference a new crossing would make to traffic flows in Kent and Essex.

4. Apparent inconsistencies between LTC and LPA HRAs

4.1. There are a variety of reasons why two transport models may have different model flows e.g:

- Modelled years - the Lower Thames Area Model (LTAM), models a proposed opening year of 2030 and a design year of 2045. Maidstone may model different years. The model year affects the amount of growth included in the model, the change in the affordability of motoring and which planned highway schemes are included.
- It is not known how Maidstone has represented LTC in their model:
    - LTC makes a significance difference in the traffic flows in this area.
    - LTAM includes a variable demand module. This means that where people are travelling to and from varies.
    - LTC opens up the possibility of travelling to Essex with much quicker and more reliable journey times. A proportion of people in the Maidstone area will change where they are travelling to, and the roads they use once LTC opens.
    - It is important to have a model which covers both sides of the river in order to model the impact of LTC.
    - We don’t know how the impact of LTC has been modelled by Maidstone and have no record of them asking us for information about the predicted impacts of LTC on travel patterns in Kent.
- How the network has been coded for future years can vary between models
    - It is important to have junctions coded correctly including the traffic signal settings.

- In the future years we see the forecast flow of traffic and we optimise the traffic signal settings based on the new travel patterns. If the signals are not readjusted to accommodate the changed pattern of flows at key junctions, it results in long delays at the junctions, which has a knock-on impact on rat running to avoid the delays at the junctions which wouldn't happen in reality.
- Local Authorities include sites above their needs which do not end up being developed as they are allocated to ensure a range of sites is available to come forward.

4.2. As a general point, it would not be surprising for a small area model to have different predictions of flows on roads than the much larger LTAM.

4.3. LTC has not received any requests for information from Maidstone despite that LTC has a significant impact on travel patterns in the area. Gravesham, Dartford and Thurrock have used LTC's transport model as the starting point for their local plan modelling work. They identified that they needed to take into account LTC and decided that using extracts from the LTC transport model was the best way to do this.

5. Confirmation of approach

5.1. LTC confirms that LTAM is the definitive model for forecasting the level of traffic growth in the Lower Thames area and the impact on travel patterns from opening LTC. It represents an appropriately precautionary method for the purposes of HRA.

5.2. LTC confirms that it considers any apparent inconsistencies between the HRAs of LTC and LPAs does not undermine the sufficiency of the LTC HRA, which has used the best available information to inform its HRA. Any apparent inconsistencies with Local Plans is due to the difference of the purpose and methods and not a matter of the robustness or precautionary nature of the LTC model.

Annex C Coalhouse Point e-mail update 24 February 2023

From: [redacted]
Sent: 24 February 2023 09:25
To: [redacted]
Cc: [redacted]
Subject: FW: LTC Coalhouse RTE installation timing & REAC

Hi [redacted],

Please see below further information as requested by [redacted]

The discussions on the Coalhouse Point habitat water supply and the related REAC commitments were had at the following SoCG meetings:

- 04.05.2022 – water supply options discussed and possibility of including a timing commitment for construction of a self-regulating tide gate
- 29.06.2022 – discussion of timing constraint commitment for construction of a self-regulating tide gate which included a wording change to construct where possible between April and August but not so that it prevented habitat creation prior to the commencement of works on the Northern tunnel entrance compound.
- 13.07.2022 – discussion of REAC commitments relating to the habitat creation water supply (HR010 and HR011) and an assessment of potential disturbance impacts of the tide gate construction had been completed and concluded no LSE even if works were undertaken in the overwintering period

The following paragraphs in the HRA report provides other related content:

- There is no REAC commitment to seasonally constrain the construction of the tidal gate or the wetland creation itself. Paragraph 7.1.28 sets out the good practice seasonal constraint.
- Paragraph 7.1.28 to 7.1.31 assess the potential effects of the tidal gate construction out of good practice window and determines no LSE. The contractor will have to programme the works to fit his tunnelling programme and the tidal gate may not need to be constructed overwinter but if it does the works are so short term and localised that no LSE are predicted.

Regards

[redacted]

[redacted]

Jacobs Challenging today. Reinventing tomorrow.

Annex D Underwater noise e-mail update 24 April 2023

Sam Ireland

From: [redacted]
Sent: 24 April 2023 16:38
To: [redacted]
Cc: [redacted]
Subject: Coalhouse Point & Underwater Noise

Hi [redacted],

On the last SoCG call, we promised to clarify two elements of the assessment to help inform the SoCG discussions, relating to:

- Assessment of disturbance from construction of the tidal gate at Coalhouse Point
- Underwater noise and effects on birds

Assessment of disturbance from construction of the tidal gate at Coalhouse Point
We inadvertently misled you on the call by saying that the assessment of disturbance from the construction of the tidal gate was given to you in a technical note separate from the HRA report. This is not the case I'm afraid, we assess the disturbance of the tidal gate within the HRA report as submitted. For ease of reference, please see APP-487 "6.5 Habitats Regulations Assessment - Screening Report and Statement to Inform an Appropriate Assessment" on the PINS website https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR010032/TR010032-001776-6.5%20Habitats%20Regulations%20Assessment%20-%20Screening%20Report%20and%20Statement%20to%20Inform%20an%20Appropriate%20Assessment.pdf

Please see paragraphs 7.1.27 to 7.1.31 in the mitigation section that reports the discussion on whether the construction of the tidal gate would add significantly to the overall disturbance for which the habitat creation (including the tidal gate) would be mitigation.

Figure 18 shows the bird distribution overlaying the noise (unmitigated) and visual zones of influence that are used in the assessment, which includes the construction of the tidal gate (the label on the drawing highlights the location)

Figure 26 shows the bird distribution overlaying the noise zone of influence with the noise attenuation mitigation in place.

Hopefully this clarifies that the construction of the tidal gate has been assessed in the submitted HRA, and that it would be unlikely that any significant disturbance would result due to the temporary nature and limited zone of influence of those works alone.

Underwater noise and effects on birds
Our position is that the submitted conclusion of no LSE from underwater noise is robust, being predicated primarily on there being no pathway to an effect and that this is evidenced by the modeling showing that the noise generated by the TBM is less than the background and therefore not perceivable. It is therefore the case that irrespective of the sensitivity of birds or their prey, there could be no LSE. Your advice suggests that stage 2 AA is more appropriate for this assessment as a lot of work has been done on thinking through the sensitivity of birds' hearing and concluding that any assessment of cetaceans would be an appropriate proxy for assessing effects from any change to noise stimuli. Our position is that we have done that thinking in response to your comments / advice and that the HRA does not rely on this, so having responded to your comments / questions we still consider the submitted HRA to be robust.

The relevant paragraphs in the HRA are 6.2.24 to 6.2.28. This submitted assessment uses the lack of pathway from an imperceptible noise as the argument for an inconsequential pathway to effect and no LSE alone or incombination. The definition of "inconsequential" used within the assessment is given in paragraph 2.5.13. There is a reference to a more detailed assessment of underwater noise provided in the Marine biodiversity chapter of the ES, but the HRA assessment does not rely on that to conclude no LSE.

Hopefully this clarifies why we maintain the position that the conclusion of no LSE is robust, and it is not necessary to take the pathway through to stage 2 AA.

Please do let us know if you have any further questions or comments.

Kind regards,

[redacted]

[redacted]

[redacted]

[redacted]

National Highways Customer Contact Centre:
0300 123 5000

www.nationalhighways.co.uk

Annex E1 Air Quality Methodology briefing note

Air Quality Methodology

AIM – To set out the proposed process to determine how the Project will result in habitat degradation as a result of the changes in air quality impact pathway and whether this effect (loss of habitat area) will result in an adverse effect on the integrity of the European sites.

<table>
<tr><th colspan="2">Simple or detailed assessment</th><th>Guidance/ Methodology</th></tr>
<tr><td>Does the project trigger any of the traffic scoping criteria for any road in the TRA where there are receptors within 200m? ↓</td><td>No – AQ assessment scoped out. Record decision. No requirement for further assessment</td><td rowspan="4">Highways England, DMRB LA 105 Air Quality (2019) Figure 2.10</td></tr>
<tr><td>Yes – Is there sufficient baseline air quality data to undertake an assessment? ↓</td><td>No – Write to Overseeing Organisation with justification to undertake additional monitoring</td></tr>
<tr><td>Yes- Identify project lifecycle stage:

Detailed Design – Assess the potential for the project to impact on traffic and the sensitivity of the receiving environment.

<table>
<tr><th rowspan="2">Risk potential of project</th><th colspan="4">Receiving environment sensitivity</th></tr>
<tr><td>Risk</td><td>High</td><td>Medium</td><td>Low</td></tr>
<tr><td>High</td><td>detailed</td><td>detailed</td><td>simple</td></tr>
<tr><td>Low</td><td>detailed</td><td>simple</td><td>simple</td></tr>
</table>

Option Stage – Simple assessment required. Where a detailed assessment is proposed, write to the Overseeing Organisation with justification.</td><td>-</td></tr>
<tr><td colspan="3"></td></tr>
<tr><th colspan="3">Assessment of significant effects on designated sites</th></tr>
<tr><td>Calculate the Do Minimum and Do Something project N deposition. Is the total N deposition with the project less than the applicable lower critical load? ↓</td><td>Yes – Not significant</td><td>Highways England, DMRB LA 105 Air</td></tr>
</table>

No – **Is the change in N deposition with and without the project less than 1% of the lower critical load?** → Yes – Not significant ↓		Quality (2019) Figure 2.98 (Natural England, NEA001 , 2018)
No – Identify whether the site air quality attribute is either restore or maintain: Restore – Use the lowest change in N deposition regardless of background N deposition which would bring about a change of a loss of 1 species corresponding to the lower critical load range. Maintain – Use change values to bring about loss of 1 species corresponding to background N deposition.	-	
Does the change in N deposition associated with the Project lead to the loss of 1 species? → No – Not significant ↓		
Yes – Undertake detailed site investigation. **Are there species located in the area where the assessment has determined an increase in N deposition that could lead to loss of 1 species?** → No – Not significant ↓		
Yes – **Will a Project Air Quality Action Plan (PAQAP) be effective in reducing the impact of the Project so the N deposition increase does not trigger a loss of 1 species?** → Yes – Not significant ↓		
No – Likely Significant Effect	-	
Assessment of integrity of site (loss of habitat area available through effects of AQ change)		
Construction		
AQ Modelling - **What will the AQ change be at the European Site locations within 200m of the ARN during construction?**[1] → No change/improvement – (no LSE) no further assessment required. ↓		AQ assessment (model as per DMRB LA105) to supply NOx and Nutrient nitrogen deposition for European sites.

[1] Distance of 200m from affected road boundary included within Highways England, DMRB LA 105 Air Quality (2019) and NEA001 (Natural England, 2018).

Negative change - Is the ecology receptor within 50m of the boundary of the site; or 50m of the route(s) used by construction vehicles on the public highway, up to 500m from the site entrance(s)? ↓ →	No – level of risk to ES is defined as being "negligible", meaning any effects will not be significant. Conclude no adverse effect on integrity of European site.	(IAQM, 2014)
Yes – further assessment required. **What dust generating activities are due to occur in this area? What habitat is located within this area?** ↓	-	(IAQM, 2014)
Apply best practice (embedded) mitigation measures (i.e. restricting dust, emissions, barriers etc.) to identified activities. **Do these measures ensure that dust/ nitrogen emissions will not cause significant changes in air quality (increase less than 1% of lowest range of critical load)?**[2] ↓ →	Yes – Conclude no LSE (alone[3]) and therefore no adverse effect on integrity of European site	(IAQM, 2014)
No – likely adverse effect on European site habitat area and therefore integrity of site.[4]		
Operation		
AQ Modelling - **What will the AQ change be at the European Site locations within 200m of the ARN during operation?** ↓ →	No change / improvement – Conclude no adverse effect on integrity of European site.	AQ assessment (model as per DMRB LA105) to supply NOx and Nutrient nitrogen deposition for European sites.
Increase in NOx / nitrogen deposition - **What is the total deposition rate (critical load) at each receptor from the Air Pollution Information System?** ↓	-	APIS website (APIS, n.d.)
Where predicted changes in NOx or nitrogen deposition exceed the critical load[5] for a habitat, then the magnitude of change in nitrogen between the Do-Minimum (DM) and Do-something (DS) scenarios to be considered. 'Imperceptible impact' – less than or equal to 1% of the critical load (not →	No – Conclude no LSE or adverse effect on integrity of European site.	Highways England, DMRB LA 105 Air Quality (2019)

[2] Average annual daily flow (AADT) screening threshold (1000 AADT for traffic numbers or 1% of the critical load) for likely significant effect (Highways England, 2019a). Also advocated in NEA001 (Natural England, 2018).
[3] Where proposal is below the screening threshold 'alone' then same screening threshold to be considered 'in-combination' with other plans/projects that would also increase traffic on the same roads or other non-road plans and projects (NEA001 - Natural England, 2018).
[4] Applying IAQM guidance would normally reduce dust effects to an insignificant level
[5] Where relevant high end of critical range could be used (e.g. where weather conditions appropriate)

significant). **Does the change in nitrogen deposition between DM and DS exceed 1%?** ↓		(Natural England, NEA001 , 2018)
Yes (potential for LSE) – **How close to roadside exceedances of critical level for NOx are predicted to occur (e.g. 10m)?** Identify and map (GIS) habitat types within ES within XXm of the affected road (where exceedances predicted e.g. 10m). **What is the composition (habitats/species) of the area affected by AQ change?** ↓	-	Up to date ecological information - Phase 1 and NVC habitat surveys (conducted for the project or projects covering same area). UK HAB to level 5 Aerial imagery and OS Mapping
Is the habitat affected either a qualifying feature, or does it support a qualifying feature of the European Site?[6] → ↓	No – Conclude no adverse effect on integrity of European site	-
Yes - Is the European Site and/or the habitat affected sensitive to air pollution, either directly or indirectly? → ↓	No – Conclude no adverse effect on integrity of European site	Review the SSSI unit data to determine habitat composition present in area affected.
Yes – consider the following determining factors: What conditions is the habitat affected currently exposed to (e.g. existing exceedance of critical load)?[7] What is the area and quality of the habitat affected as a proportion of the qualifying habitat within the European Site?	-	Collate NE designated sites information for SSSI unit condition/ risks Survey data

[6] For example "hard surface of a road and/or its adjacent verge might simply have been unavoidable when denoting a boundary (for a European Site) and included simply for convenience. These areas will therefore constitute 'site-fabric', being of no special nature conservation interest" (NEA001- Natural England, 2018).
"If none of the site's sensitive qualifying features known to be present within 200m are considered to be at risk due to their distance from the road, there is no credible risk of a significant effect which might undermine a site's conservation objectives" NEA001- Natural England, 2018.

[7] "Small contributions of nitrogen deposition from the air have the potential to lead to more significant changes in vegetation composition where a site is below but near to the Critical Load, compared to a site which significantly exceeds a critical load." NECR210, Natural England 2016 as referenced in NEA001.
"Habitats that have already been subject to high background nitrogen deposition can develop an effective tolerance to the effects of further deposition." NECR210, Natural England 2016 as referenced in NEA001.

Will there be any direct loss of habitat or change to the distribution of such habitats?

Are nitrogen deposition / NOx operation changes predicted below the current baseline deposition levels? (e.g. due to technological improvements in vehicle emissions between now and the time the scheme is operational)

Determinative Factor	Decreased likelihood of integrity loss	Increased likelihood of integrity loss
Existing exceedance of critical load in affected habitat	✓	X
Low proportion of European Site affected	✓	X
Affected habitat in 'poor' condition (less than favourable status)	✓	X
No direct loss to affected habitat or change to habitat distribution	✓	X
Predicted nitrogen deposition/ NOx changes below current baseline conditions	✓	X

Using professional judgement, taking into account the above determinative factors, will there be a reduction in habitat area that significantly contributes to the favourable conservation status of the European site? →	No – Conclude no adverse effect on integrity of European site	-
↓ Yes – Conclude there would be an adverse effect on the integrity of the European site (proceed to stages 3-5)	-	-
Other contributory factors to be considered for cumulative adverse effects on integrity of European site		
Are there any additional impact pathways that may cause a reduction in habitat area?	-	-
Is there any potential for in-combination effects other projects to in combination cause a loss of integrity to the ES?	-	-

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Highways England. (2019b). Design Manual for Roads and Bridges Volume 11 Section 3 Part 1. *LA 115 Habitat Regulations Assessment Revision 1*.

IAQM. (2014). Institute of Air Quality Management. *Guidance on the assessment of dust from demolition and construction. Version 1.1*.

Natural England. (2016). Commissioned Report NECR210. *Assessing the effects of small increments of atmospheric nitrogen deposition (above the critical load) on semi-natural habitats of conservation importance*.

Natural England. (2018, June). NEA001 Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitat Regulations. NE Internal Guidance.

Annex E2 Feedback received by email from Natural England

Air Quality Methodology

AIM – To set out the proposed process to determine how the Project will result in habitat degradation as a result of the changes in air quality impact pathway and whether this effect (loss of habitat area) will result in an adverse effect on the integrity of the European sites.

<table>
<tr><th colspan="2">Simple or detailed assessment</th><th>Guidance/ Methodology</th></tr>
<tr><td>Does the project trigger any of the traffic scoping criteria for any road in the TRA where there are receptors within 200m? ↓</td><td>No – AQ assessment scoped out. Record decision. No requirement for further assessment</td><td rowspan="3">Highways England, DMRB LA 105 Air Quality (2019) Figure 2.10</td></tr>
<tr><td>Yes – Is there sufficient baseline air quality data to undertake an assessment? ↓</td><td>No – Write to Overseeing Organisation with justification to undertake additional monitoring</td></tr>
<tr><td>Yes- Identify project lifecycle stage:

Detailed Design – Assess the potential for the project to impact on traffic and the sensitivity of the receiving environment.

<table>
<tr><th rowspan="2">Risk potential of project</th><th colspan="4">Receiving environment sensitivity</th></tr>
<tr><td>Risk</td><td>High</td><td>Medium</td><td>Low</td></tr>
<tr><td>High</td><td>detailed</td><td>detailed</td><td>simple</td></tr>
<tr><td>Low</td><td>detailed</td><td>simple</td><td>simple</td></tr>
</table>

Option Stage – Simple assessment required. Where a detailed assessment is proposed, write to the Overseeing Organisation with justification.</td><td>-</td></tr>
<tr><th colspan="3">Assessment of significant effects on designated sites</th></tr>
<tr><td>Calculate the Do Minimum and Do Something project N deposition. Is the total N deposition with the project less than the applicable lower critical load? ↓</td><td>Yes – Not significant</td><td>Highways England, DMRB LA 105 Air</td></tr>
</table>

Commented [HS1]: As mentioned during the meeting in March, Natural England's, having checked with our national specialists, our advice to Highways England remains that the consideration of air quality impacts should be in accordance with our published guidance 'Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations (NEA001)' http://publications.naturalengland.org.uk/publication/4720542048845824 rather than DMRB LA105. Following the national discussions between Natural England's and Highways England's national teams, I understand our colleagues are awaiting responses to a number of concerns and queries regarding the difference in approach within DMRB LA105 and our NEA001 guidance. Given the ongoing discussions and concerns at a national level, our advice remains that the HRA and air quality assessment for this project should follow the NEA001 published guidance.

Commented [CR2]: Are similar tables for atmospheric NOx and NH3 required?

No – **Is the change in N deposition with and without the project less than 1% of the lower critical load?** ↓	Yes – Not significant	Quality (2019) Figure 2.98 (Natural England, NEA001 , 2018)
No – Identify whether the site air quality attribute is either restore or maintain: Restore – Use the lowest change in N deposition regardless of background N deposition which would bring about a change of a loss of 1 species corresponding to the lower critical load range. Maintain – Use change values to bring about loss of 1 species corresponding to background N deposition.	-	
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Yes – **Will a Project Air Quality Action Plan (PAQAP) be effective in reducing the impact of the Project so the N deposition increase does not trigger a loss of 1 species?** ↓	Yes – Not significant	
No – Likely Significant Effect	-	
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AQ Modelling - **What will the AQ change be at the European Site locations within 200m of the ARN during construction?**[1] ↓	No change/improvement – (no LSE) no further assessment required.	AQ assessment (model as per DMRB LA105) to supply NOx and Nutrient nitrogen deposition for European sites.

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<tr><td>Will there be any direct loss of habitat or change to the distribution of such habitats?

Are nitrogen deposition / NOx operation changes predicted below the current baseline deposition levels? (e.g. due to technological improvements in vehicle emissions between now and the time the scheme is operational)

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<tr><th>Determinative Factor</th><th>Decreased likelihood of integrity loss</th><th>Increased likelihood of integrity loss</th></tr>
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<tr><td>Low proportion of European Site affected</td><td>✓</td><td>X</td></tr>
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<tr><td>No direct loss to affected habitat or change to habitat distribution</td><td>✓</td><td>X</td></tr>
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</table>
</td><td></td><td></td></tr>
<tr><td>Using professional judgement, taking into account the above determinative factors, will there be a reduction in habitat area that significantly contributes to the favourable conservation status of the European site?</td><td>No – Conclude no adverse effect on integrity of European site</td><td>-</td></tr>
<tr><td>Yes – Conclude there would be an adverse effect on the integrity of the European site (proceed to stages 3-5)</td><td>-</td><td>-</td></tr>
<tr><td colspan="3">Other contributory factors to be considered for cumulative adverse effects on integrity of European site</td></tr>
<tr><td>Are there any additional impact pathways that may cause a reduction in habitat area?</td><td>-</td><td>-</td></tr>
<tr><td>Is there any potential for in-combination effects other projects to in combination cause a loss of integrity to the ES?</td><td>-</td><td>-</td></tr>
</table>

Bibliography

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Natural England. (2016). Commissioned Report NECR210. *Assessing the effects of small increments of atmospheric nitrogen deposition (above the critical load) on semi-natural habitats of conservation importance*.

Natural England. (2018, June). NEA001 . *Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitat Regulations*. NE Internal Guidance.

Annex F1 Methodology for the assessment of in-combination effects

Methodology for the assessment of In-combination Effects

Identifying the need for In-combination assessment

Stage 1 Screening

The in-combination assessment will be completed for the stage 1 screening for all effect pathways for which LSE alone can be discounted, but the effect alone would not be absent or could not be classed as nugatory (i.e. would be incapable of adding appreciably to other effects).

Based on preliminary conclusions on the potential/risk of LSE at Screening:

i. Effect pathways requiring in-combination assessment at screening because no LSE alone concluded are:
   - Changes in air quality from the operation phase affected road network.

ii. Effect pathways not requiring in-combination assessment at screening because effects are either absent or nugatory are:
   - Vessel collision
   - Change in air quality - vehicle emissions – construction
   - Change in air quality - vessel emissions – construction river transport
   - Changes in light levels – operation
   - Change in recreational pressure – construction and operation
   - Changes in surface water quality and quantity – construction and operation
   - Vehicle collision
   - Utilities infrastructure collision
   - Change in air quality - dust emissions - construction
   - Changes in noise & vibration - tunnel construction only
   - Changes in light levels – construction
   - Changes in groundwater quality and quantity - tunnel construction and operation
   - Disturbance as a result of operation

Stage 2 Appropriate Assessment

All effect pathways that are taken forward to stage 2 appropriate assessment will require an in-combination assessment. Based on preliminary conclusions from Screening, the Stage 2 Appropriate Assessment will assess (and therefore require in-combination assessment) the following pathways:

- Land take in terrestrial and aquatic environment
- Disturbance as a result of construction

Projects to be included in the in-combination assessment

For each relevant effect pathway, a specific area around each European site was defined and searched to identify other plans and projects that could contribute to the effect in combination with the Project.

Past projects and projects for which potential effects are fully determined were included in the environmental baseline and will not feature in the in-combination assessment. Rejected and withdrawn planning applications were also not included in the in-combination assessment as they are not considered to be reasonably foreseeable developments.

The list of reasonably foreseeable plans and projects is based on Advice Note 17 (The Planning Inspectorate, 2019), with the following types of development considered:

a. Projects that are under construction

b. Permitted application(s) not yet implemented

c. Submitted application(s) not yet determined

d. All refusals subject to appeal procedures not yet determined

e. Projects on the National Infrastructure's programme of projects

f. Projects identified in the relevant development plans and emerging development plans

Stage 1 Screening In-combination – detailed methodology

Changes in air quality from the operation phase affected road network.

Search Area

The contribution of changes in traffic from other plans or projects have already been considered with the "alone" assessment as the data used within the traffic model includes the predicted changes in traffic from other plans and projects. The scope of the in-combination assessment for this effect pathway will consider other potential sources of nitrogen deposition. Other plans and projects that potentially contribute to nitrogen deposition in ways other than traffic (and could be identified via a permitting system) would be broadly limited to industrial processes and intensive agricultural units. Both of these types of development are given permission (at least in part) via Environment Agency permitting.

The size of search area has been determined based on the advice given by the Environment Agency for assessing risks for your environmental permit (Environment Agency, 2020) and includes project types within the following distances from each European Site:

- 10km - Industrial emissions, e.g. energy generation plants
- 5km – intensive livestock units
- 500m - agricultural biomass boilers

Assessment method

Results will be presented in a table, similar to the examples shown in Table 1 below, for each of the European Sites where the projects identified have provided nitrogen deposition data for the European site in question.

Table 1: Information used to determine the combined nitrogen deposition on each European site

Site	Projects within the search area N deposition (Kg N ha^{-1} yr^{-1})			Background N Deposition (Kg N ha^{-1} yr^{-1})	Combined N deposition (Kg N ha^{-1} yr^{-1})
	LTC Project	Project 1	Project 2		
European Site name				Taken from APIS site relevant critical loads (average deposition for relevant feature)	

The combined contribution to nitrogen deposition are calculated by summing together the predicted nitrogen depositions (kg N ha-1yr-1) for each of the projects within the search area and determining the % of the critical load for the habitats of each site. The likelihood of LSE of all the projects in combination will be determined based on the combined figure with consideration given to the likely sensitivity of the habitats present and the use of those by the bird species in the case of the SPA sites.

Stage 2 Appropriate Assessment In-combination – Detailed methodology

Land take in terrestrial and aquatic environment disturbance (from construction)

Project land take effects functionally linked land (supporting habitat) used by bird features of SPAs and Ramsars. In-combination assessment of land take therefore only requires identification of other projects and plans that would also result in additional land take of supporting habitat types.

Search area

The supplementary advice (Natural England, 2019; Natural England, 2017; Natural England, 2018; Natural England, 2016) for the potentially affected European sites, (see Appendix 1 for relevant sections), provides targets for the type, extent of supporting habitat for the features e.g. mudflat, saltmarsh, coastal lagoon, etc. Therefore, in-combination effects from other plans or projects are considered to be when the combined habitat loss would prevent the targets being achieved for these habitats. In-combination projects that require assessment are those projects within the areas where these habitats are most likely to occur, i.e. within the estuary and coastal environment.

The qualifying birds potentially affected by the Project alone have a generic range of 20km. Therefore, a 20km area around the Project will be searched to identify any NSIP projects proposed within estuarine or coastal environments and therefore have potential to contribute to in-combination effects. Projects that are generally permitted via the local planning system are unlikely to be of a type that would be within the coastal zone, e.g. residential, however the area within 10km of the Project will be searched for any projects where the habitat types listed in the supplementary advice could be impacted.

Assessment method

The list of projects will be reviewed in terms of habitat loss from developments and compared with the attributes and targets relating to supporting habitat in the supplementary advice to provide a measure of likely prevention of achieving the targets and therefore have an effect on the integrity of the identified European site.

Disturbance as a result of construction (visual stimuli and noise & vibration- construction)

Search area

The supplementary advice for the potentially affected European sites with regards to disturbance related attributes/ targets indicated that the key areas of disturbance risks are associated with recreational disturbance and disturbance (in particular by dogs) within the intertidal areas. Therefore, the in-combination assessment for the Project will focus on considering any combined disturbance from other projects' construction within 300m (Cutts, et al., 2013) of intertidal areas within an adjacent or concurrent time frame to the Project.

Other projects with potential for in-combination effects of disturbance will be considered as those construction activities that could affect the same area as potentially affected alone by The Project. This will be based on other projects that are within a precautionary 1km of the Order limits (i.e. over three times the zone of influence for disturbance (300m)).

Assessment method

The time line of projects taken from the cumulative effects list will identify potentially important construction phases as well as noise levels and visual stimuli within the 300m zones.

	Construction period															
Project	2020 Q1	Q2	Q3	Q4	2021 Q1	Q2	Q3	Q4	2022 Q1	Q2	Q3	Q4	2024 Q1	Q2	Q3	Q4
LTC project																
Project X																
Project Y																

Any spatial and temporal overlaps will be considered in terms of the season, the use of habitats effected, and the activities proposed. The assessment will consider the potential effects on the individual birds and the likely proportion of the European site populations affected at any one time and therefore consider whether there is an adverse effect on integrity.

References

Cutts, N., Hemmingway, J. & Spencer, K., 2013. *Waterbird Disturbance & Mitigation Toolkit Version 3.2.* [Online]
Available at: https://www.tide-toolbox.eu/tidetools/waterbird_disturbance_mitigation_toolkit/
[Accessed 2 Dec 2019].

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[Accessed 15 May 2020].

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[Accessed 23 Apr 2020].

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https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK9012031&SiteName=Medway%20Estuary%20and%20Marshes&SiteNameDisplay=Medway+Estuary+and+Marshes+SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=11
[Accessed 23 Apr 2020].

Appendix 1: Information from the Supplementary Advice that will be used for the in-combination assessment of land take

Site	Target
Thames Estuary and Marshes SPA	Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of the non-breeding/wintering period (moulting, roosting, loafing, feeding) at: Intertidal sand and muddy sand 1.16 ha; Intertidal mixed sediment 0.61 ha; Coastal reedbeds 30.83 ha; Coastal lagoons 136.64 ha; Freshwater and coastal grazing marsh 1126.11 ha; Saltmarsh 108.14ha.
Medway Estuary and Marshes SPA	Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of its breeding cycle (courtship, nesting, feeding) to: Intertidal mud: 3154 ha, Intertidal sand and muddy sand: 0.6 ha, Saltmarsh: 852 ha, Freshwater and coastal grazing marsh: 644 ha, Coastal lagoons: 7 ha, Intertidal coarse sediment (extent unknown), Intertidal mixed sediments (extent unknown), Water column (extent unknown)
Benfleet and Southend Marshes SPA	Restore the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of the non-breeding/wintering period (moulting, roosting, loafing, feeding) to: Atlantic salt meadows Glauco-puccinellietalia maritimae, Salicornia and other annuals colonising mud and sand, and Spartina sward Spartinio maritimae174.41ha; Freshwater and coast grazing marsh: 47.40ha; Intertidal course sediment: 22.17ha; Intertidal mixed sediments: 1.01ha; Intertidal mud: 487.51ha; Intertidal sand and muddy sand: 396.40ha; Intertidal seagrass beds: 111.44ha; Water column: extent unknown

Annex F2 Feedback received from Natural England

Date: 30 June 2020
Our ref: 320681
Your ref: -

Customer Services
Hornbeam House
Crewe Business Park
Electra Way
Crewe
Cheshire
CW1 6GJ

T 0300 060 3900

[redacted]
Lower Thames Crossing

By email only, no hard copy to follow

Dear [redacted]

Lower Thames Crossing
Habitats Regulation Assessment Screening Report and associated reports/briefing papers

Thank you for seeking Natural England's views on the Habitats Regulations Assessment Screening Report and associated documentation for the Lower Thames Crossing scheme which [redacted] and I have reviewed. This advice is being provided as part of Natural England's Discretionary Advice Service and is based upon the information within the following documents:

- Lower Thames Crossing Habitats Regulations Assessment Stage 1 Screening Report dated 2 June 2020
- Approach to climate change assessment briefing paper dated 21 May 2020
- Briefing on construction traffic modelling and air quality effects dated 3 June 2020
- Habitats Regulations Assessment - Methodology for the assessment of In-combination Effects dated 21 May 2020
- Ornithology baseline plans to inform the Habitats Regulations Assessment dated 18 May 2020
- Figure 28 Areas of potential habitat loss within the functionally linked land dated 22 May 2020
- Mitigation and monitoring briefing note dated 10 June 2020
- Land take methodology briefing note dated 10 June 2020
- Epping Forest Botanical Survey Report dated 29 May 2020

For ease, I have provide comments on each document in separate sections in Annex One appended to this letter although in some cases there is overlap between the documents. Detailed comments in relation to the potential for traffic generated air quality impacts to Epping Forest Special Area of Conservation and the Botanical Survey are provided in Annex Two.

In summary my advice is that further clarity, provision of the supporting/underpinning information and survey results is required to allow a better understanding of the likely significant effects that may result from this project. At present, it is not possible for me to concur with the conclusions of the Habitats Regulations Assessment Stage 1 Screening Report and this letter provides advice on the areas that should be considered further within any revised Screening Report and subsequent Stage 2 or appropriate assessment.

The advice provided in this letter has been through Natural England's Quality Assurance process. The advice provided within the Discretionary Advice Service is the professional advice of the Natural England adviser named below. It is the best advice that can be given based on the information provided so far. Its quality and detail is dependent upon the quality and depth of the information which has been provided. It does not constitute a statutory response or decision, which will be

made by Natural England acting corporately in its role as statutory consultee to the competent authority after an application has been submitted. The advice given is therefore not binding in any way and is provided without prejudice to the consideration of any statutory consultation response or decision which may be made by Natural England in due course. The final judgement on any proposals by Natural England is reserved until an application is made and will be made on the information then available, including any modifications to the proposal made after receipt of discretionary advice. All pre-application advice is subject to review and revision in the light of changes in relevant considerations, including changes in relation to the facts, scientific knowledge/evidence, policy, guidance or law. Natural England will not accept any liability for the accuracy, adequacy or completeness of, nor will any express or implied warranty be given for, the advice. This exclusion does not extend to any fraudulent misrepresentation made by or on behalf of Natural England.

I trust these comments are helpful, for clarity on any of the points in this letter please do not hesitate to contact me by email to [redacted] or by telephone on [redacted].

Yours sincerely

[redacted]

Annex One: Detailed advice in relation to the Habitats Regulations Assessment Screening Report and accompanying documents.

Lower Thames Crossing Habitats Regulations Assessment Stage 1 Screening Report

For the reasons details within this letter, at present it is not possible for me to concur with the conclusions within Table 1-1 that a likely significant effect can be ruled out for the designated sites for one or more of the potential impact pathways. Without being provided with the underlying information to support this statement, more detailed comments are likely to be provided once the environmental statement has been shared. As such, these matters may need to be considered further through the Habitats Regulations Assessment.

In relation to changes in recreational disturbance (Table 4-3 The potential impacts and ZoI [zone of influence] at construction and operation) within the Habitats Regulations Assessment Stage 1 Screening Report, it is concluded that there is no predicted change in usage of the public rights of way along the northern and southern sides of the estuary. During previous discussions, we have raised the need to consider whether recreational users would be displaced to other more tranquil sections of the coast due to the impacts from construction which could increase recreational disturbance to the coastal designated sites. Without being provided with the underlying information to support this statement, more detailed comments are likely to be provided once the environmental statement has been shared. As such, these matters may need to be considered further through the Habitats Regulations Assessment.

For the changes in surface water quality and quantity during construction, Table 4-3 highlights that the project design will be constructed in accordance with best practice and that no change is anticipated to the current situation. Within other advice letters provided through Natural England's Discretionary Advice Service, concerns have been raised regarding the southern construction compound discharge into the Thames Estuary and Marshes Ramsar Site (letter reference 320550 dated 25 June 2020) and the northern construction drainage and outfall (letter reference 320528 dated 25 June 2020). The advice in both of these letters recommended that further consideration and information was required and that the measures needed to be fully considered through the appropriate assessment. I would therefore recommend that the advice on the construction surface water drainage is considered further within the screening report and proceeds to the Stage 2 Appropriate Assessment Report as recommended in these advice letters.

Section 4.3.4 of the Screening Report refers to the embedded mitigation included within the Design Principles and the good practice and essential mitigation are included the Code of Construction Practice. Whilst the draft Code of Construction Practice has been shared with Natural England, it does not, at present, contain sufficient detail of the mitigation measures required and as such further, more detailed comments on the appropriateness or otherwise of these measures will need to be provided once this information is available.

For clarity, where a proposed development contains (or requires) specific measures intended to avoid or reduce the likely harmful effects on a European site or Ramsar Site, following the People over Wind ruling by the Court of the European Union, it may not be appropriate to rule out the potential for a likely significant effect to result at the screening stage – the ruling has confirmed that such embedded measures may need to be considered through an appropriate assessment. For this reason, my advice is that on the basis of the information supplied it is unclear whether all of the embedded measures referred to within the Screening Report and associated briefing papers have been provided to avoid/reduce impacts. Given the lack of clarity, it may be appropriate for such measures to be considered and confirmed by the competent authority, via an appropriate assessment, in accordance with the Conservation of Habitats and Species Regulations 2017 (as amended). Such measures that can avoid or reduce any likely harmful effects, can be considered as part of the appropriate assessment, to determine whether a plan or project will have an adverse effect on the integrity of the European site. The formal advice that Natural England is likely to provide at the statutory application stage is that it is a matter for the competent authority to decide whether an appropriate assessment of this proposal is necessary in light of the *People Over Wind* ruling.

In relation to lighting (Sections 4.3.12-15), whilst mention is made of the specific measures that will be deployed along the Thames to mitigate impacts to wildlife, no information is proposed for Construction Areas 3A and 3B which are in close proximity to the Ramsar Site and/or functionally linked land. Without the impact assessment within the environmental statement it is unclear whether there will be impacts to the designated site from these compounds and further comments are likely to be made at subsequent stages of the project. As such, the Screening Report may need to be updated to reflect any further comments at this stage.

Table 6-1 of the Screening Report details the potential pathways to result in a likely significant effect for the various designated sites. The potential for recreational users on both sides of the Thames to be displaced to other areas of the coast during the construction works has been highlighted as a potential impact pathway in discussions with the Lower Thames Crossing. Despite this, I note that changes due to recreational pressure has been screened out for all sites; in the absence of the supporting information within the environmental statement, it is likely that further comments will need to be made at subsequent stages of the application process. As such, the Screening Report may need to be updated to reflect any further comments at this stage.

In addition, I note that Table 6-1 has screened out the consideration of 'changes in surface water quality and quantity – construction' for the Thames Estuary and Marshes SPA and Ramsar Site. I have provided separate advice (letter reference 320550 dated 25 June 2020) on the potential impacts from the surface water drainage strategy for the southern construction compound. Discussions with the Lower Thames Crossing Project Team and my detailed advice letter for the discharge has highlighted the need to consider the discharge proposals through the Habitats Regulations Assessment as I do not consider that a likely significant effect can be ruled out on the information provided. Similar advice has been provided for the northern construction discharge proposals. As such I would recommend that the Screening Report is amended to reflect this advice.

Previous advice provided through Natural England's Discretionary Advice Service has suggested that the areas of land identified as being functionally to the SPAs and Ramsar Sites may not reflect the full extent of such land in the area (please see my email of the 18 May 2020). The Screening Report appears to discount the arable land as being a significant component of the functionally linked land but in the absence of the supporting evidence (including historical ecological information), it is likely that more detailed comments will be made when the supporting information within the environmental statement is available. As such, the Screening Report may need to be updated to reflect any further comments at this stage.

The area of potential habitat loss within the functionally linked land plan does not appear to reflect the advice and recommendations provided in my email of the 18 May 2020. In summary, these advised on the need to consider areas of land in agriculture/horticulture, clarity on the survey results (similar to the comments above regarding the Ornithology baseline plans) and the use of historical survey information to inform the extent of functionally linked land. It would be helpful if clarity were provided on whether the work underpinning the area of potential loss of functionally linked land has fully considered these earlier comments. Based upon the information provided, it is likely that more detailed comments will be made when the supporting information within the environmental statement is available. As such, the Screening Report may need to be updated to reflect any further comments at this stage.

In relation to the project commissioned bird surveys (Sections 6.2.12-6.2.21), these provide some indication of the location and peak counts recorded during the surveys but provide limited information in relation to their spatial or temporal distribution (please see subsequent sections for further comments on the ornithological plans to support the Habitats Regulations Assessment). Based upon the information provided, it is likely that more detailed comments will be made when the supporting information within the environmental statement is available. As such, the Screening Report may need to be updated to reflect any further comments at this stage.

Section 6.2.32 of the Screening Report on details the habitat types with The Swale SPA and Ramsar Site, not the Medway Estuary and Mashes or the Thames Estuary and Marshes SPAs and

Ramsar Sites, all of which in part fall within 200metres of the affected road network and may be impacted by traffic generated air quality impacts (as confirmed in Section 6.3.14 of the Screening Report). It would be helpful to understand why these two sites have been omitted from this section.

Considering direct land take from within the Thames Estuary and Marshes Ramsar Site to facilitate the drainage for the southern construction compound, despite no details being provided on the nature of the structure to be installed, the additional working area required and any required ancillary areas of hard standing for maintenance, for example, the Screening Report confirms that 0.01 hectares will be lost. Notwithstanding the advice provided in the advice letter of the 25 June 2020 (letter reference 320550) regarding the need to consider alternative approaches, given the uncertainties around the design it would be helpful if further clarity on the direct land take and working area is provided before ruling out an effect. Where there is a direct impact to a designated site, these may need to be considered through an appropriate assessment and as such, the Screening Report may need to be updated to reflect any further comments at later stages of the consultation process.

Vehicle emissions are covered within Sections 6.3.13-19 of the Screening Report it is stated that within 200metres of the affected road network, the following sites were identified:

a. Epping Forest SAC
b. Medway Estuary and Marshes SPA and Ramsar Site
c. North Downs Woodlands SAC
d. Thames Estuary and Marshes SPA and Ramsar Site
e. The Swale SPA and Ramsar Site

I understand from the Screening Report that detailed air quality modelling was undertaken with total nitrogen deposition calculated at 10 metre intervals along a 200 metre transect perpendicular to the affected road network for each of these sites with a modified approach taken for Epping Forest SAC given the affected road is in a tunnel.

To help better understand the likely vehicle generated air quality impacts, it would be appreciated if plans could be provided (at a sufficiently detailed scale) for all of the designated sites listed above detailing where there is predicted to be an exceedance of 1% of the lower critical load. This will enable an appreciation of the contours and locations with respect to the designated site features as well as the area of the designated sites predicted to exceed the 1% critical load threshold. Unfortunately I have been unable to find such information in the documents shared to date.

For all of the sites detailed above, Section 6.3.17 confirms that the methodology follows the Design Manual for Roads and Bridges (DMRB) LA105 guidance. For the North Downs Woodland SAC and the Thames Estuary and Marshes SPA and Ramsar Site, despite the modelling detailing that the project will result in an increase of more than 1% of the lower critical load, a likely significant effect has been screened out on the basis that 'the change in N deposition is less than 0.4 kgN/ha/yr… and this would therefore not lead to the loss of one species'. My advice is that the loss of one species as the sole test of likely significant effect is inadequate for these purposes, and a more thorough approach is needed.

I would advise that for the purposes of assessing road traffic emissions under the Habitats Regulations, the guidance within NEA001[1] 'Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations' should be used. This guidance differs from DMRB LA105 in a number of key points, and in this respect I would advise it would be more appropriate to screen the potential for likely significant effect based upon 1% of the lower critical load for the specific habitat types. Where this is exceeded, further consideration on whether the project will have an adverse effect on the integrity of the site(s) should be considered through the Stage 2 appropriate assessment.

At present, it is not possible for me to concur with the conclusions within the Screening Report that

[1] http://publications.naturalengland.org.uk/publication/4720542048845824

traffic generated air quality impacts during the operational phase will not result in impacts to the designated sites. Based upon the information provided, it is likely that more detailed comments will be made when the supporting information within the environmental statement is available. As such, the Screening Report may need to be updated to reflect any further comments at this stage.

More detailed comments in relation to Epping Forest and the supporting botanical survey report in Annex Two appended to this letter.

In relation to the potential for groundwater impacts to the Thames Estuary and Marshes Ramsar Site (sections 6.3.20-28 of the Screening Report) suggests that <2% of the water resource in the designated site comes from the groundwater seepage. Similarly, the Screening Report states that the proposed tunnels will not result in any perceivable change in groundwater levels within the Ramsar Site based upon the modelling undertaken to date. I would recommend that given the duration of the construction period that a robust monitoring programme is implemented to ensure that these assumptions based upon the modelling remain valid; should the monitoring show that water availability in the Ramsar Site is negatively impacted then a mechanism for remedial action will be required.

I note that the Screening Report suggests, that based on the modelling undertaken, that no likely significant effects are predicted from noise as a result of the tunnel boring works (Sections 6.3.30-32). However in the absence of the detailed information and impact assessment within the ecological chapter of the environmental statement, it is likely that more detailed comments will be made when the supporting information within the environmental statement is available. As such, the Screening Report may need to be updated to reflect any further comments at this stage.

In addition to the referenced loss of 370 hectares of functionally linked land, Sections 6.3.33-36 suggest that the construction works within the functionally linked land could also result in noise and vibration impacts to species associated with the designated sites and that a likely significant effect cannot be ruled out. However the Report states that during operation (Section 6.3.38) no disturbance is expected given the long-term removal of the functionally linked land. As the Screening Report highlights that the loss of the functionally linked land will in effect be permanent given the 6-7 year construction period, this needs to be fully assessed through the Stage 2 Habitats Regulations Assessment.

Section 6.3.40 of the Screening Report states that the functionally linked land adjacent to the constructions compounds will not be affected to the extent that a likely significant effect will be likely. Unfortunately no information has been provided to give certainty on this, such as light contour plans. In the absence of the detailed information and impact assessment within the ecological chapter of the environmental statement, it is likely that more detailed comments will be made when the supporting information within the environmental statement is made available. As such, the Screening Report may need to be updated to reflect any further comments at this stage.

Section 6.3.47 of the Stage 1 Screening Report details the visual disturbance during the operation phase and discounts a likely significant effect on the basis that the functionally linked land where impacts might occur north of the Thames will have, in effect, been lost due to the 6-7 year construction period. As the Screening Report highlights that the loss of the functionally linked land will in effect be permanent given the 6-7 year construction period, this needs to be fully assessed through the Stage 2 Habitats Regulations Assessment.

Given the comments in this advice letter, I am not able to concur with the conclusions drawn in Section 6.3.55 that 'The Project will not affect the water quality or quantity at any of the European sites identified as it includes drainage design at construction and operation that will result in no change in the water entering the surrounding watercourses and no LSE are anticipated'. There are a number of significant outstanding areas of concern regarding the construction surface water drainage strategies both north and south of the Thames (see advice letters dated 25 June 2020, reference numbers 320528 and 320550). My advice is that these should be considered further in the Stage 2 Assessment and a likely significant effect should not be ruled out.

Section 6.4.3 of the HRA Screening Report details the nature of the projects that will be considered as part of the air quality in-combination assessment. However, the criteria for consideration of projects does not appear to fully reflect current[2]. For example, energy generation facilities over 50 megawatts may need to be considered up to 15 kilometres from a designated site (rather than the 10 kilometres recommended in the report). Similarly, the biomass boiler distance criteria may need to be greater than 500 metres depending on the megawatt output. The types of project that are listed does not appear to include all those which could result in sources of airborne nitrogen and as such it would appear appropriate for the list and in-combination assessment to be updated to reflect the broader range of projects which could potentially act in-combination.

Approach to climate change assessment briefing paper
The production of the paper looking at the potential climate change elements is welcomed. I note that it states that 'The Project would contribute to an estuary wide enhancement/restoration programme, such as those delivered by organisations such as the Thames Estuary Partnership (TEP), as part of its obligations under the Water Framework Directive' – it is unclear if this is a mitigation/compensation requirement of the Habitats Regulations Assessment or part of the wider ecological mitigation package and it would be helpful if clarity could be provided. As far as I am aware the Thames Estuary Partnership are not a deliverer of such works so it would be helpful if clarity were provided on the mechanism by which they will be secured.

Briefing on construction traffic modelling and air quality effects
Notwithstanding the ongoing discussions between Highways England and Natural England on the differing approaches to considering traffic generated air quality impacts with the Design Manual for Roads and Bridges LA 105 Air Quality and Natural England's approach to advising competent authorities[3], we have no comments to make in relation to the briefing paper at present.

Habitats Regulations Assessment - Methodology for the assessment of In-combination Effects
Notwithstanding the comments on the Stage 1 Screening Report and the details of the individual projects that will need to be considered in-combination, the broad approach seems to be appropriate.

The one area that I would recommend is updated to reflect current guidance however is the proposed approach for considering projects generating air quality impacts in-combination with the Lower Thames Crossing does not appear to follow current guidance[4]. For example, energy generation facilities over 50 megawatts may need to be considered up to 15 kilometres from a designated site (rather than the 10 kilometres recommended in the report). Similarly, the biomass boiler distance criteria may need to be greater than 500 metres depending on the megawatt output. The types of project that are listed does not appear to include all those which could result in sources of airborne nitrogen and as such it may be appropriate for the list and in-combination assessment to be updated to reflect the broader range of projects which could potentially act in-combination.

Ornithology baseline plans and report to inform the Habitats Regulations Assessment
Whilst the provision of the baseline maps is welcome, without the detailed information behind the point maps or any interpretation, it is difficult for me to be able to provide detailed comments. It would be helpful if greater information such as the individual species, the number of each species recorded and the peak count for each species, for example, were provided. This information may be forthcoming within the environmental statement but without more detailed information, it is not possible for me to provide comments other than repeating previous comments that it would appear sensible to supplement these with historical data from local recording groups and biological record centres which may require revisions to the Habitats Regulations Assessment.

Figure 28 Areas of potential habitat loss within the functionally linked land

[2] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

[3] Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations http://publications.naturalengland.org.uk/publication/4720542048845824

[4] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

The area of potential habitat loss within the functionally linked land plan does not appear to reflect the advice and recommendations provided in my email of the 18 May 2020. In summary, the se advised on the need to consider areas of land in agriculture/horticulture, clarity on the survey results (similar to the comments above regarding the Ornithology baseline plans) and the use of historical survey information to inform the extent of functionally linked land. It would be helpful if clarity were provided on whether the work underpinning the area of potential loss of functionally linked land has fully considered these earlier comments.

Mitigation and monitoring briefing note

The report highlights a number of 'potential' mitigation measures, as they are potential and the scale of the impacts has yet to be shared, I have not provided detailed comments on the acceptability or otherwise of the measures detailed in the briefing note but have provided some general observations which I hope are helpful.

I note that the approach proposed for avoiding impacts to the Thames Estuary and Marshes Ramsar Site for the proposed construction compound surface water drainage within the designated site is for the works to be undertaken in the months of May, June and July. Similarly the works to the intertidal habitat for the jetty on the northern side of the Thames are proposed for the same months. Given that the underpinning Sites of Special Scientific Interest are notified for their breeding birds (in addition to the wintering species), such an approach is unlikely to be acceptable to Natural England at the formal consultation stage. As such, I would recommend that the briefing note and environmental statement ensures that the measures proposed are compatible with all of the ecological interest in the round by taking a holistic approach.

The document refers to both functionally linked land and supporting habitat impacts and to avoid confusion, I would recommend that this is clearly defined so that all parties understand what is meant by these two terms. Similarly, reference is made to maintaining access to 'alternative habitats' for birds and again it would seem appropriate for this to be defined to avoid confusion.

Whilst the other mitigation measures suggested for the marine licence appear appropriate in relation to the Habitats Regulations Assessment, in the absence of the underpinning in formation within the environmental statement it is not possible at this stage to provide detailed advice on their acceptability or otherwise. They should however reflect the requirements of the extant planning permission and marine licence.

In relation to the proposed disturbance monitoring, the disturbance may also influence bird behaviour (for example by causing birds to take flight reducing their time to feed) which may impact their fitness. It would seem appropriate for the monitoring to reflect this.

For the monitoring proposed for both the land take and disturbance, I note that there does not appear to be a feedback loop should the monitoring highlight that impacts may be occurring. Such a feedback and mechanism to secure any necessary remedial measures approach is generally a key component of any monitoring strategy so I would recommend that this is reflected within the report.

Annex Two: Detailed comments in relation to Epping Forest Special Area of Conservation and the Botanical Survey (Appendix F to the HRA)

With reference to Section 1.3.2 and Table 1-1, I do not agree that the effects of 'change in air quality – vehicle emissions – operation' should be screened out as being unlikely to have a significant effect. I also note that a distance criterion of 200m has been used in Table 4-3 titled 'the potential impacts and ZoI at construction and operation', and advise that although the use of areas within 200m of the operational Affected Road Network (ARN) is set out within DMRB LA105 guidance, this distance may not be sufficiently precautionary for use in assessing effects to Epping Forest Special Area of Conservation (SAC), as evidence suggests that effects may extend beyond this distance. Our previous comments on the methodology for the Epping Forest habitat survey contains further details on this. Nevertheless I note that Epping Forest SAC has been identified as one of the European sites within 200m from the ARN in paragraph 5.1.9.

I note that Epping Forest SAC is listed within Table 5-2 as a European site identified for screening purposes, with the high level conservation objective described as 'Ensure that the integrity of the site is maintained or restored as appropriate'. It should be noted that that the Supplementary Advice Package for Epping Forest SAC[5] makes it clear that for air quality (as a supporting process on which features rely) has 'restore' objectives: 'restore as necessary, the concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System[6].' I also note that Epping Forest SAC has been identified within Table 6-1 with potential for likely significant effects due to 'change in air quality – vehicle emissions – operation' with the effect being a 'reduction in habitat area'.
In Section 6.3 'Assessment of potential LSE' and 'Reduction in habitat area' I note that Epping Forest SAC has been identified in paragraph 6.3.14 as potentially affected (being within 200m of the ARN), and a maximum change in total nitrogen deposition at this SAC is noted as 0.41 kgN/ha/yr (with reference to the appropriate lower critical load of 10 kgN/ha/yr) is modelled at Table 6-11. Paragraph 6.3.17 described the workings of the methodology as following Design Manual for Roads and Bridges (DMRB) LA105 guidance, identifying that at bullet e "the change in N deposition is greater than 0.4 kgN/ha/yr at sample points within the Epping Forest SAC and this could lead to the loss of one species." Please note that the loss of one species as the sole test of likely significant effect is inadequate for these purposes, and a more thorough approach is needed. We have separately provided specific comments on the use of DMRB LA105 and refer you to those for more details.

I advise that for the purposes of assessing road traffic emissions under the Habitats Regulations, the guidance NEA001 'Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations'[7] should be used. This guidance differs from DMRB LA105 in a number of key points, and in this context I highlight in particular that it is appropriate to use a habitat threshold of 0.1 kgN/ha/yr as the measure of change for purposes of HRA screening for nitrogen loading (i.e. 1% of the critical load of 10 kgN/ha/yr).

Paragraph 6.3.19 sets out the findings of surveys in the area where N deposition change is predicted to be greater than 0.4 kgN/ha/yr, concluding that the species recorded 'did not include any that were sensitive to N deposition. Therefore, this habitat is considered to be resilient to this impact and no further loss of species is anticipated as a result of this change in N deposition. The changes in air quality predicted at Epping Forest SAC will not result in LSE.' The area of SAC affected (SSSI unit 105) contains veteran trees within 200m of the relevant Section of the M25, and the habitat within the area of scope (i.e. area likely to be subject to the 1% increases in critical level of NOx and critical load of total N deposition due to the LTC M25 increase in AADT traffic) is dominated by woodland, describable as W15 mosaic that forms part of the characteristic SAC woodland feature habitat.

The outworking of the above assessment approach are seen in the conclusion to screen out Epping

[5] http://publications.naturalengland.org.uk/publication/5908284745711616
[6] www.apis.ac.uk
[7] http://publications.naturalengland.org.uk/publication/4720542048845824

Forest SAC for operational air quality effects in Table 7-2 and Table 8-1, but please note I disagree with this conclusion for the following reasons:

- Natural England guidance NEA001 as noted above should be used for these purposes. This would have identified that the appropriate habitat threshold to use for the assessment of N deposition is 0.1 kgN/ha/yr (i.e. 1% of the critical load of 10 kgN/ha/yr). Please note it is not clear why NOx or ammonia figures do not apparently appear within the HRA air quality assessment, as there are critical levels for these as well and 1% thresholds may have been exceeded with ecological consequences.
- The presentation of traffic uplift should use (Annual Average Daily Traffic) AADT as the appropriate measure. I could not locate this type of analysis in the traffic modelling reports provided, but LTC have provided clarification that this amounts to a 3% increase at Epping Forest SAC. The Local Model Validation Report (LMVR) has only recently been provided and may contain this detail, but I have been unable to review this report in detail in the time available. An initial review through suggests figures up to an increase of 4.1% occur, so it would be helpful to have modelled locations shown on sui Table Maps for ease of reference.
- Consequently, the modelled area of the SAC affected by this predicted increase in N deposition (but NB see also for NOx and ammonia) can be expected to be larger than that reported, and as a result the area of habitat surveyed for N sensitive features is smaller than what should have been undertaken.
- I provided advice on the scope of the ecological assessment undertaken, and although this is noted to have been taken into consideration, it was not necessarily applied, and as currently presented, lacks assessment of the following key features:
    - No assessment of lichens;
    - No soil analysis;
    - No air quality monitoring transects in the SAC to calibrate and validate air quality modelling outputs, and enable overlay of predicted emissions onto habitat / feature maps, accounting for critical levels / loads.
- Although partially referenced within the HRA screening report, the Conservation Objectives (and in particular the Supplementary Advice Package) for the SAC is not properly taken account of, in particular the objective to 'restore' air quality levels as a supporting process upon which the features rely.

With reference to the current Draft Appendix F Epping Forest Botanical Survey Report I can advise as follows:

- The referenced 'origin of the point in the SAC where nitrogen was modelled to exceed 0.4kgN/ha/Year' is not made clear within Figure 1 in Appendix A. This needs to be shown and described more clearly on the Figure 1 and in the text and any 'origin' relevant to our requested 0.1kgN/ha/year total N loading should also be shown to enable relevant HRA assessment consistent with my advice to date.
- There is a need for the area relevant to the 0.1kgN/ha/year to be shown and made clear and it would be helpful to have incremental increases in kgN/ha/year shown as contour lines relevant to the sample plots. There is reference to 'three plots were nested within the 50m x 50m plot in the north of the SAC where nitrogen deposition was modelled to exceed 0.4kgN/ha/yr, but this is relevant to the inappropriate threshold of 0/4kgN/ha/year rather than the requested 0.1kgN/ha/year, and the relevant area needs to be shown more clearly to avoid any confusion.
- Table B.1 – it is not clear why the relevant Plots 2.1 and 3.1 are not included within this Table but I presume this is because 1.1 covers a 50km area and plots 2.1 and 3.1 are nested within this.

- The sample 1.5 is wrongly labelled as 1.3 within the Field survey form which creates uncertainty about whether survey samples have been recorded in the correct order along transect 1.

Additionally, when considering the survey content, assessment and conclusions of this report I note the following:

- The highest mean Ellenberg figures (i.e., most nutrient-liking) for non-bryophyte plants within the understorey are located within the sample area closest to the M25.
- There are no bryophytes associated with tree boles in the sample area closest to the M25 and no bryophytes are recorded on lower branches within 250metres of the M25.
- The Nitrophilic negative indicator species of sycamore, cleavers, nettle and rough meadow grass are generally recorded in locations within 100metres from the M25 and/or the B1393.
- No beech trees or saplings appear to have been recorded in the sample areas closest to the M25.

The above supports Natural England's view that the areas closest to the M25 show signs of being adversely affected by excessive nitrogen-loading. Continued levels of nitrogen-loading above the Critical Load and Critical Levels are likely to continue this adverse effect and impact on the capacity of the SAC woodland feature to effectively recover. The predicted increases in AADT are significantly higher than screening thresholds of an increase of 1,000 and I anticipate an area of the SAC up to and possibly larger than 250metres distance from the M25 being affected by an increase of more than 1% of the Critical Levels and Critical Loads.
In the absence of the additional studies that were requested, I refer to previous field-based studies in this location as further support of evidence that the areas closest to the M25 have been affected by nitrogen pollution and the continued exceedances are likely to be prolonging this situation.

Gadsdon, S.R.M., 2007. Ecosystem health at Epping Forest. Ph.D. thesis, Imperial College London, UK.

G1) Based on diffusion tube surveys, NO_2 concentrations were elevated above background levels up to 250m away from the road (Gadsdon 2007).
G2) In a location within the LTC study area of Epping Forest, Gadsdon (2007) recorded higher NO_2 concentrations in spring and summer compared with other background sites, regarding this as evidence of the influence of emissions from the M25 and B1393. In these situations, mature and veteran trees may become increasingly susceptible to die back during summer droughts.

Stansted Airport 35+ Expansion Project – RPS 2018 Epping Forest Ecology Survey

SA1) There are at least 8 veteran trees (including mainly beech but also hornbeam and oak) within 200 metres from the M25, and at least 17 veteran trees within 250 metres from the M25.
SA2) Many of the trees displayed evidence of stress including abundant epicormic growth and branch die-back. It is not possible from observational evidence to determine the cause of this stress, although nutrient imbalance due to nitrogen enrichment was regarded as likely to be a contributory factor.
SA3) There is an absence of Nitrogen-sensitive lichen species within the sampling areas surveyed at 50 metres and 200metres distance from the M25.
SA4) There was an increase from 'Nitrogen Polluted' to 'Very Nitrogen Polluted' (based on Lichen Indicator Score and Nitrogen Air Quality Index) with increasing proximity to the M25 (ie, comparing 200metres with 50 metres distances from the M25).

The HRA screening report also should be reviewed to identify whether additional plans and projects should be included for the in-combination assessment. These include:

- The Epping Forest District Council Local Plan, with its associated HRA and air quality assessment work. Please note that the available report is being updated, and is expected in

due course. Please note that although there is no current assessment of the increase in road traffic on the M25 caused by the EFDC Local Plan (the M25 was not identified as a key local road for assessment), nevertheless there may be an (as yet unknown) traffic uplift on the adjacent B1393 resulting in an overlap between the areas of the SAC affected by the LTC scheme and the EFDC Local Plan. Further consideration of this work is needed to explore the additivity of these two projects and the ability to undertaken appropriate in-combination assessment in the scenario whereby the two roads (M25 and B1393) do not directly connect, but where their respective permissions potentially affect the same area of SAC habitat. The Inspector's report can be found here.

- NEXT development. EPF/2503/19 Hybrid application - Phase 1: 52,621m2 of Class B8 distribution centre with a 4,645m2 sui generis photo studio space with ancillary office facilities including a multi-storey car park, vehicle wash station and fuelling island. Phase 2: 22,733m2 of employment floorspace with all matters reserved. Associated Habitats Regulations Assessment (HRA). Land North of Dowding Way, Waltham Abbey, EN9 3YX

Linked to the above, SSSI unit 106 (which I understand is also predicted to be in receipt of air quality exceedances as a result of LTC) which is not part of the SAC, should also be assessed within the appropriate EIA equivalent assessment.
For the reasons set out above, I advise that consistent with key guidance reference NEA001, operational air quality effects should not be screened out at this stage as part of the test for likely significant effects. The traffic and air quality levels are comfortably within the range that should be more robustly tested through the Appropriate Assessment process, and I will be happy to work with LTC to ensure the challenges linked to this assessment work are appropriately thorough and fit for purpose.

More detailed assessment should involve the elements of air quality modelling with ground-truthing (validation and calibration as previously advised) and ecological assessment (air quality contour overlap with SAC features and habitat maps – as advised with reference to City of London sources). The detailed assessment – which in my view should be called an Appropriate Assessment due to it going beyond initial screening - needs to assess the likely scale of impacts on the SAC features at this location accounting for (a) the predicted scale of increases in traffic-related emissions, noting (b) Critical Levels and Critical Loads are likely to already exceed appropriate thresholds.
Please also note that the NECR210 report[8] (Assessing the effects of small increments of atmospheric nitrogen deposition (above the critical load) on semi-natural habitats of conservation importance) only briefly considers woodlands with no reference thresholds provided, so the only relevant threshold for HRA assessment at this stage is for LSE screening and this would be 1% of the Critical Levels for NOx (and NH3 if being considered) and 1% of the Critical Load for Total Nitrogen. Therefore a bespoke assessment for the woodland habitat at this location is needed.

Although there are challenges with directly attributing signs of nutrient enrichment on SAC features (particularly within the short timescales of the planning process), when taken as a whole there are many signs of nutrient enrichment in the M25 zone of influence within SSSI unit 105 (part of Epping Forest SAC) which may be attributed to the prolonged exposure to Critical Load and Level exceedances for Nitrogen deposition (and NOx and Ammonia) and the proximity of the SAC habitats to the M25 and B1393. It is not yet clear to me what the scale of increase to NOx levels (and Ammonia) and Nitrogen deposition on this area of Epping Forest SAC can be attributed to the Lower Thames Crossing for HRA assessment alone and in combination with other plans and projects. Clearly, in this context, the proportionality of its contribution to the 'in combination' situation and the significance of its impacts on SAC features needs to be carefully considered.

[8] http://publications.naturalengland.org.uk/publication/5354697970941952

Annex H HRA and EIA Evidence Technical Note Rev1 Air Quality from vehicle emissions

Lower Thames Crossing

HRA and EIA Evidence Plan: Air quality effects from vehicle emissions

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

DATE: November 2021

VERSION: 1.0

Lower Thames Crossing

HRA and EIA Evidence Plan: Air quality effects from vehicle emissions

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1 Introduction

1.1.1 The purpose of this document is to set out Lower Thames Crossing's emerging approach to issues relating to nitrogen deposition in order to facilitate a response from Natural England so that this document may develop to provide an iterative record to facilitate consultation on and agreement wherever possible of the evidence supporting the Habitats Regulation Assessment (HRA) (including stage 2 appropriate assessment) and Environmental Impact Assessment (EIA) of construction and operational air quality effects from vehicle emissions on ecologically designated sites and habitats.

1.1.2 The final contents of the document will be subsumed into the supporting documents for the DCO application as follows:

i. Environmental Statement (ES) Chapter 8 Terrestrial Ecology and Appendix 8.14 Designated Sites Air Quality Assessment

ii. HRA Statement to Inform an Appropriate Assessment (including within Appendix C of that report – the Evidence Plan, which will also document other evidence used on other aspects of the HRA such as effects on birds)

iii. Statement of Common Ground (SoCG) with Natural England.

1.1.3 As such, it is hoped this document can be a helpful means for recording the principal points from engagement up to final document production for the DCO Application – with inputs from both Lower Thames Crossing (LTC) and Natural England (NE). It is expected a number of iterations or revisions will be produced, incorporating the developing discussions and agreements.

1.1.4 This Evidence Plan follows the contents of The Planning Inspectorate Advice Note 11 - Annex H Evidence Plans for Habitats Regulations Assessments of Nationally Significant Infrastructure Projects.

2 Working arrangements

2.1.1 This evidence plan is being developed with Natural England (NE) as the relevant Statutory Nature Conservation Body (SNCB) in consultation through a Discretionary Advice Service (DAS) agreement. The plan sets out LTC's intended approach to the evidence to be provided within the HRA and EIA in relation to air quality effects for resubmission of the Development Consent Order (DCO) application. The level of agreement on the assessment in this evidence plan will be the basis of the statements on agreement with NE in the HRA and EIA reports and the SoCG.

2.1.2 Previous consultation on the evidence to be provided has included the following (which will be documented in Appendix C (Evidence Plan) of the HRA report, which documents the consultation with NE):

a. Presentations and discussions on consultation calls

b. Technical notes

c. Draft reports

   i. Evidence base (early consultation on methodologies, baseline to use, etc.)

   ii. Drafts of HRA stage 1 screening report

   iii. HRA stage 1 screening report (from withdrawn DCO application (DCO 1.0))

   iv. Statement to Inform an Appropriate Assessment (SIAA) (from DCO 1.0)

   v. Drafts of SoCG

d. Tables of responses to written advice

2.1.3 The first draft of this document (Revision 0) was produced in August 2021 to act as an iterative vehicle for developing and recording agreement on the evidence to support the HRA and EIA in the final run up to resubmission of the DCO application. Revision 1 was produced in November 2021 to provide an update of the final methodologies, outline results of the assessments and emerging thinking on proposed approach to mitigation and compensation for both HRA and EIA.

2.1.4 Advice provided by NE from August 2021 is referred to within this document where provided. Agreement or otherwise on the evidence to be used is also recorded in this document in Appendix A Change Log.

3 Scope of evidence required

3.1 Impact pathway considered

3.1.1 The impact considered in the HRA is 'Changes in air quality as a result of vehicle emissions' in construction and operation. The pathway considered in the ES is 'Change in air quality on designated sites'. The assessment follows a source, pathway, receptor model for assessing the impact, where the assessment of Adverse Effects on Integrity (AEoI) or significance (EIA significant effect) relates to the final 'receptor' part of the impact (in that integrity depends on the response of the receptor to an impact, not to the cause or pathway of an impact).

3.1.2 The Source is identified as the change in traffic from Do Minimum (DM) to Do Something (DS – the project) to a level of significance of change from guidance (both National Highways (NH) and NE – 1000 AADT (& other Affected Road Network (ARN) criteria) change level).

3.1.3 The Pathway is identified as the increase in Nitrogen deposition (Ndep), which includes the contribution from both NO_x and ammonia, from DM to DS to a level of significance of increase that would warrant further consideration of the effects.

a. For HRA the 1% Lower Critical Load (LCL) threshold has been used following the LA115 standard and assumption of LSE in due consideration of NE's advice.

b. For EIA the 0.4kgha-1yr-1 threshold has been used following the LA105 standard which uses the 1% LCL threshold, together with a consideration of background Ndep, and a precautionary assumption that the conservation objectives are to restore, following the LA105 standard, specifically Figure 2.98 and paragraphs 2.99 to 2.102.

3.1.4 The Receptor is identified as the features of the designated sites or habitats.

3.1.5 The Effect is identified as the response of the receptors to the increase in Ndep and whether any response would hinder the achievement of the conservation objectives.

3.1.6 The scope of the evidence required is structured within the following elements of the assessment to provide specific areas of agreement, disagreement, and areas still under discussion as part of the SoCG process – for the Examining Authority to consider. This structure will facilitate discussion, amendment where necessary, and agreement of each element of the assessment that leads to the overall conclusion in turn:

i. The methodology of identifying the source (traffic model methods)

ii. The methodology of identifying the pathway (air quality model methods and thresholds)

iii. The methodology of identifying the response of the receptor (i.e. the further considerations to identify whether any exceedances of the

1%LCL/0.4kgNha^{-1}yr^{-1} thresholds would lead to a AEoI/EIA significant effect)

iv. The baseline data used in the assessment

v. The evidence available in the literature used in the assessment

vi. The outputs from modelling

vii. The conclusions of the HRA and EIA assessments without mitigation

viii. Proposed measures to mitigate significant effects

ix. The conclusions made in light of the assessment with mitigation

x. Proposed measures to compensate for residual significant effects

3.2 HRA Assessment

European sites features and conservation objectives

3.2.1 Sites considered within HRA assessment are those within 200m of the ARN.

a. Epping Forest SAC

b. North Downs Woodlands SAC

c. Medway Estuary & Marshes SPA/Ramsar

d. Thames Estuary & Marshes Ramsar

e. The Swale SPA/Ramsar

3.2.2 Since DCO1.0 the air quality modelling methodology has been amended in light of NE advice (not least in the inclusion of ammonia in the Ndep predictions) and included the latest traffic and monitoring data. The list of European sites where an LSE may occur has been identified as those where a change in nitrogen deposition between the Do Minimum and Do something scenario is greater than 1% of the Lower Critical Load (LCL) of the site. Of the sites within 200m of the ARN only Epping Forest SAC was identified as at risk of LSE.

Epping Forest

3.2.3 The following features are considered to be present in the affected area:

a. H9120. Atlantic acidophilous beech forests with *Ilex* and sometimes also *Taxus* in the shrub layer (*Quercion robori-petraeae or Ilici-Fagenion*)

b. S1083 Stag beetle *Lucanus cervus*

3.2.4 The following features are not considered to be present in the affected area from desktop and survey information:

c. H4010 Northern Atlantic wet heaths with *Erica tetralix*

d. H4030 European dry heaths

3.2.5 The Epping Forest SAC citation highlights air quality as a key attribute underpinning the conservation objectives of the sites. The Epping Forest Site Improvement Plan (Natural England, 2016) lists 'air pollution: impact of atmospheric nitrogen deposition' as the highest priority issue for the site. The SAC has a 'restore' target for the air quality attribute of the conservation objectives which relate to the concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values.

Risk of being unable to avoid adverse effects on integrity

3.2.6 The risk of being unable to avoid adverse effects has been defined through further consideration of any exceedances of the 1%LCL threshold. The considerations used in the assessment have been derived from LA105 DMRB standards and Natural England guidance NEA001. The considerations can be seen as separate elements of the assessment in Table 1 below.

Other plans and projects considered in the in-combination assessment

3.2.7 The following plans and projects have been considered within the in-combination assessment:

a. Riverside Energy Park

b. North London Heat and Power Project

c. Proposed extension to existing Allington EfW Generating Station

d. Thurrock Flexible Generation Plant

e. Wheelabrator Kemsley Generating Station (K3) and Wheelabrator Kemsley North (WKN) Waste to Energy Facility

f. Kemsley Paper Mill (K4) CHP Generating Station

3.3 EIA designated sites and habitats

3.3.1 Sites considered within EIA assessment include the following designations that have been recorded within 200m of the ARN:

i. Site of Special Scientific Interest (SSSI)

ii. Sites listed on the Ancient Woodland Inventory (AW)

iii. Veteran Trees (VT)

iv. Local Nature Reserves (LNR)

v. Local Wildlife Sites (LWS)

vi. Sites of Importance for Nature Conservation (SINC/SINC (GiGL))

vii. Roadside Nature Reserves (RNR)

viii. Nature Improvement Area (NIA)

3.3.2 Since DCO1.0 the air quality modelling methodology has been amended in light of NE advice (not least in the inclusion of ammonia in the Ndep predictions) and included the latest traffic and monitoring data. The sites identified as having a risk of significant effects were those within 200m where the air quality modelling calculated the change in nitrogen deposition between the Do Minimum and Do something scenario to be greater than 0.4kgNha^{-1}yr^{-1}, following the LA105 standard. The following list is the numbers of sites in the latest assessment within 200m of the ARN where the change in nitrogen deposition was greater than 0.4kg N ha^{-1}yr^{-1}:

a. SSSI 9

b. AW 40

c. VT 27

d. LNR 1

e. LWS 37

f. RNR 7

g. SINC/SINC (GiGL) 14

h. NIA 1

3.4 Change and Programme

3.4.1 Any changes in the scope and evidence provided in the HRA and EIA will be documented through iterations of this document.

3.4.2 At the time of revision 1 of this document, the timescales set out in Table are considered.

Table 3.1: Estimated programme

Milestones for changes	Estimated programme
AQ Presentation	4 Nov 2021
Call to explain North Downs Woodlands SAC conclusion LTC share evidence planLTC share evidence plan Weekly clarification calls NE Area Manager Meeting NE formulate feedback	4 Nov – 2 Dec 2021
NE send written response	2 Dec 2021
Workshop presenting NE advice	6 Dec 2021
Fix Order Limits for consultation	Mid-Dec 2021

Consultation	Feb - March 2022
Last input from Natural England that can be incorporated into the DCO application documents (allowing time for assurance / production)	Mid-May 2022
Application for DCO	Q2/Q3 2022
End of Acceptance	+28 days
End of Pre-Examination	Q1/Q2 2023
End of Examination	Q3 / Q4 2023

4 Approach to uncertainties

4.1.1 It is possible to quantify the cause and extent of the impact pathway through traffic and air quality modelling. The modelling used is the best available scientific knowledge to estimate impacts and the results are verified through monitoring data and the criteria and thresholds within the DMRB methodologies have been developed in light of research on significance of quantifiable criteria. The thresholds used are defined in DMRB standards[1] and Natural England guidance NEA001[2].

4.1.2 Using the modelling outputs defines the degree and extent of any exceedance of the 1% LCL threshold (for HRA) and 0.4 $kgNha^{-1}yr^{-1}$ threshold (for EIA), which requires further consideration of whether there would be AEoI (for HRA) and significant effects (for EIA).

4.1.3 Competent experts in ecology have obtained all the available evidence to assess the effects on designated sites and habitats, following published standards and in consultation with NE. Professional judgement by the competent experts has been used to develop conclusions on what constitutes any AEoI or EIA significance caused by the quantified impact of exceedances of the 1%LCL and 0.4 kg N $ha^{-1}yr^{-1}$ thresholds respectively, i.e., whether the risk of AEoI/EIA significance is real as opposed to theoretical.

[1] Highways England; Transport Scotland; Welsh Government; Department for Infrastructure (2019) DMRB Vol. 11 Section 3 Part 1 LA105 Air Quality http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section3/LA%20105%20Air%20quality-web.pdf

[2] Natural England (2018) Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations (NEA001)

5 Evidence to be collected

5.1.1 Table provides a summary of all the elements of the assessment that form the evidence to support the conclusions. The term evidence is used here to include all the information supporting the HRA and EIA assessments, including the methodologies used to undertake the assessment, the results /outputs from the methodologies, the supporting information / baseline data, and conclusions of the assessment. The purpose of the summarising of the elements of the assessment is to demonstrate how the assessment has been carried out and how conclusions have been drawn. Splitting the assessment into its all its constituent elements, is intended to create focus on agreement or disagreement on the appropriateness of each element within the assessment, to facilitate solutions to any disagreements.

Does Natural England consider there are other elements of the assessment that need to be defined and agreed to have a comprehensive list to form agreement on the whole assessment?

5.1.2 Table sets out LTC's emerging thinking and can be amended in future iterations of the evidence plan if required to ensure a comprehensive understanding of the whole assessment is consulted on and agreement of each element recorded.

Table 5.1: Elements of the assessment

Assessment method	Assessment element	Summary of element
The methodologies of identifying the cause, pathway, and response of the receptor	Does the proposal give rise to emissions which are likely to reach a European site/ EIA designated site	As presented in DCO 1.0 Method for identifying the ARN ▪ Follows guidance as set out by DfT in TAG – adherence checked by NH assurer and DfT ▪ Use DfT traffic growth forecasts with additional spatial detail for the new developments which meet the DfT criteria for inclusion ▪ The proportion of electric vehicles affects the cost of motoring; the proportion assumed in each year is conservatively taken from the DfT TAG databook ▪ Remodelled traffic including traffic management and delay in opening year Use of 200m from the ARN to identify sites
	Are the qualifying features of sites within 200m of a road sensitive to air pollution?	As presented in DCO 1.0 Identification of qualifying features and sensitivity through APIS information on Lower Critical Loads (LCL)
	Could the sensitive qualifying features of the site be exposed to emissions?	As presented in DCO 1.0 DMRB method for calculating Ndep (NOx contribution) ▪ Undertaken in accordance with LA105 and Defra Guidance ▪ Vehicle Fleet assumptions based on the latest iteration of the Emission Factor Toolkit (EFTv10.1) ▪ Policies such as Net Zero Strategy Likely to accelerate uptake of EVs not currently included in the vehicle fleet assumptions ▪ Likely therefore that vehicle emissions will reduce faster than assumed in the assessment
		Updated method since DCO 1.0 ▪ Additional Historic Diffusion tube data on M25 used to refine the model verification around Epping Forest ▪ Inclusion of Ammonia as part of the Ndep calculations

Assessment method	Assessment element	Summary of element
		▪ NH Ammonia modelling tool currently being peer reviewed ▪ NH undertaken analysis of actual ammonia and NO_2 monitoring on the M1 to see how close the tool predicts ammonia concentrations, shown to correlate well ▪ Inclusion of imperceptible change threshold from the air quality modelling in inputs to Ndep modelling: – As N Dep which includes the calculation of contributions from road NO_2 and NH_3 ultimately pivot off the modelled NOx, we would initially review the changes in verified modelled Road NOx. Where any changes are less than 0.3µg/m³ i.e. less than 1% of the annual mean critical level of 30µg/m³ set for vegetation, they would be identified as being imperceptible and not considered further within any decision making around the scheme impacts. This aligns with the advice from Natural England around considering changes with respect to 1% of the lower critical load (LCL) and the approach adopted for the consideration of NO_2 impacts for human health and compliance with national limit values as set out in LA 105. For those locations where the change between DM and DS is more than 0.3µg/m³, then the N dep associated with the modelled Road NO_2 and NH_3 [pivoted from the Road NOx] has been calculated. The changes in N Dep at these locations between DM and DS has been compared to 1%LCL and 0.4kg thresholds. Any change in road NOx between DM and DS less than 0.3µg/m³ has not been used to inform the judgement of significant effects.
		As presented in DCO 1.0 Identification of impact requiring further consideration: • HRA – according to the assessment of Epping Forest by the competent expert the LSE could be excluded. However, with an exceedances of the 1% LCL threshold from combined modelling and a disagreement from NE with the conclusions, an LSE has been screened in on a without prejudice basis in line with LA 115 "*Where the relevant SEB(s) disagrees with the reported screening conclusions and this matter cannot be resolved, then LSE should be assumed*". • EIA – Exceedances of 0.4 kg N ha^{-1} yr^{-1} threshold from combined modelling
		As presented in DCO 1.0 Consider the best available evidence on small incremental impacts from nitrogen deposition

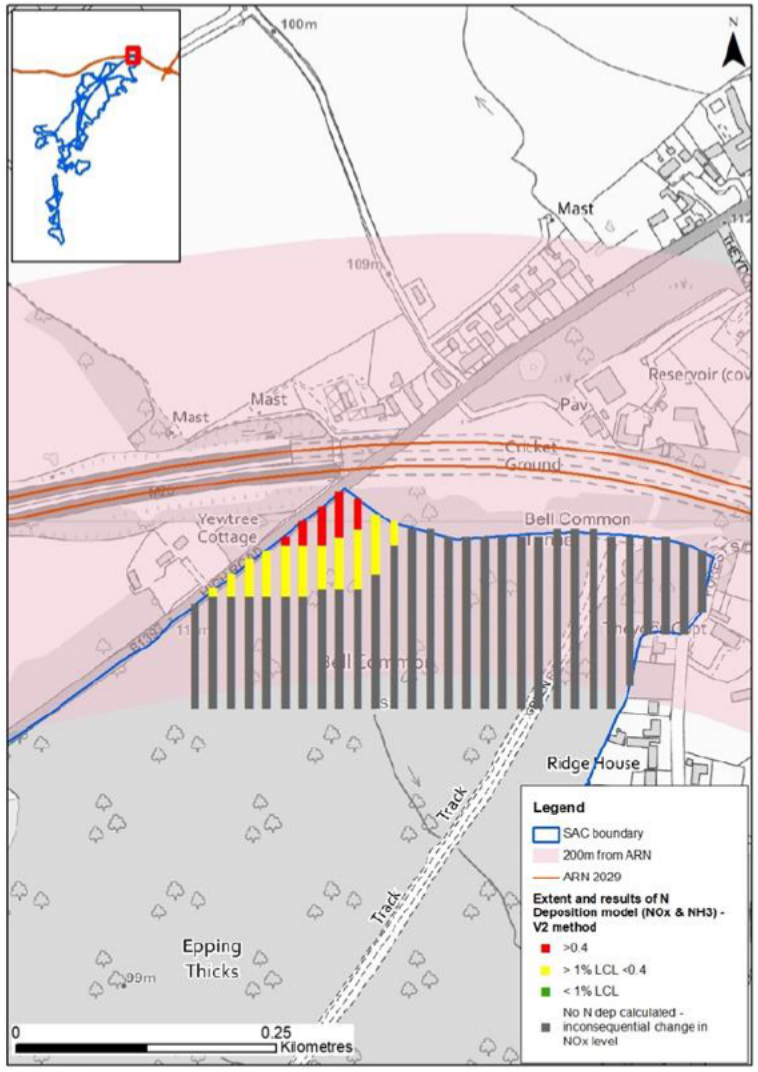
Assessment method	Assessment element	Summary of element
	Further considerations of HRA or EIA threshold exceedances	Within the HRA identification of exceedances of 0.4kgha^{-1}yr^{-1} thresholds from combined modelling
		As presented in DCO 1.0 Consider the spatial scale and duration of the predicted impact and the ecological functionality of the affected area • Proportion of the site affected
		Updated method since DCO 1.0 Consider the spatial scale and duration of the predicted impact and the ecological functionality of the affected area • Delay in timescale for a site to reach favourable condition when already exceeding environmental benchmarks and it has a restore objective. • Calculation of the timescale, in years, for the Do Something NOx concentrations to reduce to Do Minimum levels at opening year. Calculation method uses the LTC modelled NOx emissions on the relevant ARN link (relevant to the AQ model point for the designated site being assessed - The nearest ARN road link to the modelled AQ receptor point within each designated site is used. For designated sites with more than one AQ receptor point an individual calculation is done for each using the nearest ARN road links) to compare the DM NOx total emissions (tonnes) at opening year (2029) with the future predicted changes in NOx emissions for the same ARN link for the DS scenario. The future predictions are calculated for the DS scenario annually from 2029 to 2044. The duration of effect is considered to occur from the opening year until the year the DS total emissions of NOx fall below the DM total emissions at opening year. For designated sites that are affected by more then one ARN link, the worst case (longest duration to get back to DM) is used to represent the duration of effect for that designated site.
		New method since DCO 1.0 Consider the spatial scale and duration of the predicted impact and the ecological functionality of the affected area • Ecological recovery time (awaiting NE advice on how this could be assessed in light of no known evidence to predict such)
		New method since DCO 1.0

Assessment method	Assessment element	Summary of element
		Consider the spatial scale and duration of the predicted impact and the ecological functionality of each affected area • Evidence of site degradation as result of prolonged high levels of Nitrogen deposition • Not contested that historical Ndep has damaged site. No N-sensitive species recorded in surveys. Unknown whether there would have been without Ndep or how many if so. • Is this relevant to assessment of future effects?
		New method since DCO 1.0 Consider the spatial scale and duration of the predicted impact and the ecological functionality of each affected area • Degree of exceedance – is it significant? • The significance of the degree of exceedance is carried out in the further considerations of the assessment
		New method since DCO 1.0 Consider the spatial scale and duration of the predicted impact and the ecological functionality of the affected area • Site-specific – e.g. is site next to a permanent emission source? Undertaken through the in-combination assessment
		As presented in DCO 1.0 Consider whether the sensitive qualifying features of the site would be exposed to emissions: • Whether species that are sensitive to Ndep are present within the impacted area • Survey results and Ellenberg values
		As presented in DCO 1.0 In HRA consider the European site's conservation objectives • The target for air quality attributes associated with the qualifying habitats (Maintain or restore) – taken from Conservation objectives In EIA assume a "restore" target for air quality in the absence of any designated site conservation objectives.

Assessment method	Assessment element	Summary of element
		As presented in DCO 1.0 Consider background pollution
		As presented in DCO 1.0 Consider the designated site in its national context
		As presented in DCO 1.0 Consider site survey information
		As presented in DCO 1.0 Consider national, regional and local initiatives or measures which can be relied upon to reduce background levels at the site:
		As presented in DCO 1.0 Consider any likely in-combination effects with other live plans and projects from other sectors
		Would there be a 'lasting and irreparable loss' of part of the designated feature New consideration since DCO 1.0. • HRA: There would be no 'loss' of the feature (woodland habitat). The effect would be at worst a delay in recovery of quality of feature from historical effects. • EIA: There would be no "loss" of the features (woodland or grassland habitats). The effect would be at worst a delay in recovery of quality of feature from historical effects.
		Use of the Nitrogen Decision Framework • Currently no use of this framework - Not adopted or technically assurable by HE at this stage • What would the NDF do that isn't already being done by the current considerations?
The baseline data used in the assessment	Traffic data	Updated from DCO 1.0 Since DCO 1 there have been a number of changes that means that the modelled concentrations differ from the results presented in the DCO 1.0 assessment including traffic Data • The traffic data has been updated since DCO 1.0 which contain different assumptions in terms of the project design and other developments

Assessment method	Assessment element	Summary of element
		• The opening year changed from 2027 to 2029, which results in a change in emission factors (reduced emission of NOx due to cleaner fleet);
	Growth factor used	As presented in DCO 1.0 • Medium traffic growth factor used as per guidance
	Inputs to AQ model	As presented in DCO 1.0 but with updated diffusion tube monitoring data from M25, exclusion of imperceptible changes in NOx, and inclusion of ammonia as part of the Ndep calculations. Since DCO 1 there have been a number of changes that means that the modelled concentrations differ from the results presented in the DCO 1.0 assessment including: • The emission factors have changed from Emission Factor Toolkit (EFT) version 9 to EFTv10, which has resulted in a differing of emission factors used in the two assessments • The model verification has changed as a result of these changes in emission factors, model verification factors impacts on future year modelled concentrations; • The Ammonia (NH3) component to N deposition has been included in the assessment following representation from Natural England for its inclusion
	Botanical surveys	Update in method since DCO 1.0 • Surveys now include the use of habitat condition assessment forms from Defra Metric 3.0 to provide a consistent data set
The evidence available in the literature used in the assessment	Supporting reports, papers, plans and databases	As presented in DCO 1.0
Outputs of the AQ modelling	European Designated Sites	Updated from DCO1.0 Epping Forest SAC is the only European (International) designated site that is screened in for Ndep and exceeds the 1%LCL. The extent of the site affected is shown on Plate 1, with 0.81ha affected by N dep change of >1% LCL and 0.28 affected by N Dep change of >0.4 kgNha-1yr-1 (a total area of 1.09ha). The duration of this effect is approximately 4 years. This screening conclusion is not in agreement with the assessment of the competent expert and is presented on a without prejudice basis follows disagreement with NE in consultation prior to DCO 1.0 that LSE could be discounted and reports an assumption of LSE on the 1%LCL threshold as

Assessment method	Assessment element	Summary of element
		prescribed in LA115 standard para 3.11.1 "*Where the relevant SEB(s) disagrees with the reported screening conclusions and this matter cannot be resolved, then LSE should be assumed*". ***Plate 1: Epping Forest SAC – Extent of N deposition change in relation to the 1% and 0.4 thresholds***

Assessment method	Assessment element	Summary of element
		

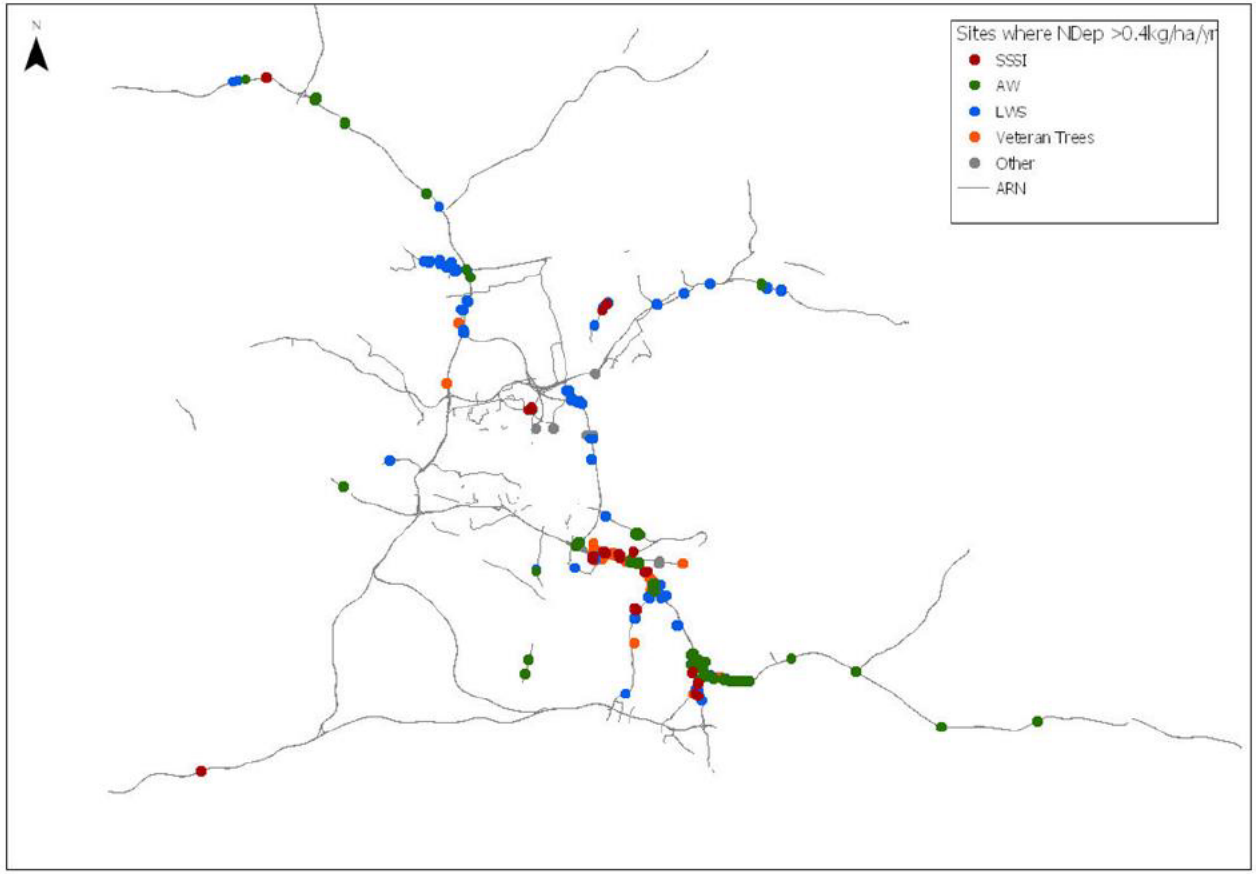
<table>
<tr><th>Assessment method</th><th>Assessment element</th><th>Summary of element</th></tr>
<tr><td></td><td></td><td>• All other European sites screened out as modelling shows no exceedance of the 1%LCL threshold
Note: North Downs Woodlands SAC was previously predicted to have an exceedance of 1%LCL. The latest modelling, which includes changes to the traffic data used and exclusion of imperceptible change in concentration of NOx in the air quality model, predicts no exceedance of the 1%LCL threshold for this site.</td></tr>
<tr><td></td><td>National and Local Designated Sites/ Habitats</td><td>Updated from DCO1.0
The table below shows the number of national and local designated sites and Veteran Trees (VT) that are screened in for Ndep and exceed the 0.4kgNha-1yr-1 threshold, the range of duration of impact and range of impact extents. Plate 2 illustrates the geographic extent of the sites where the NDep change exceeds 0.4kgNha-1yr-1 threshold.

Summary of the air quality impact for each of the designation groups
<table>
<tr><th>Designation</th><th>Number of sites exceeding the 0.4 kgha^{-1}yr^{-1} threshold</th><th>Minimum to Maximum Duration Range in Years</th><th>Impact Extent (ha)</th></tr>
<tr><td>SAC</td><td>1</td><td>4</td><td>0.28</td></tr>
<tr><td>SSSI</td><td>9</td><td>1 - >15</td><td>61.88</td></tr>
<tr><td>AW</td><td>40</td><td><1 - >15</td><td>72.24</td></tr>
<tr><td>VT</td><td>27</td><td><1 - >15</td><td>N/A - whole tree will be impacted.</td></tr>
<tr><td>LNR</td><td>1</td><td>6</td><td>3.47</td></tr>
<tr><td>LWS</td><td>37</td><td>2 - >15</td><td>105.74</td></tr>
<tr><td>RNR</td><td>7</td><td>4 - 11</td><td>Sites are part of wider LWS's and extents not currently calculated</td></tr>
<tr><td>SINC</td><td>4</td><td>2</td><td>0.33</td></tr>
<tr><td>SINC (GiGL)</td><td>10</td><td><1 - 2</td><td>30.53</td></tr>
</table></td></tr>
</table>

Assessment method	Assessment element	Summary of element

NIA	1	>15	93.94
Total for all designations	**137**	**<1 - >15**	**377.14**

Plate 2: Geographic extent of the designated sites where the change in NDep exceeded 0.4



Assessment method	Assessment element	Summary of element
Conclusions of stage 1 HRA screening for LSE		As presented in DCO 1.0 No LSE: Quantitative conclusion – absence of exceedance of 1%LCL threshold LSE cannot be discounted: Quantitative conclusion – prediction of exceedance of 1%LCL threshold Conclusions: No LSE: o Medway Estuary & Marshes SPA/Ramsar o Thames Estuary & Marshes Ramsar o The Swale SPA/Ramsar o North Downs Woodlands SAC Conclusion: LSE cannot be discounted o Epping Forest SAC This screening conclusion is not in agreement with the assessment of the competent expert and is presented on a without prejudice basis follows disagreement with NE in consultation prior to DCO 1.0 that LSE could be discounted and reports an assumption of LSE on the 1%LCL threshold as prescribed in LA115 standard para 3.11.1 "*Where the relevant SEB(s) disagrees with the reported screening conclusions and this matter cannot be resolved, then LSE should be assumed*".
Conclusions of Stage 2 HRA appropriate assessment of AEoI (unmitigated)	Epping Forest SAC	As presented in DCO 1.0 LTC conclude that AEoI can be discounted on the basis that: The further considerations within the assessment demonstrate that there is no real risk (as opposed to a theoretical risk) of an adverse effect on integrity.
Conclusions of EIA (unmitigated)	National and Local Designated Sites/ Habitats	A precautionary preliminary assessment indicates c.50% of sites assessed may be regarded as significantly affected, amounting to approximately 200ha of affected habitat. The preliminary conclusions presented on the number of different types of sites presented below will be updated as further detailed survey and assessment information is available. The preliminary results are therefore presented as indicative of the potential scale of the significant effects to help inform NE in providing their advice on their agreement with the conclusions and the likely approach and scale of mitigation and compensation measures.

<table>
<tr><th>Assessment method</th><th>Assessment element</th><th>Summary of element</th></tr>
<tr><td></td><td></td><td>

SAC: 0
SSSI: 6
AW: 28
VT: 12
LNR: 0
LWS: 11
RNR: 6
SINC/SINC (GiGL): 1
NIA:0

</td></tr>
<tr><td>Proposed measures to minimise the impact – Mitigation
Emerging thinking from NH for consultation prior to finalising proposals in December 2021, following NE advice on the presented thinking</td><td>HRA and EIA</td><td>
LTC has used the following approach to consider options to mitigate the sites where a significant effect has been predicted following consideration of the further considerations.
Approach to addressing significant effects – mitigation
<table>
<tr><th colspan="2">Mitigation Options to work through for each site considered</th><th>Necessary conditions to be a feasible measure</th></tr>
<tr><td rowspan="3">1. Reduction of impact at source</td><td>Physical barriers</td><td>9m high on flat topography to be quantifiable.
Unquantifiable otherwise</td></tr>
<tr><td>Speed limit reduction</td><td>70mph current speed limit (reduce to 60mph - otherwise ineffective)
Current average speed >60mph
Acceptable conflict with scheme or network objectives</td></tr>
<tr><td>Traffic management (enforcement cameras)</td><td>70mph current speed limit + Current average speed >70mph
Acceptable conflict with scheme or network objectives</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Assessment method</th><th>Assessment element</th><th>Summary of element</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><td>2. Disruption of impact pathway</td><td>Tree planting buffers or AQ-scrubbing technology</td><td>Does NE have evidence as to efficacy?
NH has evidence they do not work, so cannot propose</td></tr>
<tr><td rowspan="2">3. Reducing effect of impact on receptors</td><td>Removal of N from ecosystem e.g. removal of holly understory from affected area of the SAC</td><td>Within affected area of site
Agreed by NE to be 'mitigation' where it is 'additional' to existing management requirements
Site-specific plan adopted / agreed / secured</td></tr>
<tr><td>Build resilience of affected site through reduction of other threats / pressures or improving condition e.g. reduction in disturbance or enhanced connectivity</td><td>Within or adjacent to affected site
Agreed by NE to be 'mitigation' where it is 'additional' to existing management requirements
Site-specific plan adopted / agreed
Dependent on securing control</td></tr>
</table>
Approach to addressing significant effects – mitigation
<table>
<tr><th colspan="2">Compensation options where impacts not mitigable</th><th>Necessary conditions to be a feasible measure</th></tr>
<tr><td>Compensation planting</td><td>Habitat creation</td><td>Adjacent to affected site
Like for like habitat creation</td></tr>
<tr><td>Enhancement to build resilience</td><td>Build resilience of affected site through reduction of other threats / pressures or improving condition e.g. reduction in disturbance or enhanced connectivity</td><td>Within or adjacent to affected site
Agreed by NE to be 'additional' to existing management requirements
Site-specific plan adopted / agreed
Dependent on securing control</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Assessment method</th><th>Assessment element</th><th>Summary of element</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><td>Offsetting</td><td>Habitat creation and/or enhancement away from affected sites</td><td>Larger / more strategic biodiversity than individual site-based approach</td></tr>
<tr><td>Offsetting fund</td><td>Fund positive habitat projects by application / purchasing biodiversity credits</td><td>Confidence that sufficient 3rd party proposals would be forthcoming and/or suitable credits for an effective scheme can be obtained</td></tr>
</table>
</td></tr>
<tr><td></td><td>European Designated Sites</td><td>As per the assessment at DCO 1.0, LTC is of the view that no mitigation needs to be proposed at Epping Forest SAC as the effect on integrity is considered to be inconsequential by the competent experts.
Update since DCO 1.0
However, with due regard for advice from NE that they disagree with the conclusion of no AEoI, LTC has considered the efficacy and sustainability of mitigation options to deploy in the event that the Secretary of State agrees with NE.
The following mitigation options have been investigated, but because there is limited evidence to show they are feasible or effective they can be discounted:
o At-source mitigation: Physical barriers – barriers can only be modelled with certainty on flat topography and as the M25 is in cutting at this location, it is not feasible to propose barriers
o At-source mitigation: Traffic management, installing speed cameras to reduce the speed of the traffic – modelling has shown this would be ineffective
o Disruption of pathway mitigation options (tree planting or installing scrubbing technologies to reduce the nitrogen deposition travelling from the road source to the designated sites / habitats) - NH has evidence that they are not effective. However, if NE has evidence that such measures are effective, these options can be reconsidered</td></tr>
</table>

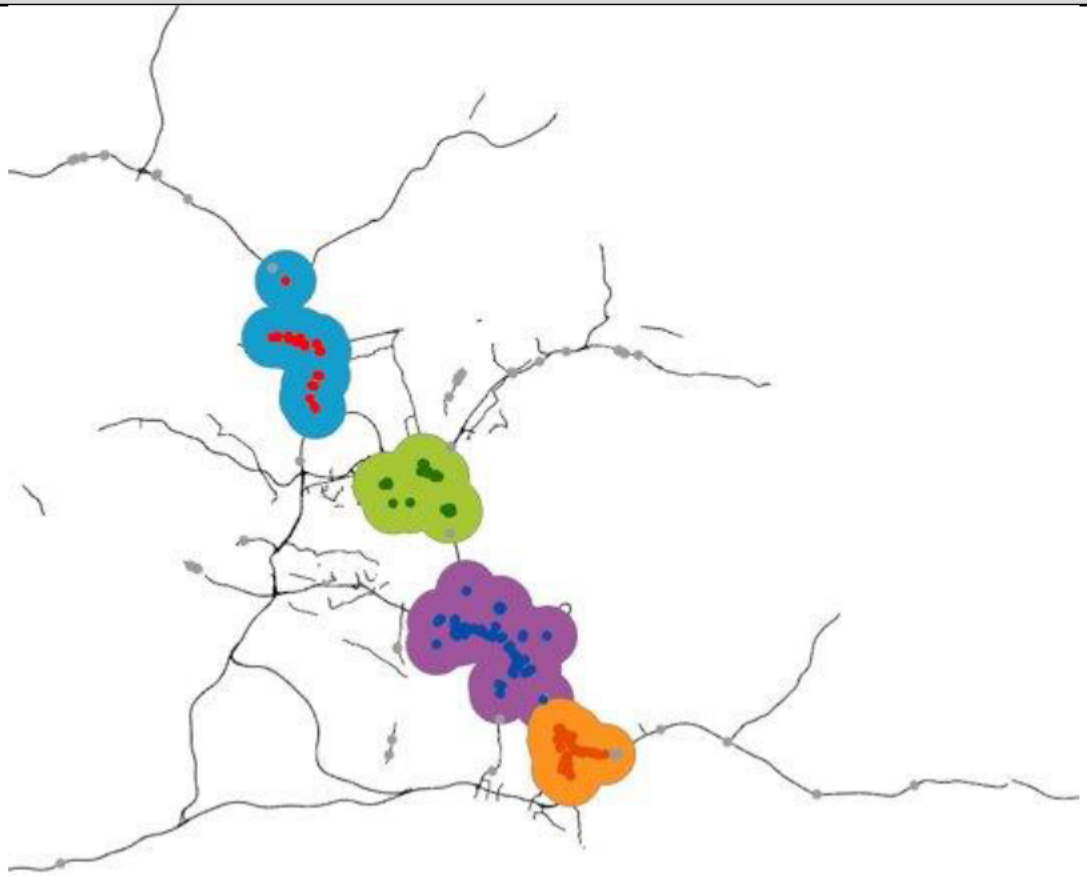
Assessment method	Assessment element	Summary of element
		LTC is currently considering the efficacy and suitability of the following two options in consultation with NE to understand the implications of any potential mitigation measures. The engagement on these options is to identify whether NE would agree to the suitability and effectiveness of the measures to avoid, in NE's view, adverse effects on integrity, if they were to be required to be implemented.
		Without prejudice mitigation option still being considered: Reduce impact at source through imposition of a reduction in speed limit from 70mph to 60 mph on the westbound carriageway, 24 hours a day for 4 years. This potential measure has been modelled as effective (modelled avoidance of exceedance of 1%LCL in the SAC + current speed >60mph). LTC is currently checking legal / safety / technical feasibility, but if there are no such constraints, it is LTC's view that implementing this would be sufficient to meet NE's concern to avoid adverse effects on integrity (though NH's position is that this would be unnecessary to exclude AEoI, given the inconsequential nature of the effect). LTC considers there is potential to identify and assess this option at examination on a 'without prejudice' basis. NH would not support imposition of speed limit given professional judgment of no AEoI but in recognition of NE's concerns, it has considered the feasibility of the measure which, subject to ongoing technical feasibility considerations could be imposed if the Examining Authority and Secretary of State consider it necessary in order to exclude AEoI Consideration of this option is in the context of the option's potential implications for scheme and network objectives, in light of the LTC conclusion of No AEoI. It is not considered appropriate for NH to support a measure that may have implications for its scheme and network when it concludes there are no effects requiring mitigation.
		Without prejudice mitigation option still being considered: Reducing the effect of impact on the receptor through implementing an agreed set of management measures within the impacted area within the SAC, including potentially removal of N from ecosystem e.g. removal of holly understory; and/or to build resilience of impacted site through reduction of other threats / pressures or improving condition e.g. reduction in disturbance or enhanced connectivity. There is an argument that such measures might be expected to reduce the magnitude of any detrimental response of receptors from increased Ndep, In the case of holly removal, the reduction of nitrogen in the ecosystem might be expected to offset increased nitrogen in the system by removing nitrogen from the system. In the case of managing other threats and pressures, it might be expected that receptors would be less likely to respond adversely to nitrogen deposition if they

Assessment method	Assessment element	Summary of element
		were less adversely affected by other impacts. However, there are uncertainties whether these measures could be considered as mitigation (as opposed to compensation in light of case law) and whether they would consider additional to required management of the SAC and therefore acceptable as mitigation. LTC could potentially identify and assess such measures if NE support such measures in-principle as appropriate as sufficient mitigation to exclude AEoI. This would include NE supporting such measures as being mitigation (as opposed to compensation) and that they would be additional to existing management requirements of the SAC
	National and Local Designated Sites/ Habitats	Updated from DCO1.0 LTC proposes the following approach to mitigation/compensation. • Undertake a site-by-site assessment of need for mitigation (significance of effect and on what features) and propose mitigation for significantly affected habitats in the first place and compensation where mitigation is not feasible. Each site's assessment will be suitable for the regulatory tests associated with the type of designation. • Test at-source avoidance of impact mitigation as identified in LA105 (physical barriers, traffic management (speed cameras) or speed limit reductions) where these are shown to be feasible through modelling of efficacy and consideration of feasibility from other constraints such as safety and implications for scheme and network objectives • Discount 'disruption of pathway' mitigation options (tree planting or installing scrubbing technologies to reduce the nitrogen deposition travelling from the road source to the designated sites / habitats) as NH has evidence that they are not effective. However, if NE has evidence that such measures are effective, these options can be reconsidered. • Discount measures to reduce the effect on the receptor on a site-by-site basis, as such measures would be uncertain as to their efficacy and whether they can be considered as mitigation and/or additional to existing management requirements. Such measures (e.g. removal of N from ecosystem e.g. removal of holly understory from affected area and/or build resilience of affected site through reduction of other threats / pressures or improving condition e.g. reduction in disturbance or enhanced connectivity). It is considered that the uncertainties associated with this type of measure makes them inappropriate to propose as mitigation on a site-by-site basis

Assessment method	Assessment element	Summary of element

		• For significantly affected habitats, where mitigation is not feasible, consider compensation measures such as:
		  o Compensation planting – creation of new patches of the same habitats adjacent to each affected site / habitat
		  o Enhancement to build resilience – measures within or adjacent to each affected site / habitat to build resilience of affected habitats through reduction of other threats / pressures or improving condition e.g. reduction in disturbance or enhanced connectivity
		  o Offsetting – compensation planting within the network of affected sites / habitats (i.e. not necessarily directly adjacent to individually affected sites / habitats)
		  o Offsetting fund – provision of a fund to facilitate positive habitat projects by application / purchasing biodiversity credits
		• Not prefer compensatory planting and/or resilience measures on a site-by-site basis on the basis that a strategic, landscape scale compensatory planting approach would provide greater long-term ecological benefit and be consistent with DEFRA advice and agreed approach with NE - Offsetting multiple nearby effects
		• An offsetting fund is not favoured on the basis that it would not necessarily support measures in the vicinity of the impacts arising from LTC and that tangible, local compensation measures are to be preferred.
		• It is considered by LTC's competent experts that, where necessary, a small number of larger compensation measures associated with identifiable habitat networks would provide the best available ecological option for compensating for theoretical degradation across a number of sites within the networks. This would provide permanent, meaningful, landscape-scale habitat creation areas that would be a long-term habitat resource of equal area to theoretical degradation. It is thought this would be a precautionary response to significant effects, but defensible on the basis of long-term high-quality solution in light of uncertainties and time to maturity
		• Define appropriate habitat networks within which to provide a smaller number of larger compensatory planting measures, using Density based cluster GIS analysis to identify networks within the overall network of affected sites across the ARN, where connectivity / proximity of sites / habitats is greater than to sites / habitats in other networks. This would

Assessment method	Assessment element	Summary of element
		define the number of search areas for appropriate compensation measures to provide permanent habitats to offset theoretical incremental degradation of habitats that are already affected providing an approximately equal area of new habitat to significantly affected habitat, spread across the different networks • Identify options for suitable measures within each network • Carry out constraints and feasibility studies on options • Identify the best available ecological location / option that can be feasibly secured • Consult on detailed measure within chosen location • Secure within the DCO Order Limits Initial analysis Initial density based cluster analysis of impacted sites has identified the networks below as search areas for compensation measures.

Assessment method	Assessment element	Summary of element
		
The conclusions made in light of the assessment and mitigation	HRA Stage 2 appropriate assessment of AEoI IF speed limit reduction on the section of the	Update from DCO 1.0 • LTC concludes that AEoI can be discounted without mitigation as the effect on the habitats caused by the nitrogen deposition would be inconsequential • However, if the Competent Authority impose the speed limit identified on a without-prejudice basis, then AEoI can be discounted on the basis that the mitigation avoids any exceedances of

Assessment method	Assessment element	Summary of element
	M25 were to be imposed by ExA / SoS	the 1%LCL threshold (though NH's position is that this would be unnecessary to exclude AEoI given the inconsequential nature of the effect).
	HRA Stage 2 appropriate assessment of AEoI IF an agreed package of site management measures were to be implemented	Update from DCO 1.0 NE are asked for their advice alternatively on whether, a package of site management measures, if implemented, would enable the competent authority to conclude that AEoI can be discounted on the basis that the mitigation reduces the risk of AEoI to an inconsequential scale as the measures would make the receptor habitat more resilient to Ndep effects. LTC will consider this option further on receipt of NE's advice on its efficacy and appropriateness as identified without prejudice mitigation.
	EIA assessment of residual significant effects	• Assessment of effectiveness of mitigation - Quantitative conclusion based on modelled efficacy of measures • Report abundance of precaution in all stages of assessment methodologies • Report the significance of effects on every site considered in the assessment • Report no significant effects where at source mitigation is fully effective • Report significant effects where at source mitigation not fully effective
Conclusions of adequacy of compensation for EIA effects		o Professional judgement that the compensation proposed is a precautionary but proportionate response to reporting of unavoidable significant effects

6 Methodology and standards for data analysis, outputs and consultations

6.1.1 The main methods (based on DMRB standards) used have been consulted on prior to and since the first application for a DCO. The traffic reports, air quality and terrestrial biodiversity chapters of the ES, and the HRA screening and SIAA reports were shared for consultation on those methods.

6.1.2 Since withdrawal of the first application, ammonia has now been included in the modelling of Ndep. The methodology has been shared with Natural England and peer review of the method is being undertaken.

6.1.3 Consultation has been ongoing since before the first application for DCO through calls and sharing of technical notes. Since withdrawal of the first application consultation with Natural England has been undertaken at the project level and at a national policy level in an attempt to agree methodologies and how to make final conclusions on AEoI. Consultation continues at both national policy and project levels. This evidence plan is meant as a record of the iterative consultation at project level.

6.1.4 A programme of milestones for the consultation is in use to manage timescales of the consultation, which will be reviewed and amended as necessary as the consultation progresses.

7 Timetable for implementing and reviewing the plan

Table 2: Proposed timetable

Review milestone	Date
Revision 0 of AQ evidence plan to discuss / agree format and process of iterative document to manage / facilitate consultation	w/b 9 Aug
Revision 1 with final modelling outputs and mitigation proposals to be issued to NE	w/b 1 Nov
AQ specific workshop - to present the final results and mitigation proposal	w/b 1 Nov
AQ specific workshop – to explain the final AQ modelling method that has caused North Downs Woodlands SAC to be screened out	w/b 8 Nov
Comments / advice from NE on Rev 1	w/b 29 Nov
AQ specific workshop - to receive feedback from NE and discuss	w/b 6 Dec
Circulation of pre-application draft assessments, having had due regard for NE advice	w/b 2022

8 Agreement on the scope of the evidence

8.1.1 **Error! Reference source not found.** enable the level of agreement on each element of the assessment to be recorded. A series of specific questions are asked of NE for each element of the assessment outline above.

8.1.2 SoCG text could be developed in future iterations of this evidence plan if appropriate and considered by NE to be a more efficient way of recording the consultation than iterating drafts of the SoCG itself.

The questions asked of NE to provide specific, actional advice on each element are:Does NE agree this element of the assessment is appropriate for the purposes of stage 2 appropriate assessment?

Would any disagreement contribute to NE being unable to agree the final conclusion of the assessment on AEoI?

Would any disagreement relate to advice on what could be improved in the element, but would not be of sufficient significance to contribute to being unable to agree with the final assessment conclusion on AEoI?

NE advice on why NE does not agree with the element ("clear and credible reasoning") – including what is significant; what thresholds / frameworks to work within to identify scale of effect and significance; and where would the precautionary principle kick in

NE further advice on "further modifications / conditions / restrictions that could, in NE's view, enable the competent authority to conclude no AEoI"

Does the disagreement or further advice relate to a national policy issue or an issue in the gift of the project?

Appendix A Change log

A.1.1 Rev 1

A.1.2 Issued to NE Nov 2021

A.1.3 Revision 1 includes the following updates of the evidence plan

i. Inclusion of final result of air quality modelling

ii. Inclusion of potential mitigation options for consultation

iii. Amendment of HRA and EIA conclusions in light of final AQ modelling results and potential mitigation options

iv. Inclusion of further briefing on the following elements of the assessment

    i. Traffic modelling

    ii. AQ modelling

v. Updates to programme

A.1.4 Amendments in light of NE advice received since Rev 0 include:

vi. NE recalled in an update call that NH had developed their own traffic methodology in terms of emissions calculations. He asked if it is a local project approach or a HE approved method? RC replied that the approach is a standard approach prescribed in DRMB. He noted that NE has previously commented on whether the traffic modelling has sufficiently considered in combination effects and LTC confirmed that a standard approach has been taken. The traffic and air quality assessment methods have been described in this revision to include narrative of where the methods have been 'standard' and where bespoke methods have been used.

vii. NE noted it would be worth adding in specific questions for their specialists. Specific questions have been incorporated into the main text where appropriate as additional questions to those posed in the tables, which represent the main actionable advice sought.

Annex I Technical note on the methodology for assessing speed limits

Methodology for the assessment of Speed Limits.

As outlined in DMRB LA105 speed limits are an option that can be used as a mitigation measure for adverse air quality effects. The benefits in terms of emissions can be quantified and hence modelled to show the predicted impact of enforcing a speed limit on a section of road. For speed limit or enforcement to be a viable option however the road needs to have a speed limit of 70mph with vehicles traveling in excess of 70mph.

National Highways have undertaken research into vehicle emissions as a function of speed and have identified that the lowest emissions occur at speeds of around 60mph for Light Duty Vehicles (LDV) (cars and vans). LDV emissions increase with speed with sharp increase in emissions as vehicles travel in excess of 70mph. DFT statistics suggest approximately 40% of LDVs exceed the 70mph speed limit on motorway and as a result reducing vehicle speeds and improving compliance with the speed limit can result in an emissions benefit and as a result an improvement in air quality.

National Highways have developed vehicle emission factors (based on the emission factor toolkit), which are incorporated into their speed band emissions tool and represent a number of speed related scenarios, including;

- High Speed – Motorway unconstrained and a proportion of the LDVs exceed 70mph;
- 70mph Enforced – Enforced 70mph and as a result an improvement in LDVs complying with the speed limit;
- 60mph Enforced – Enforced 60mph, which results in a greater proportion of the fleet traveling at speeds close to 60mph and less vehicles traveling in excess of 70mph.

Emissions per vehicle reduce for LDVs as compliance with speed improves, from the highest emission rates at High Speed through to lowest emissions at 60mph Enforced.

Speed limits are only effective in reducing emissions where the traffic model suggests that vehicle speeds are in the High-Speed band and a 70mph or 60mph enforced speed limit could be introduced. In order to determine whether a speed limit would lead to an improvement in emissions on the section of the M25 next to Epping Forest the following steps were undertaken.

1. The modelled traffic data was interrogated to determine whether there were any High-Speed links between Junction 26 and 27 of the M25;
2. Following the identification of High-Speed links from the traffic model, actual traffic speeds collected from the traffic master dataset were interrogated to determine the real-world situation in terms of compliance with the speed limits. This was undertaken to ensure that the benefits of a speed limit were not being exaggerated. For example, if compliance in the real world was more representative of a 70mph enforced situation, assuming the speeds were going from High Speed to 60mph enforced would lead to an over prediction in the improvements in emissions and the benefits of the speed limit on changes in N Deposition;
3. Based on the analysis in Step 2, the air quality models were rerun with the appropriate speed bands in both the Do Minimum and Do Something scenarios, allowing the air quality impact of the proposed speed intervention to be predicted.

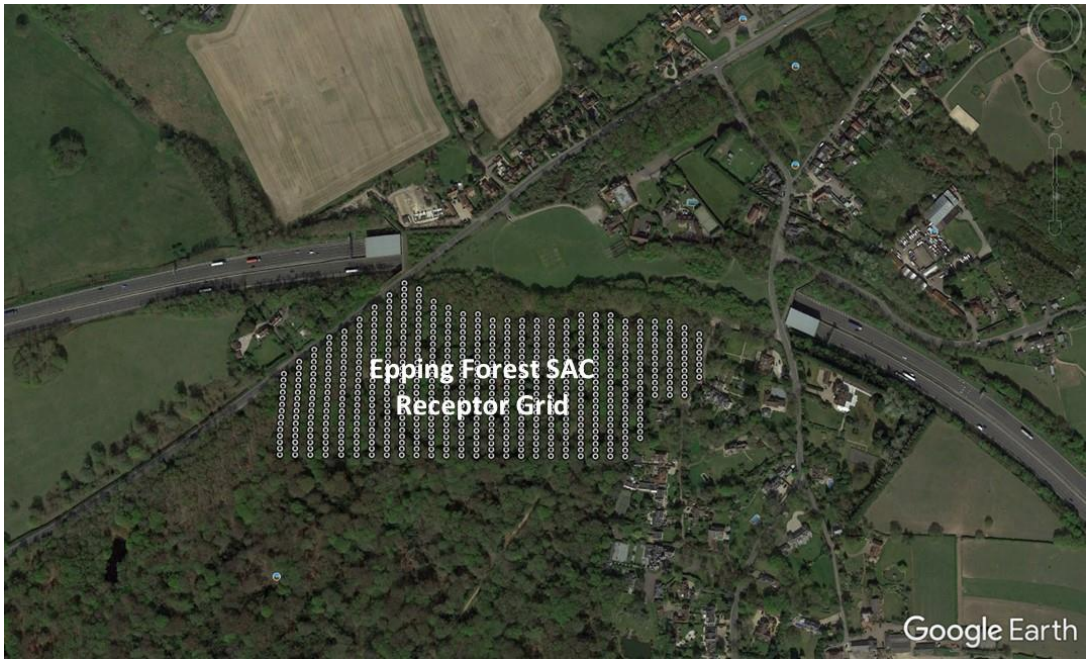
The results from the process above are discussed in the following sections.

Background

The Lower Thames Crossing Project is predicted to lead to an increase in nitrogen (N) deposition in Epping Forest SAC, due to changes in oxides of nitrogen (NOx) and ammonia (NH3) from traffic

emissions associated with the Project. Epping Forest SAC is affected by vehicle emissions from the M25 where the motorway passes through Bell Common tunnel between junction 26 and 27, as shown in Figure 1.

Figure 1: *Epping Forest SAC and Air Quality Receptor Grid*



Air quality modelling has been undertaken to investigate the reduction in N deposition that might be achieved by implementing speed restrictions.

An analysis of observed speeds on the M25 between junction 26 and 27 indicates that there is already a high compliance of vehicles observing the national speed limit of 70 mph. As a result, it was concluded that the use of a 70mph speed limit would not be effective in reducing vehicle emissions as it would have limited impact on the speeds the vehicles are currently travelling at.

Two mitigation scenarios have therefore been investigated:

- 60mphEW - on both the East and Westbound carriageways: A 24h speed limit of 60mph on a section of the M25 eastbound and westbound (length to be defined, model assumed all links between junction 26 and 27);
- 60mphW - Westbound: A 24h speed limit of 60mph on the M25 westbound only (length to be defined, model assumed all links between junction 26 and 27);

Model Setup

The same air quality model and methodology used for the Environment Statement has been used to model the mitigation scenarios, except for adjustment of speed bands, based on the analysis of current speed limit compliance and the use of speed bands for the 60mph mitigation scenarios.

Annual mean NO_x concentrations were predicted across a grid of receptors extending across Epping Forest SAC (within 200m of the M25), as shown in Figure 1. It has not been necessary to convert the NO_x concentrations to N deposition as NO_x is correlated to N deposition (from NO_2 and NH_3), so if the mitigation scenario leads to a reduction in NO_x relative to the Do-Minimum scenario, then this would also trigger a reduction in N deposition.

The following traffic datasets have been used for the air quality modelling:

- CM22 – Do-Minimum 2029
- CS40 – Do-Something 2029

It should be noted that the traffic data was modelled for the following periods (consistent with the modelling undertaken for the Environmental Statement):

- AM peak period (06:00 to 09:00)
- Inter-peak (IP) period (09:00 to 15:00)
- PM peak period (15:00 to 18:00)
- Off-peak (OP) period (18:00 to 06:00)

All traffic periods where the speed band for the M25 was 'high speed' were changed to the speed band '70mph speed limit' in the Do Minimum which reflects the analysis undertaken in terms of current compliance with the speed limit. This was to ensure that we did not over predict the improvements that could be achieved in relation to speed control. In the 60mph mitigation scenarios the Do Something traffic data was used and where the previous modelling suggested 'high speed' the speed band was set to '60mph speed limit'. In the scenario where only the westbound carriageway was proposed to be 60mph and the eastbound carriageway speed limit was unchanged, the links on the eastbound were changed to 70mph speed limit speed band again reflecting the analysis of vehicles speeds on this section of the M25. The speed band changes above were made on all M25 mainline traffic links between junction 26 and 27. Table 1 shows the periods which are high speed in the traffic model Do Something scenario for M25 links within 1.5km of Epping Forest SAC.

Table 1: *Periods with High Speed Traffic Flows in Do-Something Model*

Direction	Periods with High Speed traffic flows
M25 Westbound	IP, PM and OP
M25 Eastbound	AM, IP, PM and OP

High speed relates to the observed speed during these periods

Results

The mitigation scenarios annual mean NO_x concentrations were compared to the Do-Minimum scenario to investigate whether they would be likely to mitigate the increase in NO_x and therefore nitrogen deposition associated with the Project.

Table 2 shows the maximum, minimum and average change in NO_x predicted in Epping Forest SAC in each mitigation scenario (relative to the Do-Minimum scenario).

Table 2: *Minimum, maximum and average change in NO_x ($\mu g/m^3$) predicted in Epping Forest SAC with each mitigation scenario*

Scenario	ES Change	60mphEW	60mphW
Minimum	+0.07	-0.85	-0.67
Maximum	+1.69	-0.08	0.0
Average	+0.19	-0.16	-0.06
	The minimum, maximum and average changes in NO_x are for the mitigation scenario NO_x minus Do-Minimum NO_x		

Scenario 60mphEW and scenario 60mphW both lead to a decrease in NO_x (and therefore N deposition) across Epping Forest SAC. As shown in Table 2, there are no receptor grid points where NO_x is predicted to increase with these mitigation measures in place (the maximum change is -0.08 µg/m^3 for scenario 60mphEW and 0.0 µg/m^3 for scenario 60mphW), indicating that a 60mph speed restriction would mitigate the increase in nitrogen deposition associated with the Project.

There is little difference in the impact between the 60mphEW and 60mphW scenario which indicates that implementing the 60mph speed restriction on both the eastbound and westbound carriageway would have little additional benefit over implementing the speed restriction on the westbound carriageway only. This can be explained by the fact that Epping Forest SAC is located adjacent to the westbound carriageway and is strongly affected by tunnel emissions which occur from the westbound tunnel exit portal. Furthermore, the Project leads to an increase in traffic of approximately 3,600 vehicles per day on the westbound carriageway, but only approximately 900 vehicles per day on the eastbound carriageway.

Summary

Air quality modelling has been undertaken to examine the extent to which three different mitigation scenarios would reduce the impact of the Project on N deposition in Epping Forest SAC. Introducing a 24-hour speed restriction of 60mph on the M25 is expected to lead to a reduction in nitrogen deposition in the SAC, and this could be achieved with a speed restriction on only the westbound carriageway.

Uncertainties

It should be noted that these mitigation scenarios would need to be remodelled when we receive traffic data for the next design iteration to ensure that the conclusions of this note are still valid.

Annex J Note on Modelling Approach for Designated Sites

Lower Thames Crossing

Note on Modelling Approach for Designated Sites

1. Introduction

Following the meeting on the 8 h November 2021 and the 6th December 2021 with Natural England the Lower Thames Crossing (LTC) team agreed to provide clarification on the approach to be followed for the assessment of N deposition on designated sites. This note also sets out the rationale for the screening out of N deposition effects on North Downs Woodlands SAC. Other changes to the air quality modelling of designated sites previously submitted at DCO1 were also discussed in the meeting in order to ensure consistency with the Human Health aspect of undertaking the air quality modelling in order to align with the DMRB LA105 air quality standard.

It should also be noted that there will be changes to the N deposition results once the next iteration of the traffic data is run through the air quality model. However, the approach described in this note will apply to any future updates to the air quality modelling.

Since DCO 1 there has been a number of changes to the air quality model inputs and to the assessment methodology which have led to a change to the N deposition results from those presented at DCO1, these changes comprise;

1. Traffic Data – The traffic data has been updated and contains different assumptions in terms of the project design and other developments (National Highways projects and/or 3rd Party developments);
2. The opening year has changed from 2027 to 2029, which results in a change to vehicle emission factors (reduced per vehicle emissions of NOx due to a cleaner fleet in the Emission Factor Toolkit (EFT) for 2029 compared to 2027);
3. The emission factors have been updated from EFT version 9 to EFTv10, which has changed the emission inputs into the model;
4. Background air quality maps and the NO_x to NO_2 tool have been updated, which affects the post-processing of the model outputs (e.g. fraction of NO_x assumed to convert to NO_2);
5. The model verification against monitoring data has been updated for the new air quality modelled results, and takes into account the latest updates to the emissions factors and associated air quality tools.
6. National Highways has developed a series of ammonia (NH_3) adjustment factors, to be applied to the modelled road NOx concentrations. This allows for the calculation of a representative NH3 concentration and for inclusion in the calculation of N deposition. This follows representation from Natural England for the inclusion of NH_3 in this assessment.

Given the changes set out above, it is not a straight forward process to compare model results from the DCO 1 assessment to the current DCO 2 assessment. It is not the purpose of this note to determine which of the above changes, either singular or in combination has resulted in the greatest difference to the model results between DCO1 and DCO2. Some changes, for example, will mean that emissions from the model may be higher, e.g. increased traffic flows in the latest traffic model, whilst some changes, such as the later opening year will mean that emissions from EFTv10 will be lower.

2. Modelled Outputs DCO1 v Current Assessment

North Downs Woodland SAC is not located within 200m of the proposed route for LTC, but is affected by changes in traffic flows in the road network away from the scheme. The maximum change in modelled road NOx concentration between the with and without the Project scenario is presented for North Downs Woodland SAC in Table 1 for DCO1 and DCO2.

Table 1 – Maximum Change in Modelled Road NOx predicted in North Downs Woodlands SAC

	DCO Version 1	Updated Assessment for DCO Version 2
Modelled Change in Annual Mean Road NOx	+0.44µg/m³	+0.28µg/m³
1% of NO_x Annual Mean Critical Level	0.3 µg/m³	

As can be seen from Table 1, there are differences in the maximum change in Road NOx modelled in North Downs Woodlands SAC between the two assessments. At DCO1, the modelled concentrations were above the 1% critical level criteria, i.e. the change was greater than 0.3 µg/m³. The latest modelled road NOx concentration for DCO2 is now less than 0.3µg/m³ and therefore in line LA 105, it is considered to be imperceptible and has been scoped out from the assessment. As the maximum NOx concentration is less than 0.3µg/m³ the modelled NOx has not been used to calculate modelled road NO2 nor used in the calculation of NH3; both of which are used to calculate total N deposition.

The presentational change in reporting is consistent with the way we report impacts on human health. For human health and evaluation of limit value compliance we consider changes in air quality that are 1% of the AQS Objective / limit value (or less) to be imperceptible. This is consistent with other advice when undertaking modelling, not only in LA 105 but advice published by Environment Agency, Institute of Air Quality Management guidance and Natural England's Advice in NEA001. In all instances, where the change in concentration is 1% of the relevant pollutant threshold, it is considered imperceptible.

It is our opinion that if the judgement is made that the change in NOx is so small it is imperceptible, it is not reasonable to use this information to calculate NO_2 and NH_3 in order to inform the N Deposition assessment. Applying factors to generate another threshold from a modelled result which is imperceptible cannot be relied upon and is not appropriate.

It is worth noting that the N deposition calculations are undertaken as follows;

1. Model is used to generate road NOx;
2. Road NOx is verified using monitoring data;
3. Road NOx is factored to provide Proxy NH_3 concentration for N Deposition calculations;
4. Road NOx converted to Road NO_2, utilising Defra NOx to NO_2 calculator;
5. NO_2 factored dependent on vegetation type to generate N Deposition from NO_2 component.

Therefore, as can be seen in the steps above the generation of N deposition is totally dependent on the road NOx output from the air quality model.
Therefore, just because a change in concentration can be modelled does not mean that any significance should be attributed to that change when it is so small. Air quality models will show a

level of change over the modelled domain, this is in part due to the way the model algorithms in dispersion models work i.e. theoretical infinite end point.

3. Approach Going Forward

Before the modelled NOx concentration is converted to N deposition (modelled road NOx being the basis of generating both road NO_2 and NH_3 elements of N deposition), the changes in modelled road NOx between the Do-Minimum and Do-Something scenarios will be reviewed. Where the modelled road NOx changes are less than 1% of the NOx annual mean critical level of 30µg/m³, i.e. ≤0.3µg/m^3, they will be classed as imperceptible change and not used to calculate road NO_2 nor road NH_3. Consequently they will not be converted to N deposition and used in the judgement of the impacts of N deposition on the receiving habitat. Change in NOx of less than 0.3µg/m³ are so small that there is no certainty that it is a real change i.e. artificial precision and even with measurements made with a reference method automatic air quality analysers it would not be able to measure such changes in NOx concentrations with any certainty.

Given that NOx concentrations underpin the calculations of N deposition, where changes in NOx concentrations are considered imperceptible(<0.3µg/m³), then no calculation is required. This is consistent with the assessment of human health, where changes in air quality that are 1% of the AQS objective are considered imperceptible. It should be noted, for ecological sites, 1% of the critical level (i.e. 0.3µg/m^3) is a much smaller threshold than 1% of the NO_2 AQS objective (0.4µg/m^3 of NO_2 is equivalent to approximately 0.8µg/m^3 of NOx). Whilst we considered that an imperceptible change in line with human health could be argued to be transferable to the ecological sites (given that NOx is converted to NO_2 and it's the NO_2 that is used to generate the N Deposition) it was decided to take a **precautionary** approach, given that it will be used to assess impacts on European ecological sites.

This approach is applicable to all National Highways air quality assessments and is not specific a requirement for the assessment of LTC.

4. In-combination effects

There are two discrete elements that should be considered in relation to in-combination effects in the opening year of the Project;

- Traffic related changes associated with other developments to the Project;
- Non traffic related contribution that are currently not in operation i.e. agricultural or Industrial.

Any development that is planned and likely to be in operation (based on level of certainty) before the opening year of the Project would form the future baseline (Do Minimum scenario). It is not realistic to consider a scenario where there is no development between now and the Project opening and all developments open at the same time. Consequently we would not assess no development versus all permitted developments that are due to open between now and the Project, opening in the same year of the Project.

4.1. Road traffic

The traffic modelling has been undertaken in line with DFTs published advice. This includes advice on the assessment of likely planning applications coming forward and operational in the scheme opening year.

In addition, the traffic modelling incorporates tempro growth factors which are a representation of government policy for growth and development across the country.

Traffic modelling is therefore providing a reasonable representation of in-combination effects.

4.2. Non Traffic Sources

A review of potential future non traffic sources has been undertaken to determine whether there is any future plans or projects such as industrial or agricultural processes that haven't been included in the air quality model that would result in a larger change than has reported in the ES. This process has identified whether there are any projects within the planning regime where;

1. There is any certainty that the project is likely to go ahead;
2. Opens in a similar timescale to LTC;
3. There is potential for emissions of NOx or NH_3;
4. The emissions may cause a cumulative impact with our modelled concentrations.

Where there are any new industrial or agricultural processes identified by the above then they would be included in the assessment of in-combination effects.

This ensures that in-combination effects are considered for areas such as North Downs Woodlands SAC.

Annex K Technical Note Ramsar Advanced Grouting Tunnel and Main Tunnels Numerical Model

Advanced Grouting Tunnel 'Ramsar Tunnel' Brief

1 Background

Lower Thames Crossing (LTC) tunnels pass under the Ramsar site on the southern bank of the Thames, with their required alignment passing close to or through challenging young deposits that are associated with estuarine areas; alluvium and river terrace deposits (RTD). This poses a difficulty when tunnel face interventions are required. Due to groundwater the interventions will be required to be undertaken under compressed air for face stability and prevention of inflow of groundwater. Due to the distance under the Ramsar site, North Kent Railway and Lower Higham Road being approximately 800m, provisions for planned interventions are required.

Interventions with relative low cover (11m (0.7D)) pose the risk of not being able to maintain air pressure in the face or potential of a blowout. This risk is increased due to the geology of weathered chalk in the crown below the RTD and alluvium, then moving into a point of RTD and alluvium are in the crown.

This risk during interventions requires ground treatment above the crown to create the stable ground conditions. Traditionally this would be undertaken from the ground surface drilling down to the designed level. However, due to the sensitivities of the Ramsar site, this approach is not possible and requires an alternative approach to be developed.

The current proposed method for enabling pre-treatment of the ground is proposed within this note. The developing design of the proposed intervention tunnel is presented in Appendix A and will be a mitigation option for the design and build contractor, if other options available to them are potentially deemed too high a risk. Although, the works explained are part of the risk contingency and not the main scope of works, the proposals will be assessed appropriately as part of the core assessments that make up the Development Consent Order application.

The concept consists of a launch shaft approximately 9.7m outer diameter (OD) just south of Lower Higham Road in an agricultural field (see Figure 1). From this an approx. 5.8m OD tunnel is launched using an Earth Pressure Balance Machine (EPBM) to drive under the Ramsar site and railway to the Met Police firing range. A second shaft for the reception (Figure 2) of the Tunnel Boring Machine (TBM) would be sunk in the Met Police firing range. The intervention tunnel enables the grouting of the RTD to be completed below the Ramsar site above the alignment of main tunnels at predetermined locations. This enables planned TBM interventions to take place in the corresponding location during the construction of the main LTC tunnels. LTC's proposals would allow for four locations for robustness, due to the uncertainty in wear rates of the TBM cutting face. However, it is anticipated that a contractor would only require two interventions.

Additional to the intervention points the tunnel could be used by the contractor to grout the RTD and chalk around the cross passages. This grouting would typically be

undertaken from within the completed main bores but would allow a very slight programme benefit being undertaken from the intervention tunnel.

On completion of the works, both main tunnels passing Lower Higham road and the four cross passages under the Ramsar being completed, both the shafts and temporary tunnel would be backfilled. This would leave no temporary works in the upper 2m of ground and the sites would then be returned to their original use.

2 Components

- Launch Shaft: 9m ID (approx. 9.7m OD) 16m deep with a concrete base plug to resist flotation. Methods would require no active dewatering.

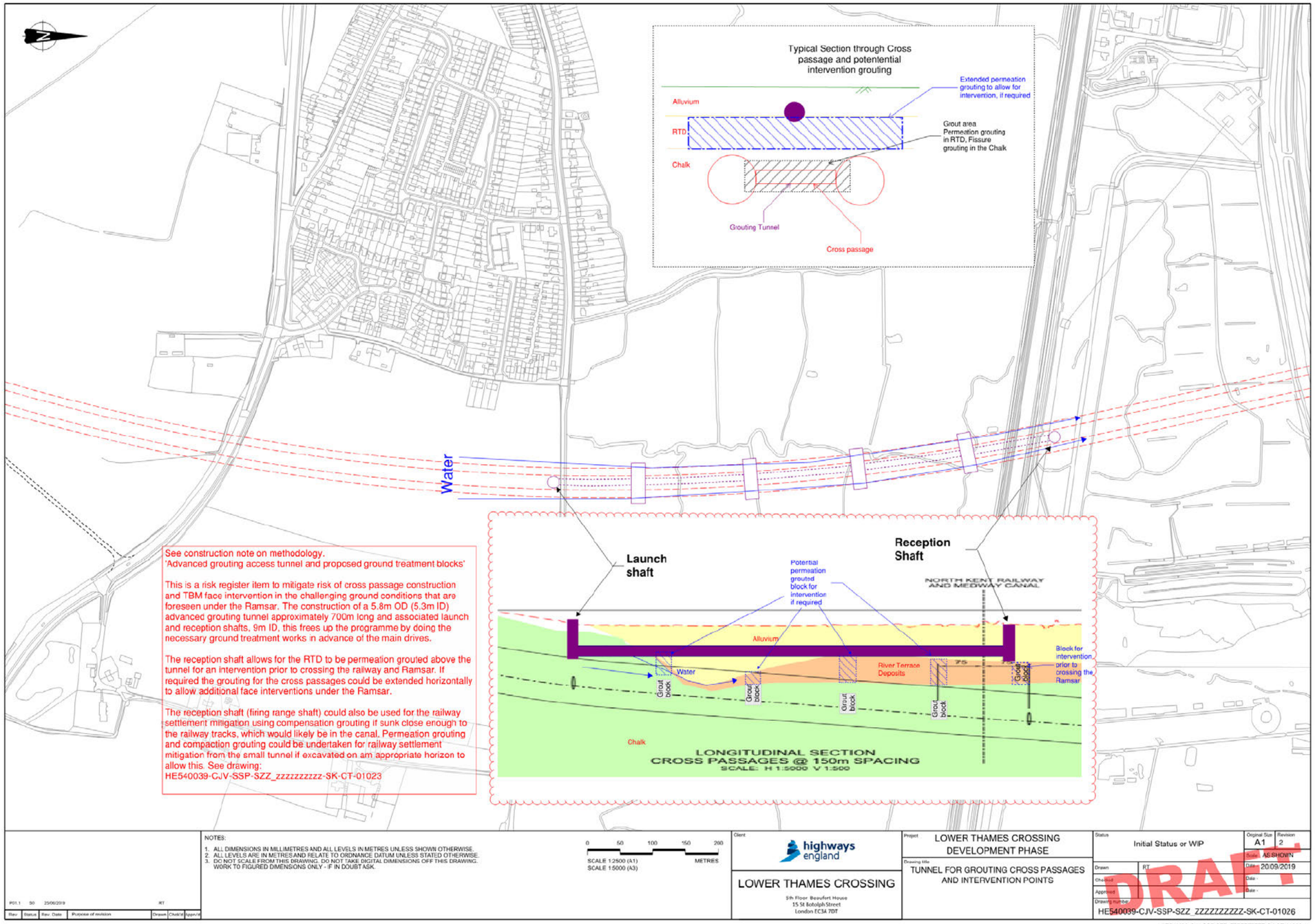
Figure 1 Launch shaft compound

- Reception Shaft: 9m ID (approx. 9.7m OD) 16m deep with a concrete base plug to resist flotation. Methods would require no active dewatering.

Figure 2 Reception shaft compound

- Intervention tunnel: EPBM driven concrete segmentally lined, 5.8m OD, gasketed and annulus grouting to minimise leakage.
- Grouting:
    - Cementitious permeation grouting from reception shaft of RTD for intervention prior to crossing Ramsar site. 0.5D wider than the main bores
    - Cementitious permeation grouting of RTD at 4 number of locations, 150 m apart for TBM interventions (same as cross passages, 0.5D wider than the main bores.
    - Cementitious fissure grouting at 4 cross passage locations that sit below the intervention tunnel (8.6x20m block).
- Decommissioning:
    - Backfilling tunnel and shaft to 2m below ground level (BGL)
    - Removal of all temporary works above 2m BGL
    - Backfill/reinstate up to ground level

Appendix A Sketch of intervention tunnel



Annex L Advanced Grout Tunnel Technical Note

Lower Thames Crossing

Ramsar Advanced Grouting Tunnel and Main Tunnels Numerical Model – Technical Note

Document Number: HE540039-CJV-GEN-GEN-TNT-GEO-00001

Confidential

October 2019

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1.0	01/10/2019	[redacted]	[redacted]		

Contents

Tables

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1 Introduction

1.1 Background

The Lower Thames Crossing (LTC) scheme consists of a new highway from the A2/M2 junction in Kent to M25 Junction 29 in Essex. The scheme includes two bored tunnels under the River Thames to the east of Gravesend. The total length of the route, including M2/A2 and M25 improvements, will be approximately 21 km, with approximately 4 km in tunnel.

The South Portal is above the water table and therefore no aquifer dewatering is anticipated. The position of the portal has removed the risks that will otherwise have needed assessment with the groundwater model. On this basis, the South Portal itself is not included in this assessment.

Construction of a 5.8m OD, 670m long, advanced grouting tunnel will enable treatment of the ground beneath the RAMSAR site (south of the River Thames). The ground treatment will mitigate against risks of groundwater inflows during cross passage construction and TBM face intervention. The grout tunnel will run above the main crossing alignment. The tunnel will launch from a shaft located to the south of Lower Higham Road. The egress shaft will be north of the Thames and Medway Canal and North Kent Railway Line. Watertight retaining structures, such as such as caisson piles will be used. This will remove the need for large scale dewatering during the excavation of the launch and reception shafts (Lower Thames Crossing - Cascade, 2019 (c)).

The ground treatment tunnel has a mid-line elevation of -6.7 m AOD and each shaft has a bottom elevation of -11.6 m AOD (Lower Thames Crossing, 2019 (d)). The main tunnels, which run parallel to this, have centreline elevations of -42 m AOD to 21 m AOD (Lower Thames Crossing, 2019 (e)).

Groundwater controls have the potential to cause drawdown and changes to the direction of groundwater flow. The Thames Estuary and Marshes Ramsar site and SSSI (hereafter Ramsar) are sensitive receptors and the underlying Chalk formation is a Principal Aquifer (Lower Thames Crossing, 2018).

1.2 Report and Modelling Objectives

This report focusses on the development of the Ramsar advanced grouting tunnel and main tunnels. This is in Stage 2 of the modelling approach described in the 'Main Crossing groundwater modelling scope memorandum' (Lower Thames Crossing - Cascade, 2019 (b)). This report describes the modelling of groundwater flows for the construction of the advanced grouting tunnel and main tunnels (for the remainder of this document named as South Portal model, for simplicity). The assessment includes:

- Predictions of the groundwater inflow into the excavation during construction of the South Portal Grout Tunnels and Tunnel; and
- Drawdown prediction of the water table.

Future upgrades for the model may potentially be required for DCO and environmental assessment. These include:

- Assessment of the movement, if any, of the saline interface; and
- Assessment of the impacts on third-party abstractions.

2 Methodology

2.1 Software

The model uses MODFLOW 2005 (MF2005). MF2005 is an industry standard software maintained by the United States Geological Survey (USGS, 2005). The model has been created using FloPy (Bakker, et al., 2016). FloPY contains a set of Python scripts enabling one to build, run and postprocess MODFLOW, MT3D, SEAWAT and other MODFLOW-related groundwater programs. Visualisation and MODPATH simulations are also completed in Groundwater Vistas 7, produced by Environmental Simulations International.

2.2 Model geometry

2.2.1 Geological model

A lithostratigraphic geological model purchased from the British Geological Society (BGS) (BGS, 2014) is used for the geological model. This geological model is a checked and peer reviewed baseline. Results of the Phase 1 ground investigation (PerfectCircle JV, 2018) at the LTC site have been included in the model by the BGS. The BGS model is assigned to model layers by comparing the model layer elevations with the geological surfaces. Figure 1 shows the outcrop geology in plan view for the model area, where the blue contour lines represent the Chalk piezometric contours (as to February 2014), interpolated from the Environment Agency regional network of observation boreholes. The geology is represented in the model using the hydrogeological parameters. The BGS model contains many layers though there are four key surfaces/layers:

- Made ground. The topography (https://www.ordnancesurvey.co.uk/opendatadownload/products.html#TERR50) forms the top surface of the model. The base of the made ground surface is provided by the BGS. Made ground in the model area includes areas alongside the Thames, the Thames and Medway Canal and industrial land east of Gravesend.
- Superficial deposits at outcrop including Alluvium, Head Deposits and RTD (River Terrace Deposits). River Terrace Deposits, underlying the alluvium. Assigned using elevation data from the BGS model for the bottom of the layer.
- Eocene deposits, such as the London Clay and the Lambeth Group and the Thanet Formation. These outcrop south of the South Portal Grout Tunnel capping the Chalk at higher elevations and above the water table.
- Chalk. The top of the Chalk is defined from the BGS model.

The BGS geological model includes many ASCII format grids. The grids include a top elevation, bottom elevation and thickness for each different stratum identified by the BGS. FloPy imports all these as TIF files using the GDAL module. The raster band value of the TIF file is the elevation. The TIF files are re-gridded by GDAL[1] (Warmerdam F. et al, 2019) to match the model grid arrays. A comparison is done in Python whereby each BGS elevation grid is checked against the elevation of a

[1] GDAL is a translator library for raster and vector geospatial data formats.

model cell. The BGS layer with the least residual from this comparison is assigned to the cell and the suitable parameters are then applied to the cell. This builds up a block model and overcomes many of the problems that can occur with complex geological models.

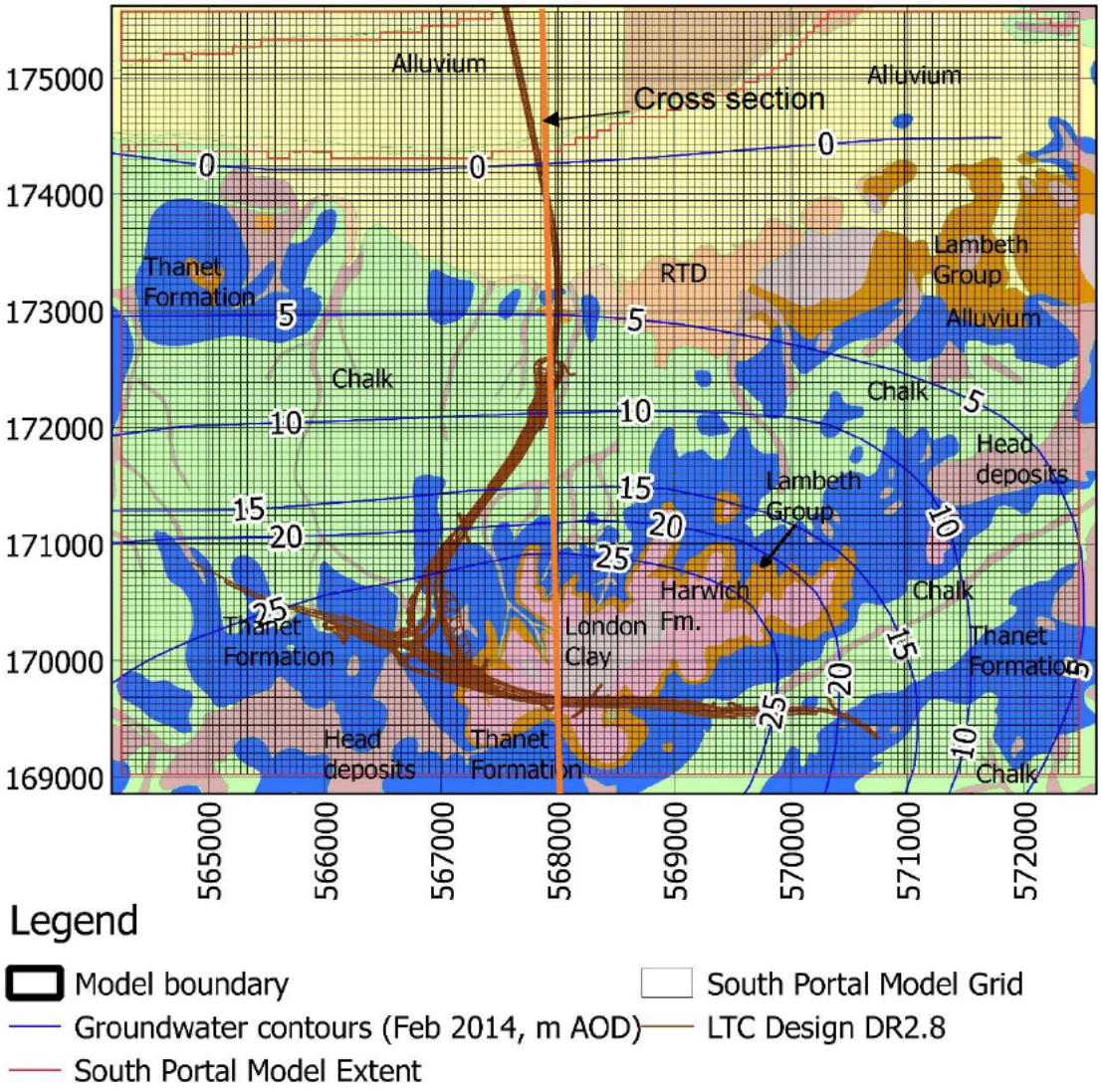


Figure 1 Model domain (6.5x8.3 km), cross section location plan and outcrop geology.

2.2.2 Model cells and hydrogeological layers

Figure 1 shows the model domain and the locations of the cross sections presented in Figure 2 (geological layering).

The numerical model is a block-centred finite difference model. All the model cells (Figure 2 and Figure 3) have a width and length of 60 m. The cell thickness is shown on the figures. Within 20 m of the ground surface the thickness of the model layers is 1 m. The top layer has the elevation of the topographic surface. As well as the strata identified in the BGS geological model (paragraph 2.2.1) three more model layers are defined in the Chalk, including:

- Unstructured Chalk. This layer has a variable thickness. Its top is the top of the Chalk and its base is 7.5 m below the observed water table or 15 m

bgl, whichever is lowest. The BGS state ‘It would appear that current recharge could probably be dissipated in a relatively thin interval close to the water table’ (BGS, 2008). The name ‘Unstructured Chalk’ used by LTC can is swappable with the 'weathered water table chalk with dissolution-enhancement of fractures' and is not referring to putty chalk weathering.

- Chalk. This layer is beneath the Unstructured Chalk and is 15 m thick. The BGS (BGS, 2008) state that ‘the upper 25 m or so of the saturated zone generally have a much greater permeability than the aquifer below that depth’ (BGS, 2008). The Unstructured Chalk and Chalk layer in the model provide the flexibility needed for calibration.
- Deep Chalk. This layer forms the remaining thickness of the Chalk in the model and has a variable thickness. This layer has a much lower hydraulic conductivity than the upper part of the Chalk.

These layers provide the capability to model the decrease in the hydraulic conductivity of the Chalk. Section 2.3 describes how the hydraulic conductivity of the Chalk decreases as the depth of the Chalk increases.

The bottom layer has a bottom elevation set to 170 m below the topography. In total there are 45 layers in the model. Model layers are thinner in the top 30 m to include for the increased geological data and project infrastructure in this zone. Between 30 m bgl and 105 m bgl the layers are 5 m thick. This zone includes the water table and Unstructured Chalk in all parts of the domain. Beneath this the layer thickness is 10 m.

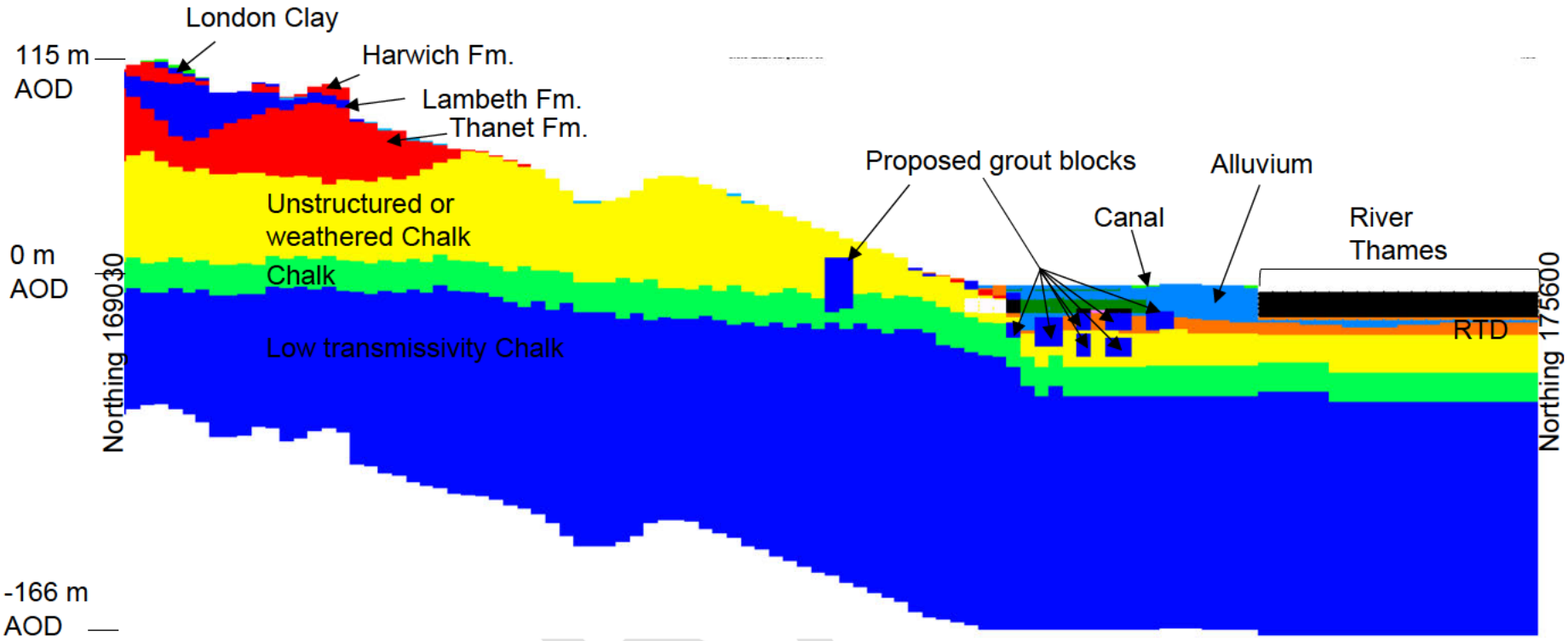
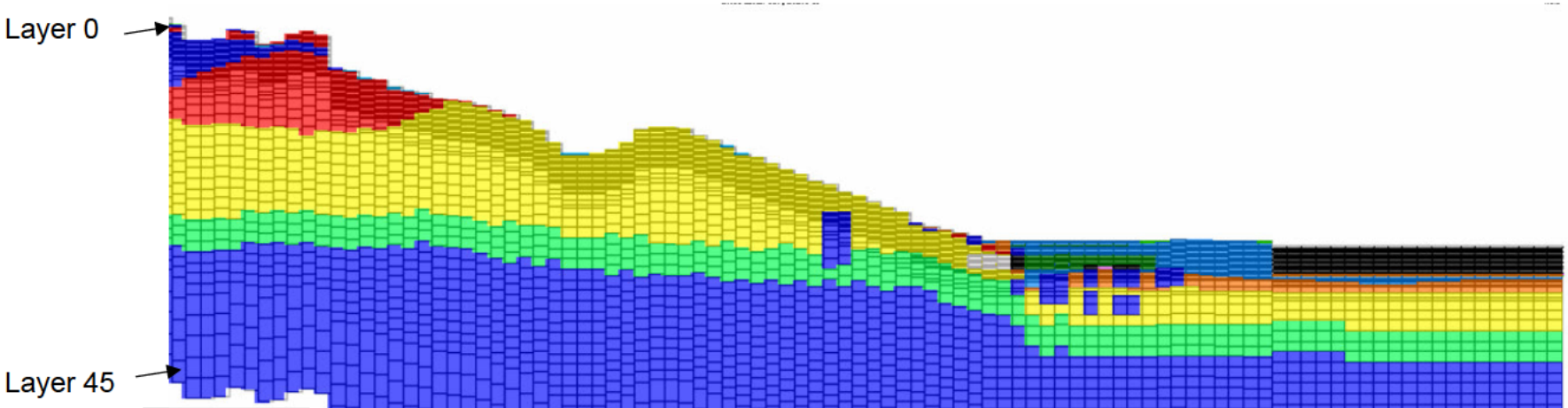


Figure 2 A south-north cross section through the geological model provided by the BGS (30x vertical exaggeration)



Layer	Depth (m bgl)	Layer	Depth (m bgl)
1	2	23	35
2	3	24	40
3	4	25	45
4	5	26	50
5	6	27	55
6	7	28	60
7	8	29	65
8	9	30	70
9	10	31	75
10	11	32	80
11	12	33	85
12	13	34	90
13	14	35	95
14	15	36	100
15	16	37	105
16	17	38	110
17	18	39	115
18	19	40	120
19	22	41	130
20	24	42	140
21	26	43	150
22	30	44	160
		45	170

Figure 3 Numerical layers in the groundwater model populated with parameters (Kx) defining geological layering

The creation of a block model has many advantages over a geology based model. Advantages include:

- Good, rapid convergence and often results in shorter run-times even with more discretisation, especially in contaminant transport models;
- Avoiding pinched-out layers inside the model or at the top surface;
- A more consistent representation of groundwater flow velocity within a layer. This can be beneficial if modelling a saline interface or contaminant transport where solute dispersion is influenced by upstream and downstream velocities;
- Better modelling of infrastructure features such as d-walls and drains. These features are often independent of or do not fully penetrate geological layers. The elevation of these features may change as the design progresses. Such changes can be incorporated without changing the model layer structure, making the results comparable; and
- Good and consistent vertical resolution around boundary conditions, thereby minimising model errors.

2.3 Hydraulic conductivity

The model hydraulic conductivity (or permeability) ranges are from site (PerfectCircle JV, 2018), the Thames Cable Tunnel Project (Haswell, 1969) and other literature sources. Material parameters can also be sourced from the Addendum PSSR (Preliminary Sources Study Report) (Tables 36-38, pages 130-132 (Lower Thames Crossing, 2018)).The model calibration will use parameter values from within these pre-defined and previously reported data ranges (Table 1). Figure 1 shows the hydraulic conductivity mapped to the outcrop geology in Layer 1 of the model. Figure 2 and Figure 3 shows the hydraulic conductivity in cross section.

Table 1 – Summary of Hydraulic Conductivity data

Geological Unit	Permeability, minimum (m/s)	Permeability, maximum (m/s)	Hydrogeological behaviour and influences
Made Ground	-	Variable, approximately $1x10^{-5}$ to $1x10^{-4}$	Variable - depends on material content. Acknowledged to be cohesive in places but assuming higher values for worst-case.
Head Deposits	-	Variable, $1x10^{-8}$ to $1x10^{-6}$	Variable - depends on underlying geology
Alluvium	-	$k_h = 1 \times 10^{-7}$; $k_v = 1 \times 10^{-8}$ (1)	Aquitard or Aquifer – depending on whether predominantly clay or granular material in the field but mapped as a single unit

Geological Unit	Permeability, minimum (m/s)	Permeability, maximum (m/s)	Hydrogeological behaviour and influences
			with an equivalent bulk permeability.
River Terrace Deposits	Lower values where clayey	2 x 10^{-5} (1) to 1x10^{-3}	Aquifer – depends on lateral extent and thickness
London Clay	Non aquifer	Non aquifer	This is a confining unit and has very limited potential to supply a water resource. On a broader scale may support underlying aquifers through slow leakage.
Harwich Formation	1.09x10^{-5}(2)	1.1x10^{-3}(2)	Aquifer
Lambeth Formation (Reading and Woolwich Fm.)	3.47x10^{-8} (2)	2.29x10^{-3} (2)	
Thanet Formation	2 x 10^{-5} (2)	4 x 10^{-5} (2)	Aquifer
Chalk	May vary with Chalk weathering grade and site-specific ground conditions. See Table 2 and Table 3		Aquifer

References for Table 1:

1. Bevan, M.A. et al (2010). Géotechnique 60 No. 8, 634-649 Influence of large-scale inhomogeneities on a construction dewatering system in chalk (Bevan, 2010);
2. BGS, EA (2000), The Physical Properties of Minor Aquifers in England and Wales, BGS Technical Report WD/00/04, Environment agency R&D Publication 68 (BGS, 2014)

Table 2 – Chalk weathering grade and permeability range

CIRIA grade	Mundford grade	Chalk type*	Approximate permeability range (m/s)
A	I and II	Structured with bedding and/or jointing.	Highly variable because of presence of fissures
B and C	III and IV	Structured with bedding and/or jointing.	1 x 10^{-5} m/s to 1 x 10^{-3} m/s
Dc	V and V	Structureless, clast dominated.	1 x 10^{-5} m/s to 1 x 10^{-3} m/s in relatively harder Chalk with chalk 'bearings' or frost shattered chalk evidenced
Dm	V and VI	Structureless, matrix dominated.	1 x 10^{-7} m/s to 1 x 10^{-9} m/s

References for Table 2:

- *After Spinck (Spinck, 2002)
- Preene M., Roberts T. O.L. Construction dewatering in Chalk. Proceeding of the Institution of Civil Engineers. Geotechnical Engineering 170 August 2017 Issue GE4 Pages 367-390 (Preene & Roberts, 2017).

Table 3 – Project specific permeability results

Location	Chalk lithology	Reported Chalk permeability (m/s)
Thames Cable Tunnel (North Shaft), Tilbury, East London	Upper 9 m of Chalk of high permeability, permeability reduced significantly at depths greater than 15 m below top of the Chalk. During the shaft sinking the upper 6 m of the Chalk indicated to be completely disintegrated	1×10^{-3} m/s to 4×10^{-6} m/s in upper zones of Chalk from in situ permeability tests. 2×10^{-5} m/s to 2×10^{-6} m/s below 15m from top of Chalk, from Lugeon tests.
Medway Crossing, Chatham, Kent	Upper 2 m to 5 m of Chalk was noted to be structureless (Mundford grade VI to V) with grade III to IV structured Chalk below	1×10^{-3} m/s to 1×10^{-5} m/s in structured Chalk (Mundford grade III to IV) estimated from in situ and laboratory tests 9×10^{-4} m/s back-analysed from dewatering system flow rate. 1×10^{-7} m/s to 1×10^{-9} m/s in structureless Chalk (Mundford grade VI to V) estimated from in situ and laboratory tests.
CTRL Thames Tunnel, south side, Swanscombe, Kent	Upper Chalk	2×10^{-6} m/s to 1×10^{-4} m/s from borehole packer tests. Numerical modelling to back analyse the dewatering system implied that a high-permeability zone of the order of 3×10^{-2} m/s to 7×10^{-2} m/s may have existed in Chalk in part of the excavation.

Figure 4 illustrates how the hydraulic conductivity of the Chalk reduces with its depth (Lower Thames Crossing, 2019). The ability to include this in the model is gained by splitting of the Chalk into 3 layers, as discussed in paragraph 2.2.2.

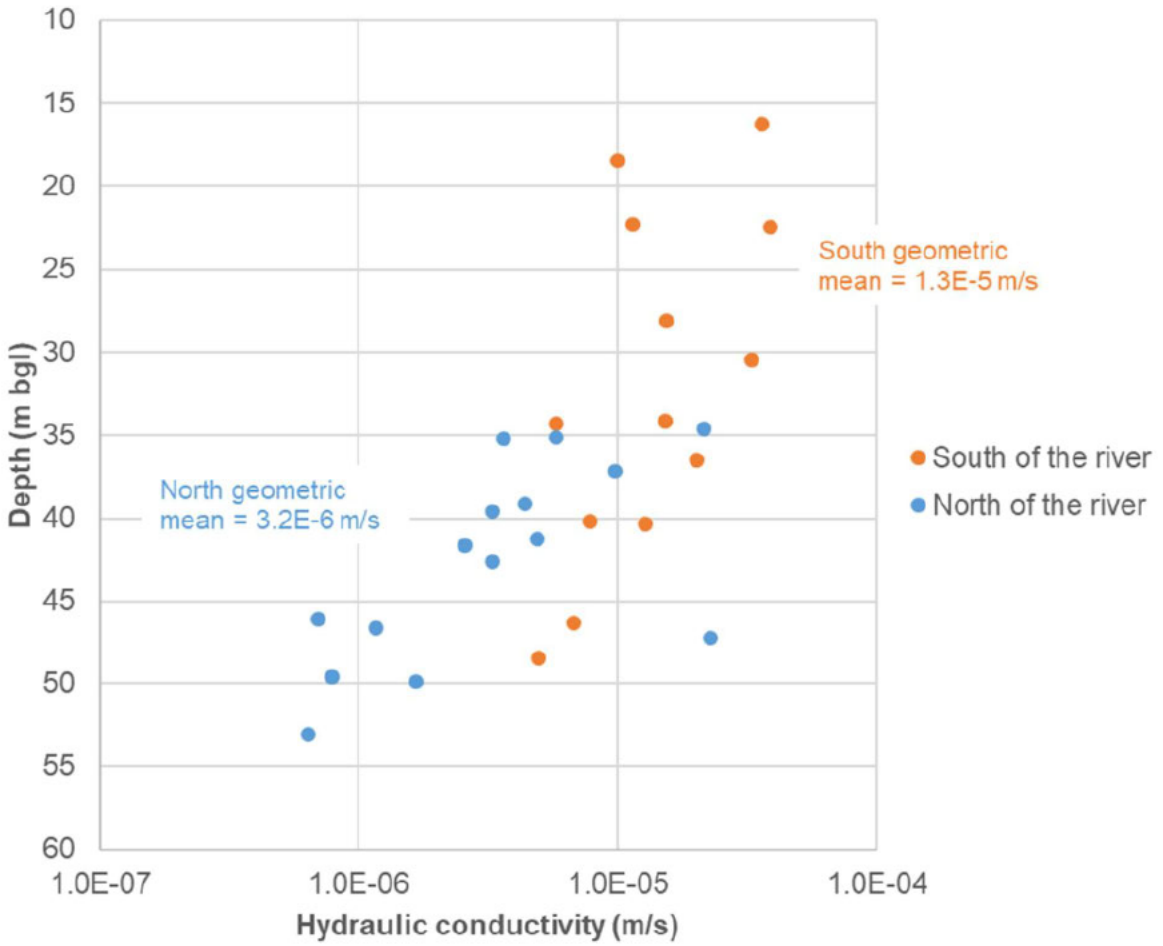


Figure 4 Chalk horizontal hydraulic conductivity results from double packer testing carried out in boreholes located to the north and south of the River Thames in lowland areas.

The relationship of depth and hydraulic conductivity presented in Figure 4, Table 1 and Table 2 is clear from the data. There are various mechanisms by which this change may occur, a selection of examples might include:

- Enhancement of discontinuity apertures by groundwater flows around the water table resulting in an increase in hydraulic conductivity. This enhancement may also occur at greater depths of burial where there has been an ancient water table;
- Current or previous weathering of the Chalk while at outcrop resulting in a decrease in hydraulic conductivity;
- Faulting or other structural processes resulting in an increase or decrease in hydraulic conductivity; and
- Closing of fractures due to burial resulting in a decrease in hydraulic conductivity with depth.

2.4 Boundary conditions

2.4.1 Northern model edge

The Thames Estuary is on the Northern model boundary. This is a river boundary condition with a river bottom elevation, stage and conductance. The river boundary conditions allow for water to move out or into the boundary from the aquifer. The rate of flow (per meter length of boundary) is dependent on the conductance of the boundary and a river 'stage'. The conductance is a function of the hydraulic conductivity, cell size and thickness of the riverbed in which the boundary resides. In practice it is often a calibrated arbitrary value as riverbed information is not known. For these models the riverbed conductance is the hydraulic conductivity of the river boundary model cell multiplied by the area of the cell. The riverbed elevation is set to -13 m AOD and the stage to 0 m AOD. This is an approximation inferred from river geophysical survey results. The river bottom elevation is compared to the model layer elevations during assignment. The boundary is assigned into the single layer that encompasses the river bottom elevation.

Where the Thames Estuary is not present on the boundary, the boundary is assumed to be no-flow. This includes the easternmost 2,400 m of the model edge (30 %) and 3,300 m from the LTC scheme. This is conservative.

2.4.2 Eastern model edge

The model simulates a part of the broader Chalk aquifer and so the aquifer continues out of the model to the north and east. ~~General head boundaries (GHB) are assigned to this model edges~~. A GHB represents a constant head at a distance from the boundary cell. The amount of flow from or into the cell depends on:

- the head difference between the model and the GHB;
- the GHB head value; and
- the conductance of the cell.

The GHB is useful where boundary effects are possible. The boundary assignment uses the MODFLOW-GHB module. A GHB is defined using a head and a conductance. The conductance is a combination of the hydraulic conductivity of the cell, boundary cell area and the distance to the conceptual source of recharge.

Figure 5 shows the locations of the GHB in the groundwater model. A GHB is assigned to the eastern edge of the model domain, covering the southern-most 66% of the northern boundary. It is used to represent the coast and Medway channels east of the model domain. It is assigned with a hydraulic head of 4 m AOD.

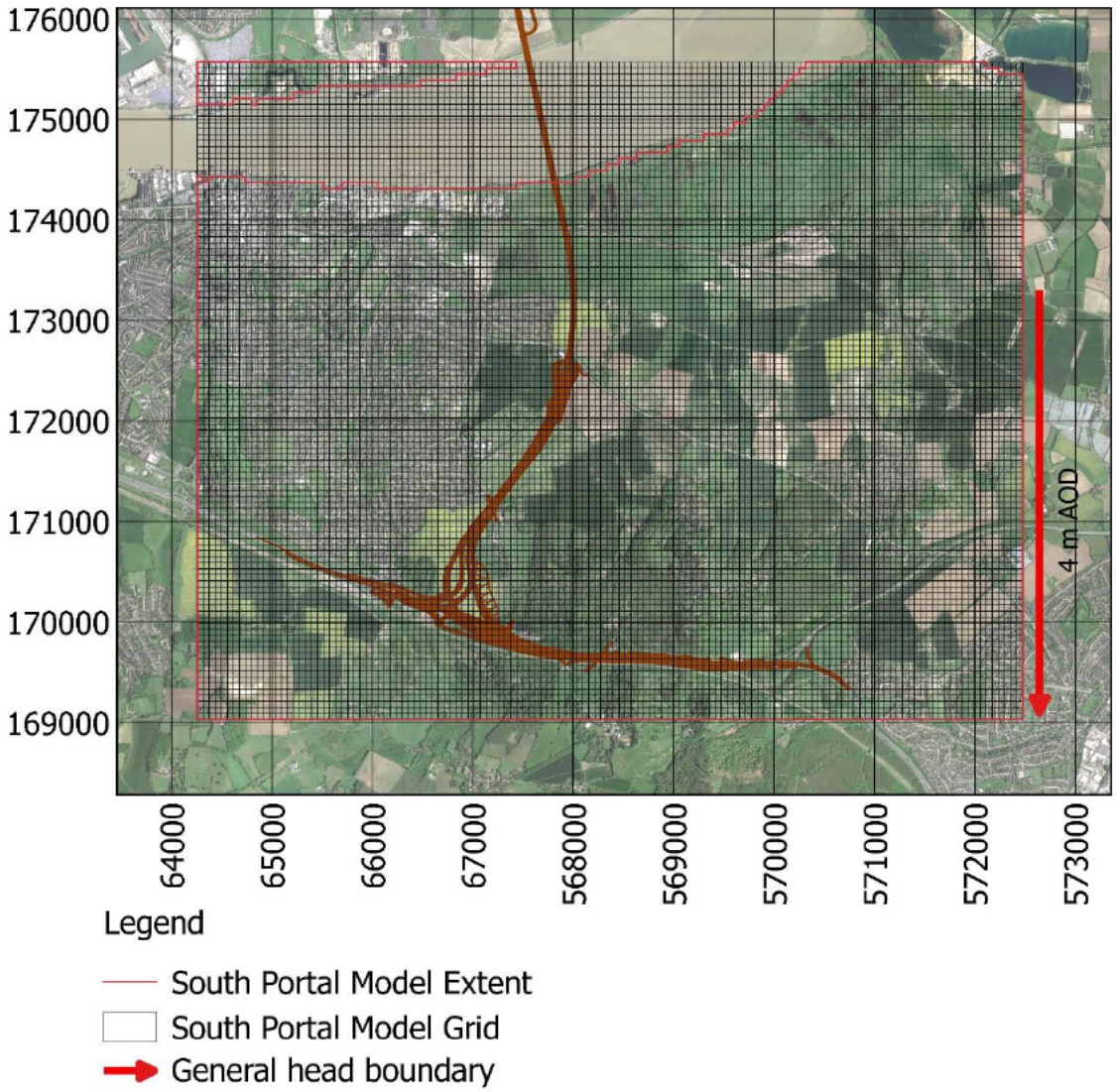


Figure 5 General head boundaries

2.4.3 Southern and Western Boundaries

The southern and western boundaries are no-flow boundaries. The southern boundary is approximately along a groundwater divide associated with recharge over high topography. The western boundary is approximately perpendicular to the direction of groundwater flow and is assigned as a no-flow boundary.

2.4.4 Drains

The DRN (drains) package is used to create the drain boundary conditions. Figure 6 shows the drain boundaries in the model. The drain boundaries simulate:

- the shafts of the grout tunnel
- the grouting tunnel;
- the main tunnels; and
- surface drains and ditches within the alluvium.

The drain cells are in all layers through which the they penetrate, based on the elevation of the drain head. Table 4 provides details of the drains used in the model.

Table 4 Drains

Feature simulated	Drain elevation	Conductance
Grouting tunnel (1 no.)	-9.7 m AOD. The centreline is at -6.8 m AOD, but the tunnel is 5.8 m in diameter	$1x10^{-7}$ m/s * 2 * pi * (5.8/2) * cell width
Grouting tunnel shafts (2 no.)	-11.6 m AOD	$1x10^{-7}$ m/s * cell height * 2*pi*(9/2)
Main tunnels (2 no.)	Variable elevation	$1x10^{-7}$ m/s (calibrated to allow approximately 0.5 L/d/m^2 of tunnel)
Surface water drains	1.1 m bgl	Based on the hydraulic conductivity of cell * cell width.

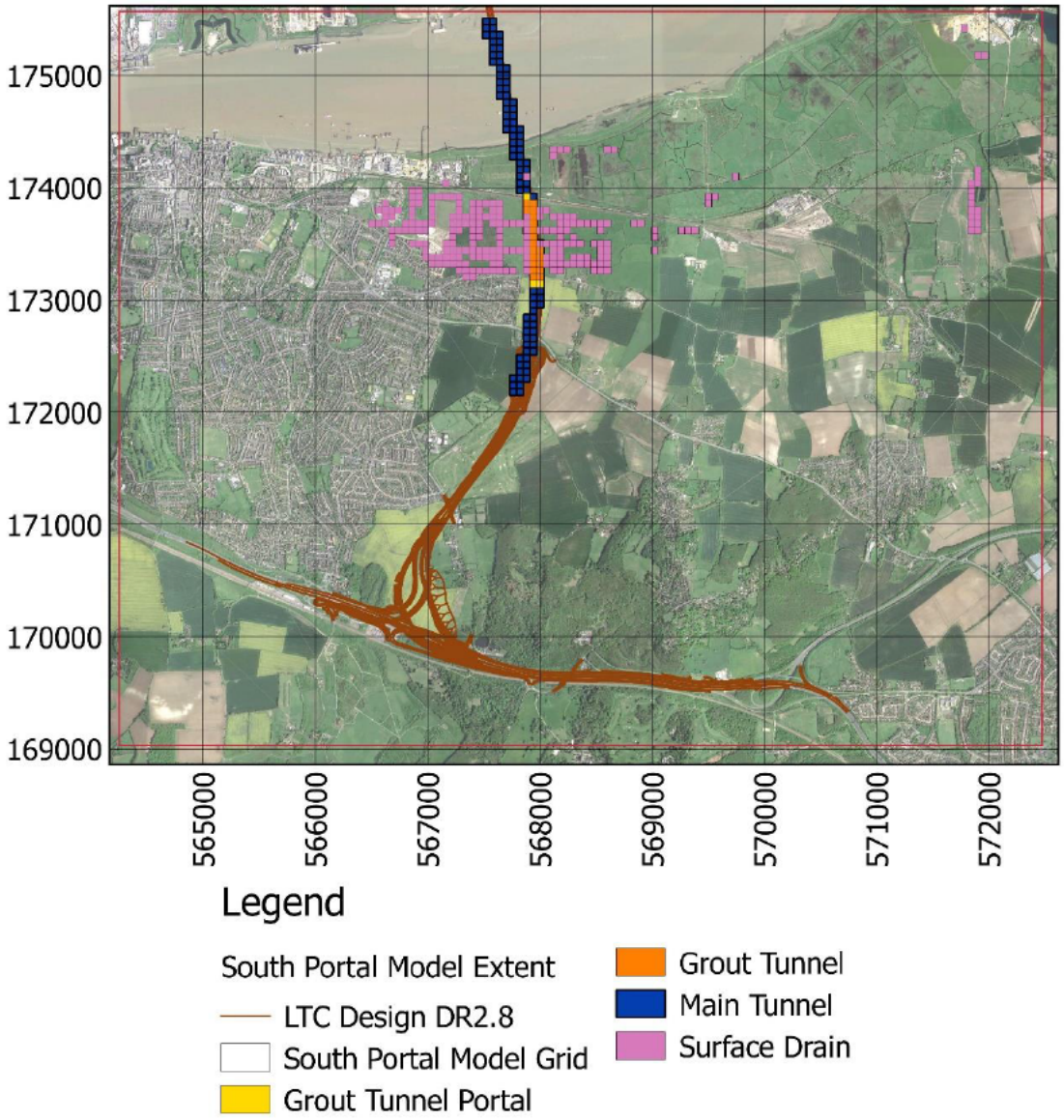


Figure 6 Drain locations

2.4.5 Recharge

The BGS discuss that 'values (of recharge) of 100 mm/a were found for the north coast of Kent and values of over 280 m/a to central and southern Kent' (BGS, 2008). In the model recharge is applied to the top-most active model cell, excluding cells with river or drain boundary conditions.

Figure 7 and Table 5 describe the distribution of recharge in the groundwater model.

Table 5 Recharge in the groundwater model

Recharge rate (m/d)	Recharge rate (mm/a)	Distribution
0.000767	280	Where the topography is above 100 m AOD
0.000384	140	Where the topography is between 70 m AOD and less than 100 m AOD
0.000274	100	Where the topography is less than 70 m AOD
0.0001	37	Where head deposits are at outcrop

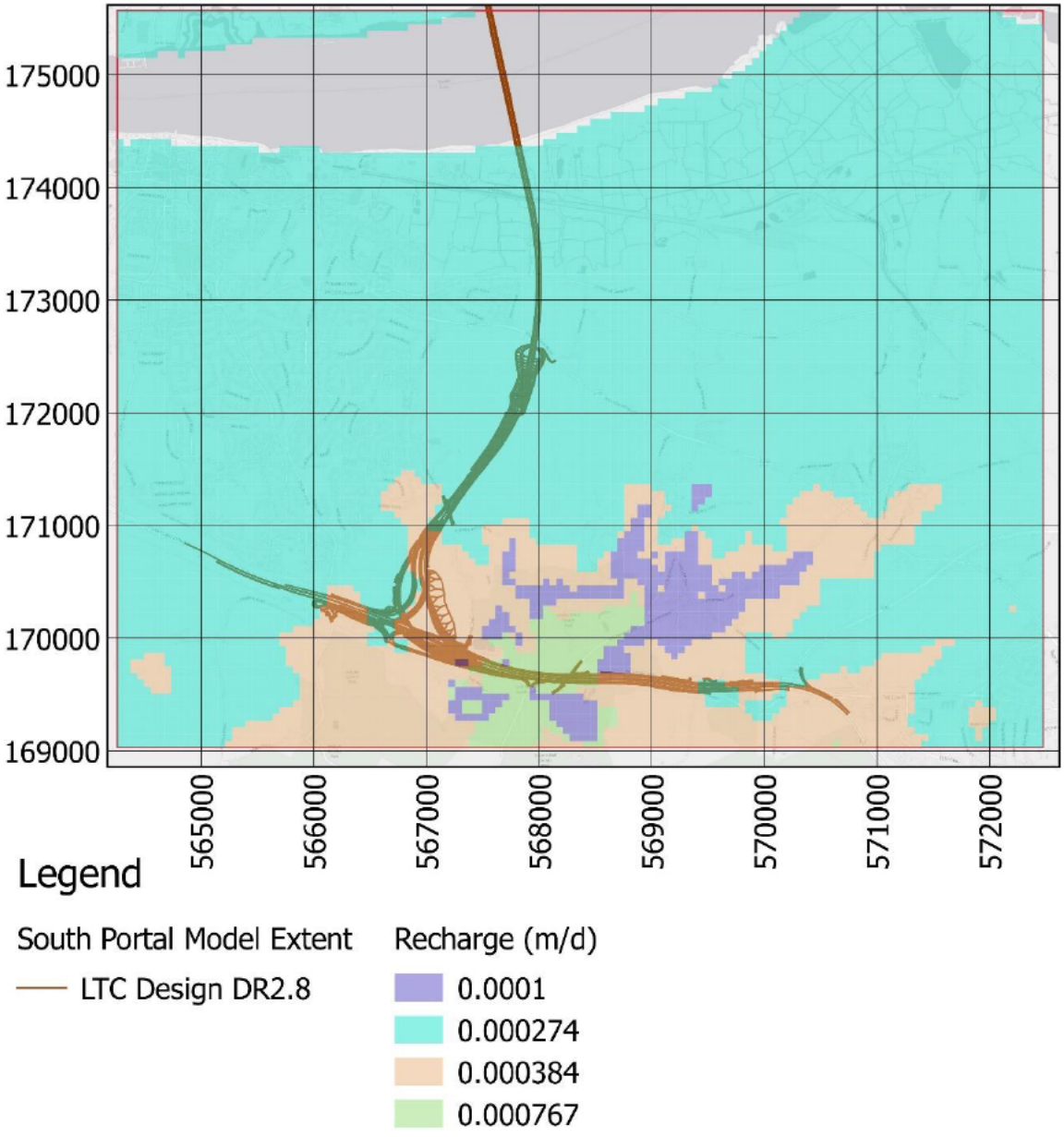


Figure 7 Recharge rates in the groundwater model

2.5 Grouting and flow barriers

Figure 2 shows the proposed grout tunnel and main tunnel grout plugs in cross section. Figure 8 shows the location and elevation of the concrete plugs for the grout tunnel and LTC main tunnels. The grout block locations were provided by the Tunnel team as vertices coordinates with an elevation (Lower Thames Crossing - Cascade, 2019 (a)). The grout blocks span many layers of the groundwater and geological models. The purpose of the grout blocks is to provide a 'dry' zone in which maintenance of the tunnel boring machine or switching of parts or systems can occur. The assignment is done using the top and bottoms of the grout wall.

The hydraulic conductivity of the grout blocks is $1x10^{-7}$ m/s.

The grout plugs are included in the model as there is potential for groundwater mounding.

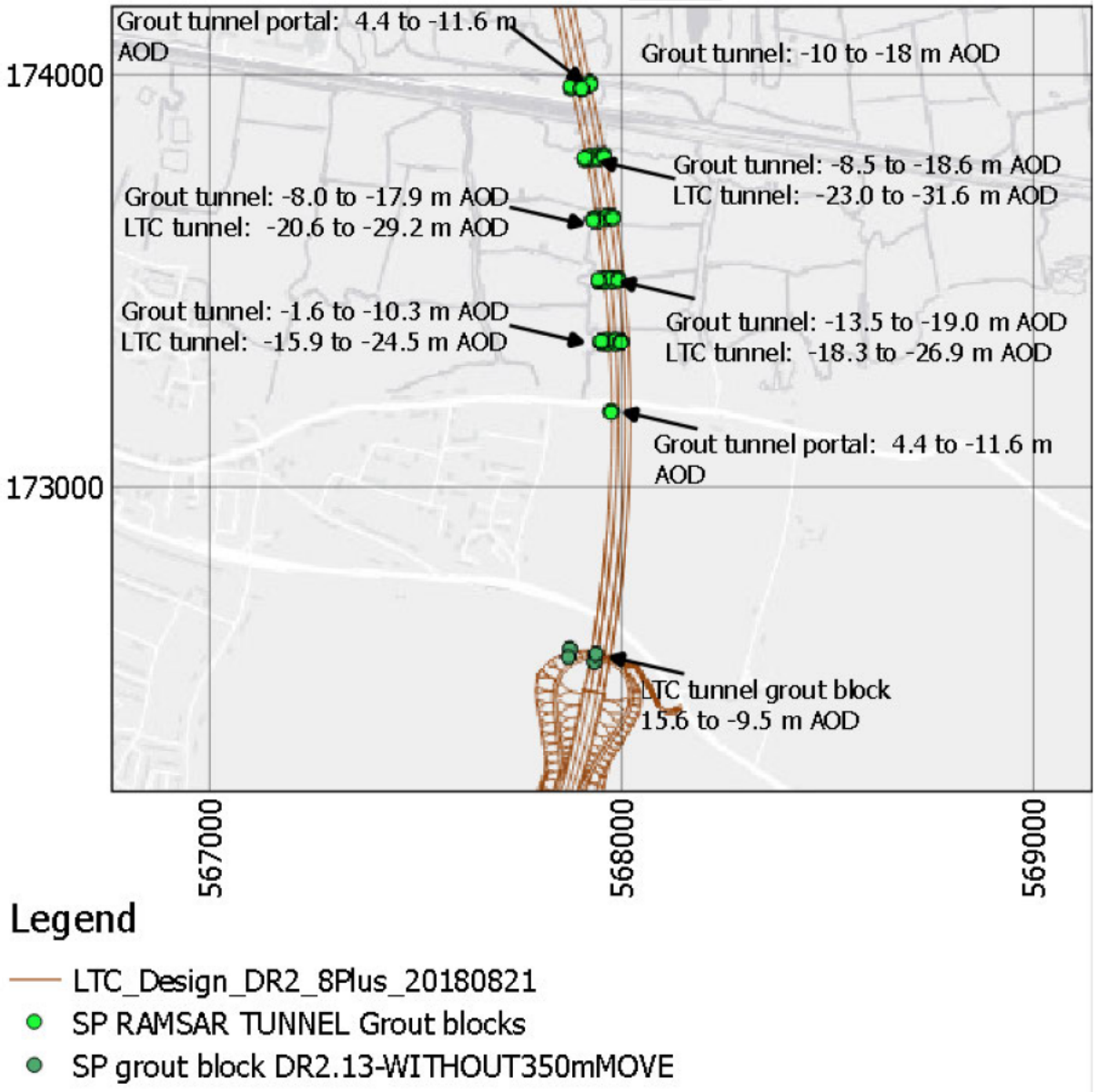


Figure 8 A location plan showing the Grout plugs for the grouting tunnel and LTC tunnel, including their elevations

The LTC main tunnels are 16.8 m in diameter. The hydraulic conductivity of the tunnel walls is expected to be less than $1x10^{-7}$ m/s, corresponding to a maximum inflow rate of 0.5L/d/m^2. This is a conservative estimate and would result in an inflow rate of approximately 12 m^3/d per 450 m long tunnel. Hence, the main tunnels are potentially a barrier to groundwater flow within the aquifers it crosses, as well as a drain with a low leakage rate. The hydraulic conductivity of model cells intersected by the barrier has been reduced to $1x10^{-7}$ m/s to reflect this.

2.6 MODFLOW - Layer setup

Layer 1 (the uppermost layer) is set as unconfined (Type 1) and so the transmissivity of the layer varies depending on the saturated thickness and hydraulic conductivity. All remaining layers are Type 3 and are able to switch between unconfined and confined conditions. This is the default setting in MODFLOW. The transmissivity of these layers also varies and is calculated from the saturated thickness and hydraulic conductivity. Rewetting is disabled for all layers.

3 Calibration

3.1 Method

The groundwater level in the Chalk is not at a 'natural' steady condition. In the past centuries, over-extraction and rebound has affected it. The groundwater levels are now controlled by a water management scheme within the Chalk but are still rising in many places.

The calibration is against the February 2014 groundwater contours (baseline model), interpolated from the Environment Agency regional monitoring network in the Chalk aquifer. These levels are the highest water levels recorded monthly in the Chalk. The SRMS (scaled root mean square) error between the grids of the simulated and observed water levels was calculated. The SRMS is a guide to the quality of the calibration. Often a single calibration is fixed upon during groundwater modelling, when many may be available within the pre-defined parameter ranges. A Monte Carlo analysis tested many hundreds of parameter combinations. For each simulation the SRMS and parameters applied were recorded. The recharge was 'fixed' at the values discussed in paragraph 2.4.5. Parameters varied in the analysis included the horizontal and vertical hydraulic conductivity (in a pre-defined ratio) for:

- Alluvium (ratio of k_z(vertical)/k_h(horizontal)= 0.3)
- River terrace deposits (ratio of k_z(vertical)/k_h(horizontal)= 0.5)
- Chalk (ratio of k_z(vertical)/k_h(horizontal)0.3)

The parameters were selected at random from the following distributions (Table 6):

Table 6 Log-normal distributions of hydraulic conductivity for the Monte Carlo simulations.

	Hydraulic conductivity (m/s)	
	Mean	Standard deviation
Alluvium	$1x10^{-7}$	$1.68x10^{-4}$
RTD	$2x10^{-4}$	$0.5x10^{-4}$
Harwich Formation	$6.9x10^{-4}$	$0.5x10^{-4}$
Unstructured Chalk	$1x10^{-4}$	$0.5x10^{-4}$
Chalk	$1x10^{-5}$	$0.5x10^{-4}$
Deep Chalk	$1x10^{-6}$	$0.5x10^{-4}$

A typical, randomly generated distribution for the Chalk, with a mean of log($1x10^{-4}$ m/s) and standard deviation of log($0.5x10^{-4}$ m/s) is given in Figure 9.

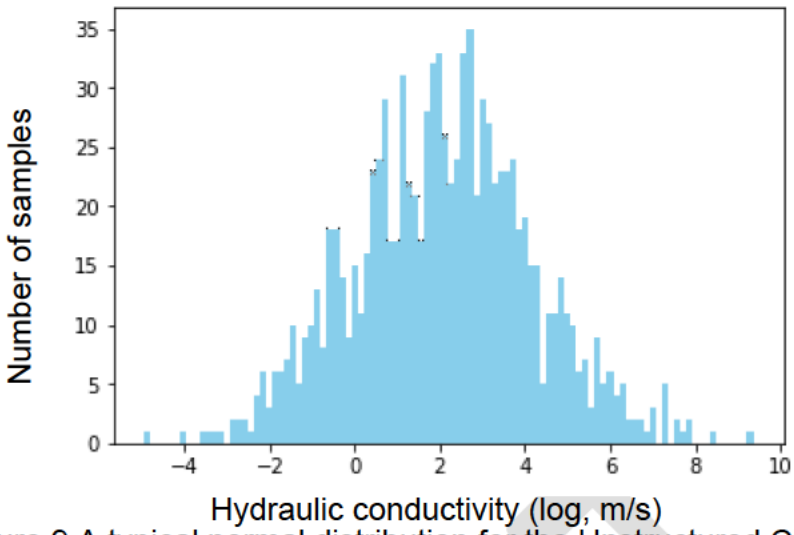


Figure 9 A typical normal distribution for the Unstructured Chalk with a mean of log(1x10^{-4} m/s) and standard deviation of log(0.5x10^{-4} m/s).

3.2 Results of the Calibration

Subsequent to the first Monte Carlo analysis (see paragraph 3.1) the 50th percentile of the results was used to inform a second Monte Carlo analysis. Table 7 shows the input values.

Table 7 Log-normal distributions of hydraulic conductivity for the Monte Carlo simulations.

	Hydraulic conductivity (m/s)	
	Mean	Standard deviation
Alluvium	7.35x10^{-7}	1.68x10^{-4}
RTD	2.58x10^{-4}	0.5x10^{-4}
Harwich Formation and Thanet Sands	5.57x10^{-4}	0.5x10^{-4}
Unstructured Chalk	1.94x10^{-4}	0.5x10^{-4}
Chalk	3.46x10^{-6}	0.5x10^{-4}
Deep Chalk	4.61x10^{-8}	0.5x10^{-4}

For each of the tested parameters a range of calibrated models was possible. 1369 simulations were run and, at the end of each simulation, the SRMS was calculated. A dewatering simulation was completed if the SRMS of the baseline model was less than 10%. This led to 249 accepted simulations, each with a different combination of hydraulic parameters. Figure 10 presents a cumulative distribution plot for each of the calibration parameters. Table 8 presents the results for the 50th and 95th percentile parameters from the Montecarlo simulation.

Table 8 – Material permeability for different percentiles.

Material	**Hydraulic conductivity 50th percentile (m/s)**	**Hydraulic conductivity 5th percentile (m/s)**	**Hydraulic conductivity 95th percentile (m/s)**
[1]Made Ground	4.28x10^{-5}		
[1]Head Deposits	5.00x10^{-7}		

Material	Hydraulic conductivity 50th percentile (m/s)	Hydraulic conductivity 5th percentile (m/s)	Hydraulic conductivity 95th percentile (m/s)
Alluvium	$1.14x10^{-6}$	$5.44x10^{-8}$	$5.99x10^{-5}$
River Terrace Deposits	$2.35x10^{-4}$	$3.06x10^{-5}$	$3.22x10^{-3}$
[1]London Clay	$1.00x10^{-7}$		
[1]Lambeth Group	$1.00x10^{-7}$		
Harwich Formation and Thanet Sands	$5.57x10^{-4}$	$5.73x10^{-5}$	$4.83x10^{-3}$
Unstructured chalk	$9.47x10^{-5}$	$2.30x10^{-5}$	$5.31x10^{-4}$
Chalk	$1.08x10^{-5}$	$8.89x10^{-7}$	$1.12x10^{-4}$
Deep chalk	$1.03x10^{-7}$	$9.48x10^{-9}$	$1.19x10^{-6}$
[1]Manual calibration and not varied in assessment			

The results showed:

- the hydraulic conductivity of the Unstructured Chalk layer was very well constrained by the assessment. It ranged between a 5th percentile of $9.47x10^{-5}$ m/s and a 95th percentile of $5.31x10^{-4}$ m/s. The 50th percentile was calculated to be $2.30x10^{-5}$ m/s.
- Minor changes to the bulk hydraulic conductivity of the Unstructured Chalk layer would cause the calibration to be poor.
- Deep Chalk was predicted to have a significantly lower hydraulic conductivity. Changes in the hydraulic conductivity of the Deep Chalk layer impacted the calibration on the southern edge of the model.
- The model is least sensitive to changes in the hydraulic conductivity of the Alluvium and most sensitive to changes in the Unstructured Chalk.

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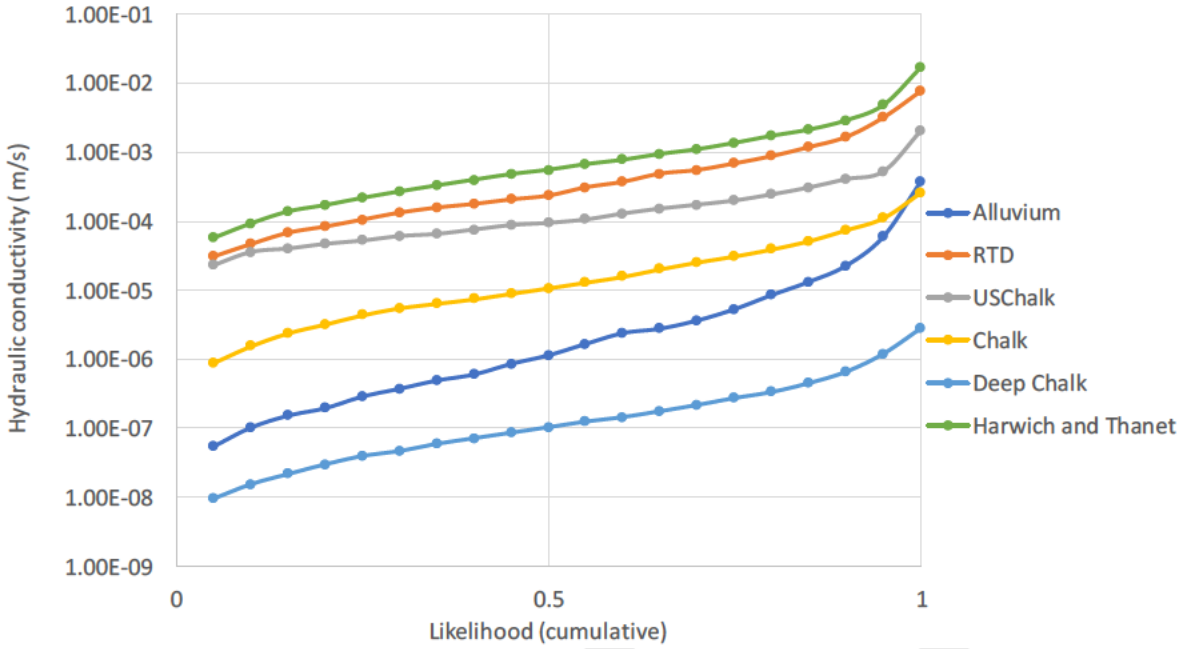

Figure 10 Cumulative likelihood of a satisfactory calibration versus hydraulic conductivity for selected parameters

The 5th, 50th and 95th percentile parameter setups for the above are presented in Table 8.

A simulation was completed using the 50th percentile values. The predicted groundwater table is shown against the observed head (February 2014) in Figure 11.

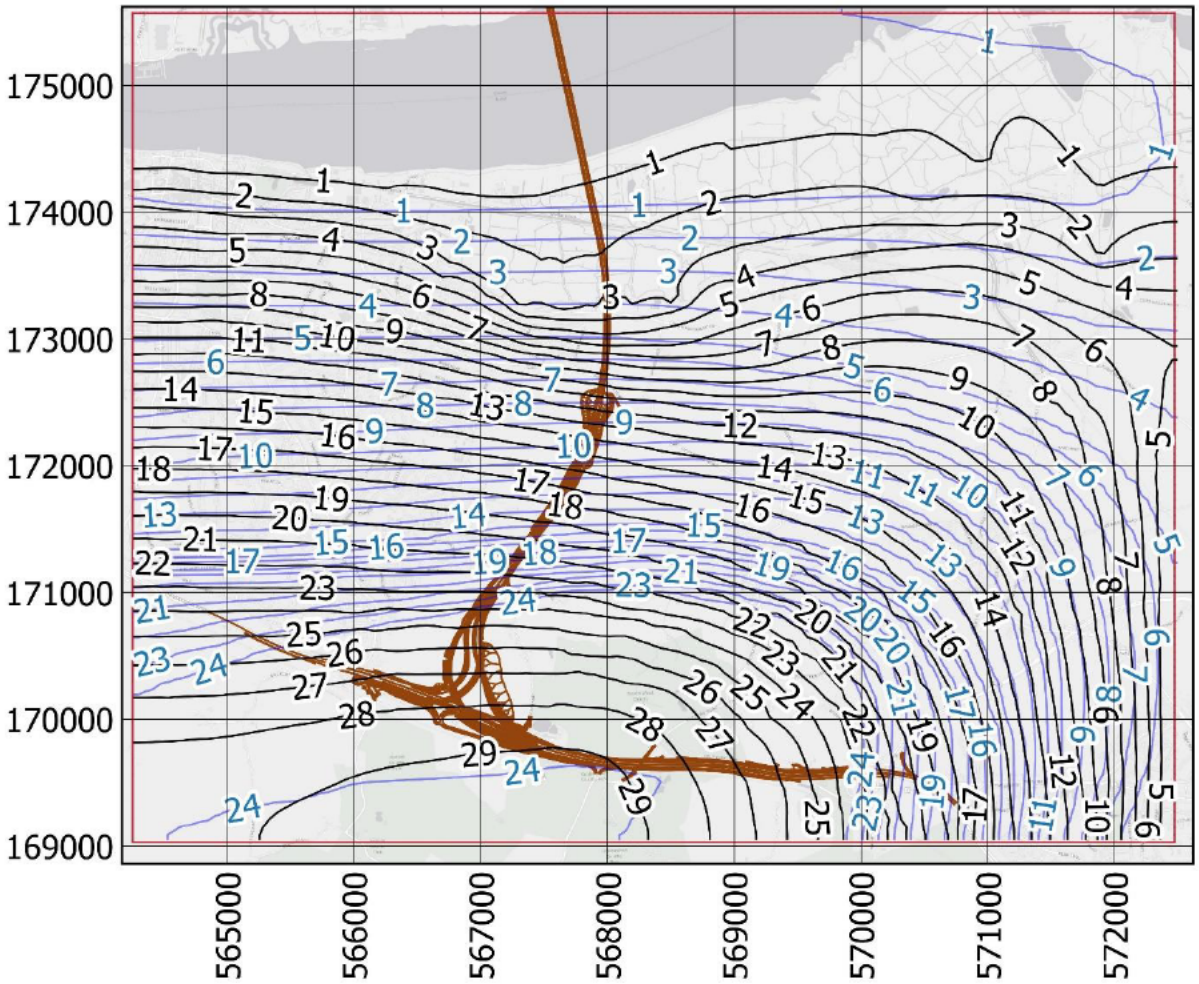

Figure 11 50th percentile parameter set model results compared with observed Chalk water levels in m AOD.

Figure 11 shows that the main area where the model diverges from the observed data is on the southern edge of the model. Here, recharge causes mounding of the water table. There is no discharge in the model across the south boundary as this is set as a no-flow boundary.

Appendix 1 presents more hydrogeological parameter values for the model. As the model is in steady state, the specific yield (Sy) and Specific Storage (Ss) parameters are not used. These are only saved into the LPF file if a time-variant model is constructed.

Table 9 shows the hydraulic conductivity values applied for the model with the highest predicted flow rate of all simulations. This is the worst-case model.

Table 9 – Material permeability for worst case model

Material	Hydraulic conductivity for highest flow rate result (m/s)
[1]Made Ground	4.28×10^{-5}
[1]Head Deposits	5.00×10^{-7}
Alluvium	1.45×10^{-6}
River Terrace Deposits	3.30×10^{-5}
[1]London Clay	1.00×10^{-7}
[1]Lambeth Group	1.00×10^{-7}
Harwich and Thanet Formations	4.35×10^{-3}
Unstructured chalk	8.16×10^{-5}
Chalk	2.68×10^{-5}
Deep chalk	1.19×10^{-6}
	[1]Manual calibration and not varied in assessment

4 Results with the LTC scheme

4.1 Simulated inflow of combined impact of construction and operation in steady state

The simulated inflows reported in this section consider the uncertainty in the model hydraulic conductivities to produce a range of outputs. This is initially done using a stochastic assessment and then by focussing on the 50th percentile and worst case (95th percentile). The uncertainty in the model is from:

- Hydrogeological parameters: There is always uncertainty in hydraulic parameters due to the heterogeneity of the geological materials and the scale-issues associated with in-situ testing. This is particularly relevant for the Chalk, which is a fractured aquifer with a wide range in hydraulic conductivity. Even pumping tests provide large ranges of results in the same geographical areas. This modelling work relies upon literature values, results from nearby projects and a limited site investigation (Phase 1 GI (PerfectCircle JV, 2018)) with some small-scale pressure testing.
- The scope of this model requires a steady-state assessment. However, the groundwater levels within the Chalk are not static, as historical dewatering and recent water management schemes are having significant impact on the water table. This makes choosing of a natural condition awkward. The February 2014 groundwater levels are the chosen baseline and represent a high water table at a point in time. This means that it is possible that there will be significant uncertainty in the final calibrated model.

Section 3.2 discusses the results of stochastic modelling of hydraulic parameters. Of these simulations, 249 had an SRMS of less than 10%. Figure 12 shows the predicted flow rate for these **249** parameter setups. The figure shows that:

- The 5th percentile of all predicted simulation results is 13.6 L/s;
- The 50th percentile of all simulations had a flow rate of 14.3 L/s;
- The 95th percentile parameter set gave a flow rate 15.6 L/s;
- The highest flow rate predicted from a calibrated model is 16.3 L/s;
- The range of predicted inflow rates was quite small. This is due to the low conductivity rates applied to the drains.

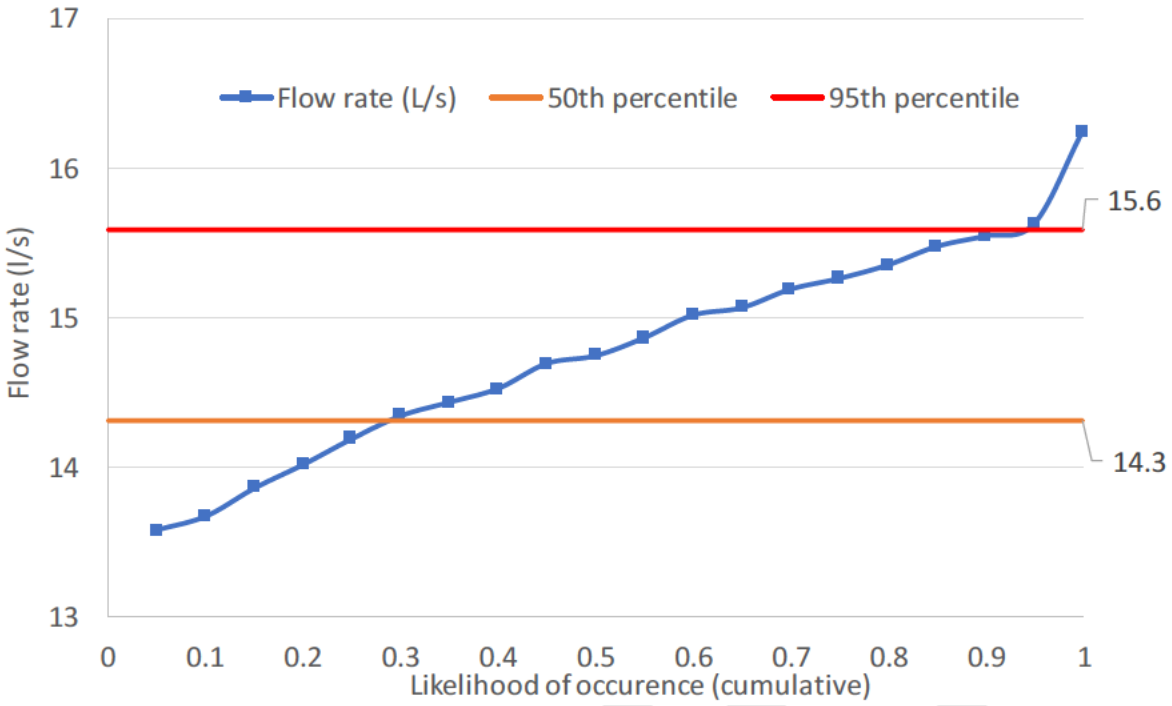

Figure 12 Predicted inflow rates resulting from stochastic modelling of parameters that result in 249 models with SRMS of less than 10 %.

For all these simulations:

- All models providing a prediction of groundwater in-flow rate were initially run without the scheme and had an SRMS in baseline conditions of less than 10 %.
- The hydraulic conductivity of the main tunnels was $1x10^{-7}$ m/s. This was used to calculate the conductance of the model drains.
- The hydraulic conductivity of cells within the grouting tunnel was set to $1x10^{-7}$ m/s so that it can represent a barrier to groundwater flow.
- The hydraulic conductivity of grout blocks was $1x10^{-7}$ m/s.
- The hydraulic conductivity of the grouting tunnel shafts was $1x10^{-7}$ m/s. The conductance of the cell was modified to reflect the perimeter area of the tunnel.
- The models use a 60 m cell size.

4.1.1 50th percentile parameter set with grout blocks, grouting tunnel and associated shafts, and main tunnels.

Figure 13 shows the drawdown and mounding predicted for the 50th percentile hydraulic parameters (see paragraph 3.2). Drawdown of 0.1 m is predicted to extend up to 1.5 km from the site to the east into the RAMSAR. The maximum drawdown at the RAMSAR site is adjacent to the grout tunnel shafts and is of between 1.3 m and 1.5 m.

A minor amount of mounding of the Chalk groundwater table is predicted to occur at the main tunnel grout block. This has a predicted magnitude of less than 0.2 m. The main tunnel grout block is required for the TBM to change face mode.

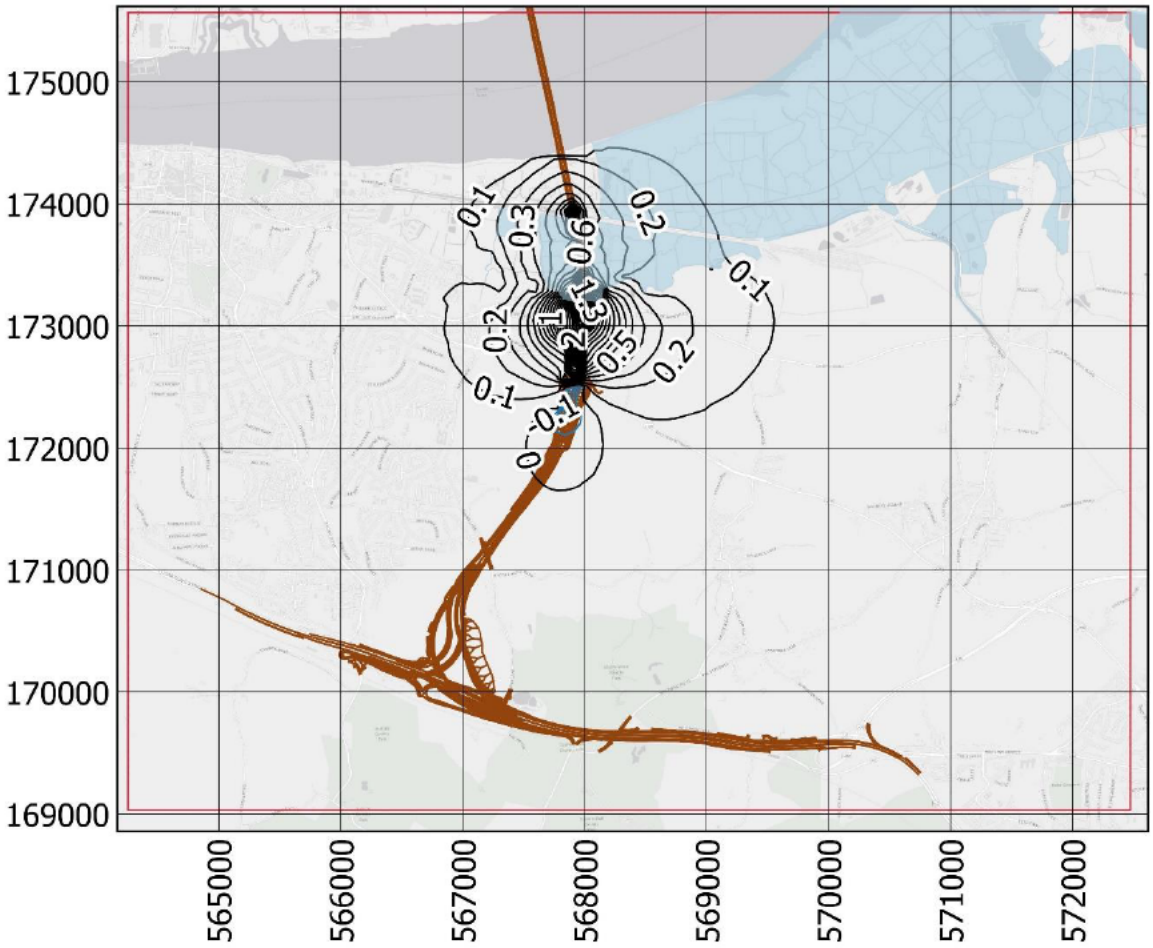

Figure 13 Drawdown and mounding predicted for the 50th Percentile parameter set. Simulation is steady-state.

4.1.2 Worst case parameter set – largest inflow result

Figure 14 shows the drawdown and mounding predicted for the highest inflow model from the analysis (see paragraph 3.2). The parameters for this model distribute the transmissivity of the Chalk into the deep chalk. This is unlikely given the information available about the Chalk in the London area.

Drawdown of 0.1 m is predicted to extend up to 2.2 km from the site to the east into the RAMSAR. The maximum drawdown at the RAMSAR site is adjacent to the grout tunnel shafts and is of between 1.5 m and 2.6 m. The highest values are predicted to occur close to the grout tunnel shafts.

The predicted total inflow was 16.3 L/s. The model domain was extended 1 Km to the west and 0.5 m to the south to remove any effects from the proximity of no-flow boundaries.

The scenario is worst case because:

- It is for the model result with the highest predicted inflow rate from a selection of 250 parameter sets with a SRMS of less than 10%;
- It includes all infrastructure components including construction and operation; and
- It is in steady state.

The combination of the above factors makes this scenario less likely.

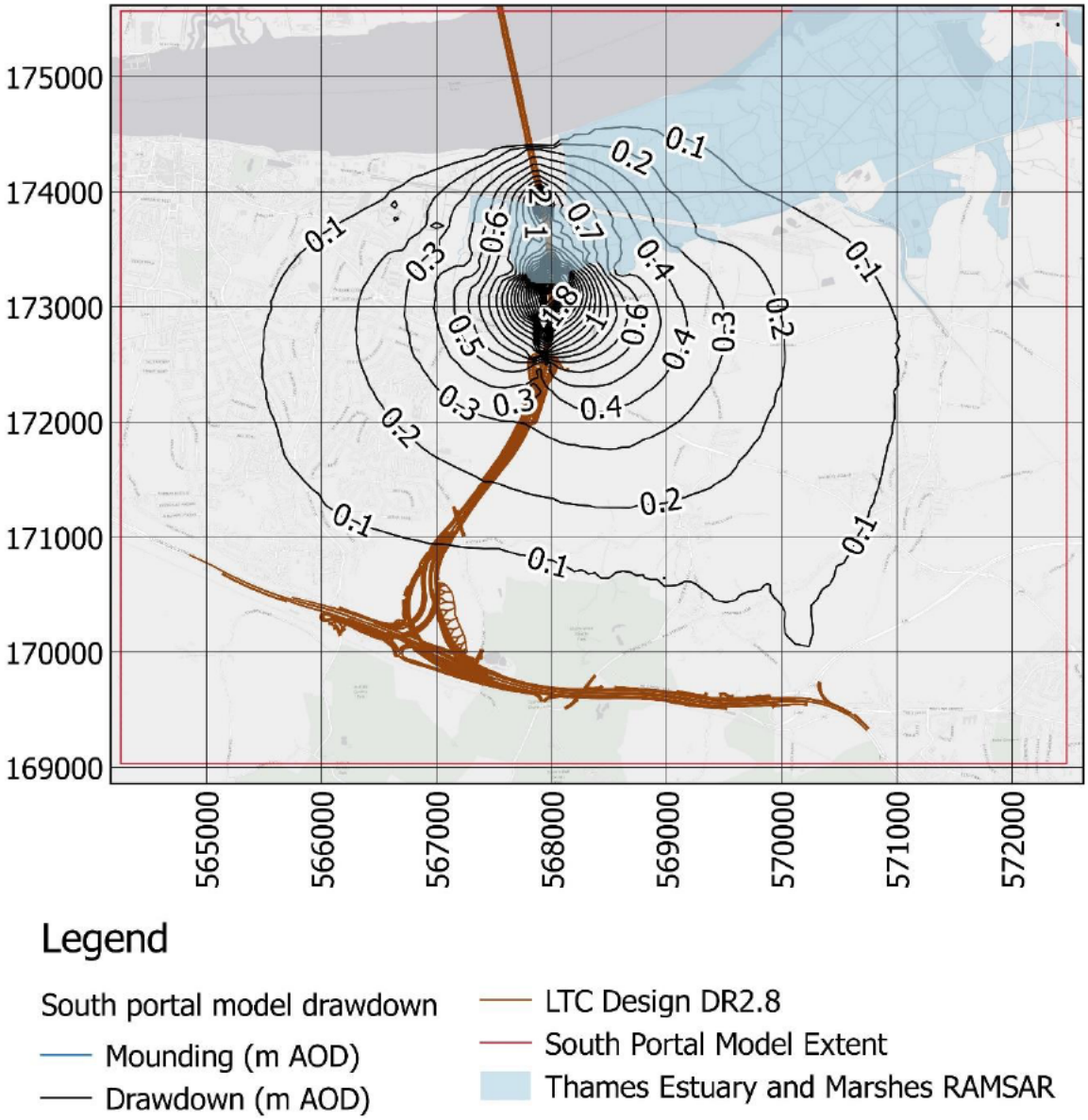

Figure 14 Drawdown and mounding predicted for the worst-case model for combined construction and operation infrastructure

4.2 Simulated inflow of operations in steady state

Figure 15 shows the predicted drawdown for the LTC south portal area during operations in steady state. In operations the grouting tunnel and its shafts are

abandoned and is not drained. Therefore, it is not a boundary condition in the model. Drawdown of 0.1 m is predicted to extend up to 860 m from the site to the east into the RAMSAR. The maximum drawdown at the RAMSAR site is adjacent to the grout tunnel shafts and is of between 0.6 m and 1.1 m.

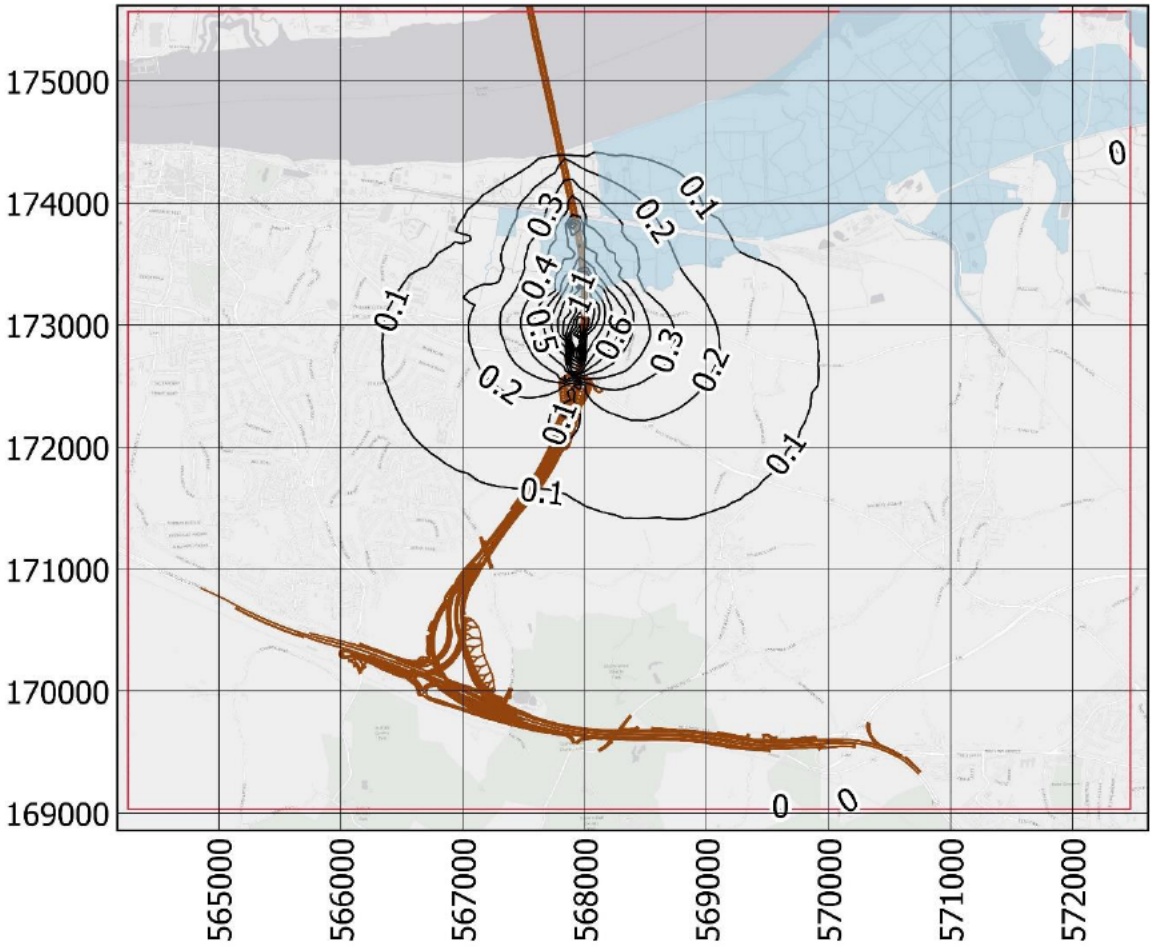

Figure 15 Drawdown and mounding predicted for the worst-case model for operations

4.3 Simulated inflow of construction in time variant mode

The drawdown cone associated with construction will take time to develop to its full extent. Therefore, the steady-state results presented in section 4.1 are worst-case. A time-variant model is presented, however, the infrastructure in the model is in a steady state and does not change with time. The model predicts the development of the drawdown cone over time and space.

Appendix 2 provides the drawdown plots for years 1 to 5. This simulation includes the grout tunnel portals, grout tunnels and grout blocks but does not include the main tunnel. The results show that after 5 years drawdown has spread to 1,500 m from the scheme towards the east.

The progression of drawdown is predicted to occurs as follows:

- 925 m in year 1
- 1,151 m in year 2
- 1,280 m in year 3
- 1,346 m in year 4
- 1,371 m in year 5

The result suggests that the majority of the drawdown will occur within the first year of construction and that the system will be approaching a steady condition by year 5. It is noted that for simplicity the infrastructure is modelled in steady-state and therefore this is worst case. In reality, components will be constructed sequentially.

5 Conclusions

Modelling has been completed using the 50th percentile model, considered the most likely parameter set, and the worst-case model (100th percentile parameter set) which had the highest inflow rate of all calibrated models, but is unlikely to occur.

The modelling scenarios completed included:

- Steady-state models that include all construction and operation infrastructure using the 50th percentile and worst-case model (100th percentile parameter set);
- A steady-state model that has operations infrastructure only using the worst-case model;
- A steady-state model that has construction infrastructure only using the worst-case model; and
- A time-variant (5 years) model of the construction infrastructure using the worst-case model.

The mitigations embedded in the design cause the inflow rates to be quite low. These mitigations include:

- Use of pressurised TBM method that inhibits groundwater inflow during drilling;
- Stopping the TBM within grout blocks for TBM maintenance; and
- Use of caisson methods and pre-grouting of ingress and egress shafts to inhibit groundwater inflow.

The inflow rate for the combined operations and construction infrastructure is predicted to be between **13.6 and 16.3 L/s**, with the 50th percentile of predicted flow rates of **14.3 L/s**. This infrastructure scenario is considered worst-case, as the grout tunnel will be abandoned and so is not present during operation of the scheme. For the 50th percentile model, 0.1 m drawdown is predicted at a distance of **1,500 m** from the scheme to the east. This is within the RAMSAR site. In the worst-case model (100th percentile parameter set), the 0.1 m drawdown contour is predicted to extend 2,200 m into the RAMSAR site east of the scheme.

In the 50th percentile model, mounding of the water table is predicted to extend up to a distance of 520 m to the south and is between 0 and 0.2 m thick. This is not predicted to occur in the worst-case model, as there is a small amount of drawdown instead. In general, recharge from the River Thames limits the propagation of the drawdown towards the north in all models.

When looking at the operations and construction infrastructure components separately, using the **worst-case** scenario, the following was predicted:

- Operations – 0.1 m drawdown extends to 890 m east of the site in steady-state
- Construction – 0.1 m drawdown extends to:
    - 925 m in year 1

- 1,151 m in year 2
- 1,280 m in year 3
- 1,346 m in year 4
- 1,371 m in year 5

The results of the time-variant simulation showed that the **majority** of the drawdown is predicted to occur within the **first year** of construction.

Overall, the model suggests that the mitigations built into the scheme are **effective** at minimising the requirement for dewatering and at minimising the amount of drawdown caused by the scheme.

The results presented above have a number of **limitations**:

- The infrastructure modelled is in steady-state. In reality, the grouting tunnel and associated shafts will only exist for the period of construction. After construction they will either be infilled with grout or abandoned. If abandoned, voids will be left to fill with groundwater. This means that the results presented are a worst-case scenario for drawdown extent;
- The models simulate saturated conditions only. This means it is not possible for perched water tables to be computed. This is a limitation for computing the water table within non-aquifers, such as in the alluvium in which the RAMSAR site is situated;
- As the model is in steady state, fluctuations in recharge are not included. It is possible that the drawdown cones could expand during dry periods compared to the model;
- The conductivity of the grout and tunnel boundaries is based on advice from the tunnelling team. The values used are quite conservative when compared to the hydraulic conductivity of concrete material; and
- As advised by the LTC CASCADE Construction team (Lower Thames Crossing - Cascade, 2019 (c)), the use of construction techniques (such as caisson) that would avoid major dewatering will be employed during the excavation of the launch and reception shafts for the advanced grouting tunnel. On this basis, no active dewatering has been included in the model for such structures. Should construction requirements change, these will be considered in future versions of the model.

6 Recommendations/further work

The following recommendations and areas of further work should be considered:

- Update the model, if considered necessary, with results of available Phase 2 GI (Package A) and pumping tests PW03001 and PW04001; and
- Assess the movement of the saline interface as a response to drawdown from the scheme.

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Appendix 1 Additional model parameters

Parameter	Parameter	Value
Made Ground	Kx (m/s)	See Table 8
	Kz (ratio of Kh/Kz)	0.2
	Sy	0.3
	Ss	$1x10^{-3}$
Alluvium	Kx (m/s)	See Table 8
	Kz (ratio of Kh/Kz)	0.3
	Sy	0.05
	Ss	$5x10^{-3}$
River Terrace Deposits[1]	Kx (m/s)	See Table 8
	Kz (ratio of Kh/Kz)	0.5
	Sy	0.15
	Ss	$2x10^{-3}$
London Clay	Kx (m/s)	See Table 8
	Kz (ratio of Kh/Kz)	0.3
	Sy	0.01
	Ss	$5x10^{-4}$
Harwich Formation	Kx (m/s)	$1.00x10^{-4}$
	Kz (ratio of Kh/Kz)	0.5
	Sy	0.3
	Ss	$1x10^{-5}$
Lambeth Formation	Kx (m/s)	See Table 8
	Kz (ratio of Kh/Kz)	0.3
	Sy	0.01
	Ss	$5x10^{-4}$
Thanet Formation	Kx (m/s)	$6.22x10^{-4}$
	Kz (ratio of Kh/Kz)	0.3
	Sy	0.02
	Ss	$8x10^{-4}$
Unstructured Chalk (<15 m below top of Chalk)	Kx (m/s)	See Table 8
	Kz (ratio of Kh/Kz)	0.3
	Sy	0.05
	Ss	$8x10^{-4}$
Chalk (>15 m below top of Chalk) and <-37 m AOD	Kx (m/s)	See Table 8
	Kz (ratio of Kh/Kz)	0.3

Parameter	Parameter	Value
	Sy	0.05
	Ss	$8x10^{-4}$
Structured Chalk (<-72 m AOD	Kx (m/s)	See Table 8
	Kz (ratio of Kh/Kz)	0.3
	Sy	0.02
	Ss	$8x10^{-4}$
[1]Includes the Taplow Gravel members.		

Appendix 2 Construction drawdown – annual plots

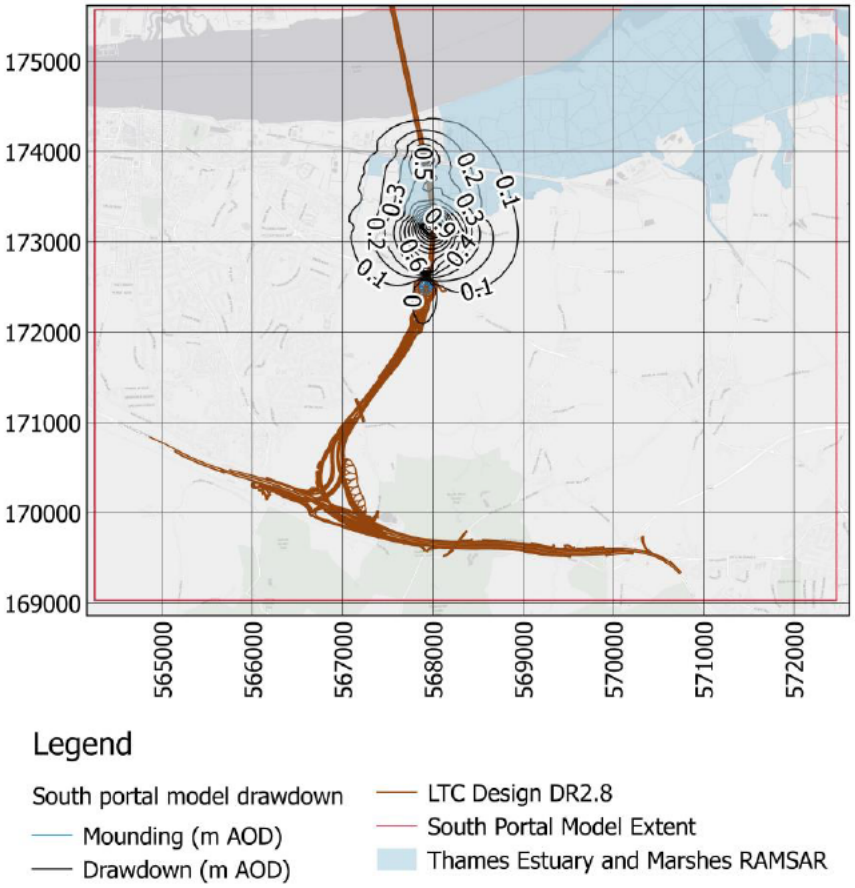

Figure A.16 Year 1

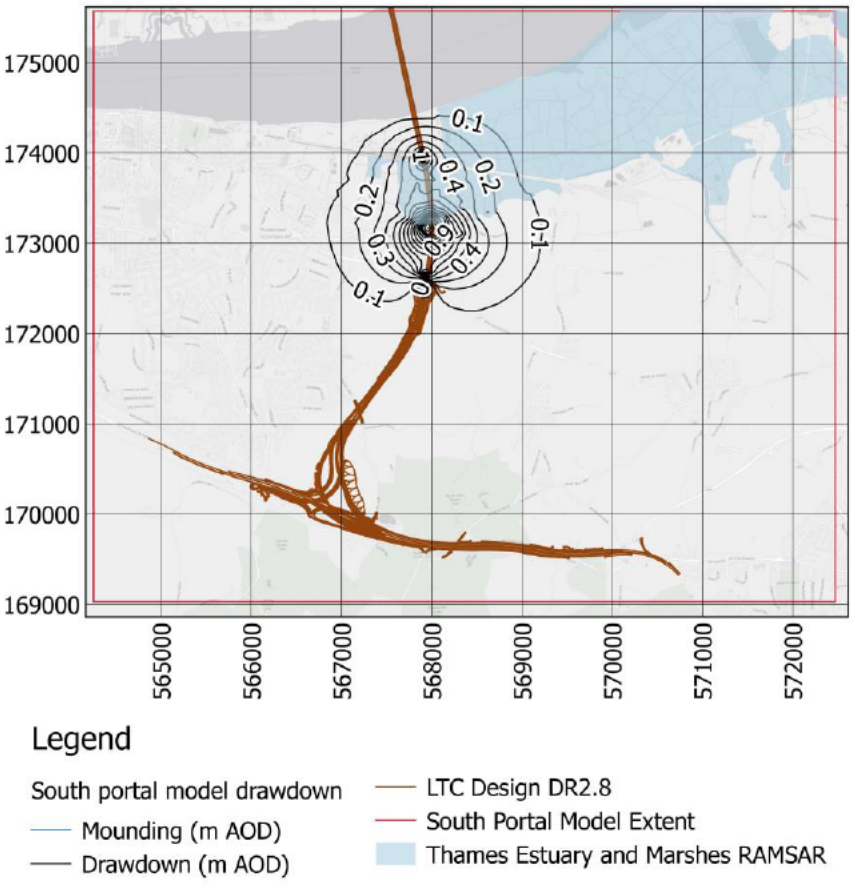

Figure A.17 Year 2

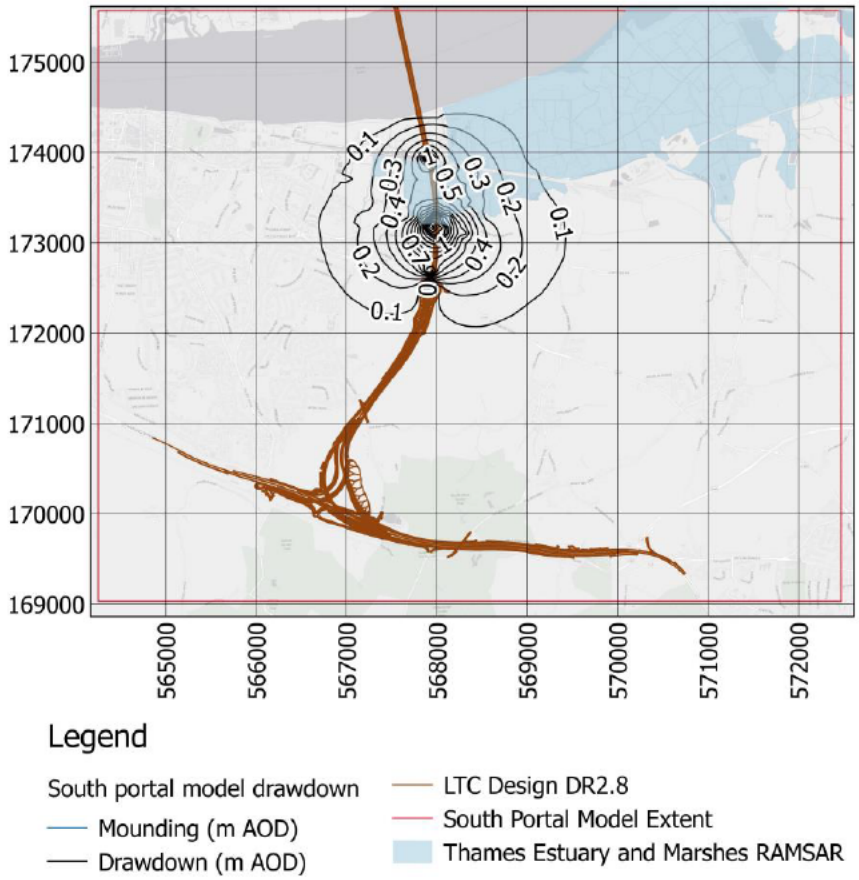

Figure A.18 Year 3

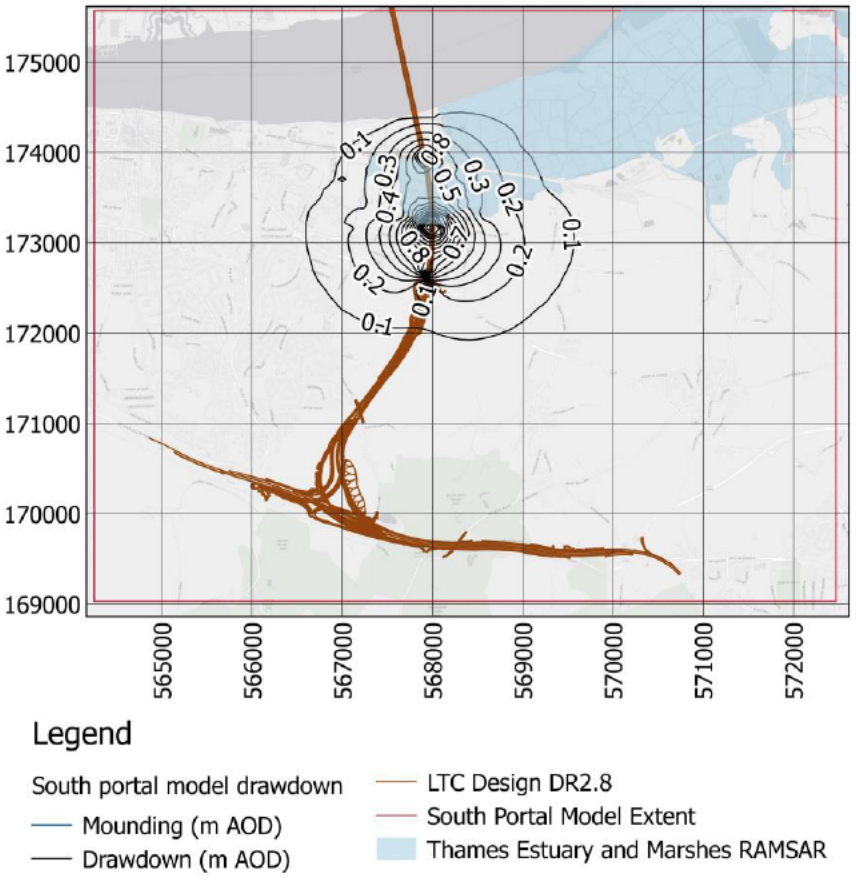

Figure A.19 Year 4

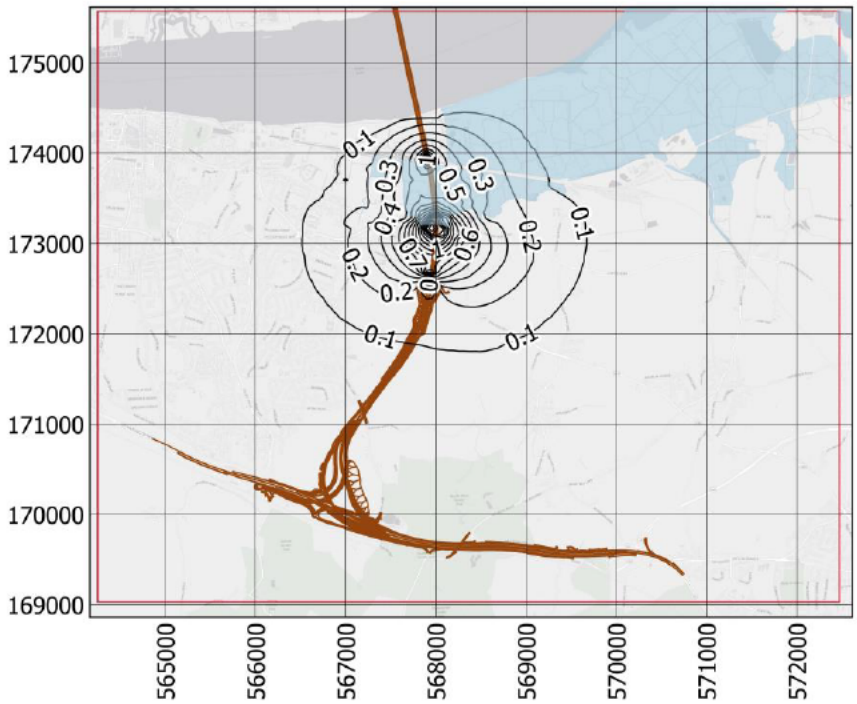

Figure A.20 Year 5

Annex M1 Disturbance – noise and visual methodology briefing note

Noise and Visual Disturbance Methodology

AIM – To set out the proposed process to determine how the Project may disturb key species as a result of the changes in noise and vibration and visual stimuli impact pathway and whether this effect (disturbance) will result in an adverse effect on the integrity of the European sites.

As the road is in tunnel under the Thames we do not believe there is a pathway to effect as a result of operational noise change.

Effect: Disturbance to key Species from changes in construction noise, vibration and visual stimuli.

Key Species: SPA/Ramsar qualifying birds

European Sites Screened in:

- Benfleet and Southend Marshes SPA and Ramsar
- Crouch and Roach Estuaries (Mid Essex Coast phase 3) SPA & Ramsar
- Lee Valley SPA & Ramsar
- Medway Estuary and Marshes SPA & Ramsar
- Thames Estuary and Marshes SPA & Ramsar
- The Swale SPA and Ramsar SPA & Ramsar

Information used to determine magnitude and extent of the impact			
Location of impact	Maps to illustrate overlaps where changes in noise, vibration or visual stimuli interface with areas of the Project that are used by SPA/RAMSAR birds		
Timing of impact	Indicate the months **when** the construction activities are programmed that will result in changes in noise and vibration and visual stimuli		
Duration of impact	Indicate **how long** the construction activities that will result in changes in noise and vibration and visual stimuli, will take. E.g. weeks/months. Timing on each day		
Impact source type	**Construction Noise**	**Construction Vibration**	**Construction Visual Stimuli**
Impact source magnitude (DMRB LA111 Noise and Vibration)	The changes in noise will be provided by the specialists in the form of contours to illustrate the noise level in decibels (dB) anticipated when the construction activities are in progress	The changes in vibration as a result of piling operations will be provided by the specialists	The assumption will be that when a construction activity is occurring there will be both people and plant present within immediate area of the activity.
Impact source ZoI (DMRB LA111 Noise and Vibration)	USE THE 55dB contour to determine ZoI	USE THE LOAEL 0.3mm/s contour	A precautionary 300m based on the Cutts et al (2013) mitigation tool kit.

	If 55dB is < 300m then use 300m If 55dB is >300m then we will extend to that distance.	Use the 300m distance (precautionary as study area is only 100m)	
Habitat types present in the ZoI	Using the Phase 1 data, list the habitat types and hectares within each ZoI		
Information used to explore magnitude/significance of the effect (disturbance)			
Map of functionally linked habitat	Provide GIS map of areas considered to be used by SPA/Ramsar QF birds i.e. functionally linked habitat – from survey results and consultation advice.		
QF species present in areas surveyed	List all the qualifying feature (QF) species recorded by the following field surveys: VP surveys (5 points) day VP survey (1 point) night FLL transects – day and night		
QF species present in ZoI	Provide a list of the QF species recorded at survey locations within each ZoI. For example – the proposed jetty location ZoI of 300m would display the data collected from VP – NW, VP Jetty, and FLL transect		
QF species peak counts	Graphs/Maps of peak counts recorded in the 6 VP areas Combine all species Individual species	FLL transects DAY Graphs/Maps of peak counts recorded along each transect. In each transect area	FLL transects and Jetty VP NIGHT Graphs/Maps of peak counts recorded along each transect. In each transect area
QF species peak count in ZoI	Filter the graphs/maps to just illustrate the peak counts recorded with the ZoI		
QF peak count as % N2K pop Population numbers as described on the Natura 2000 form for each site	Use the peak count (from all survey records) to determine the % of the "combined European site" population and of each European Site. For example, Black-tailed godwit – peak count recorded from field survey work – 590 (August), 250 (Jan) Listed as a QF on European Sites: ▪ Medway Estuary and Marshes SPA – 957 OVERWINTER ▪ Thames Estuary and Marshes SPA – 1699 OVERWINTER ▪ The Swale Ramsar - 1504 OVERWINTER ▪ Medway Estuary and Marshes Ramsar - 721 SPRING/AUTUMN ▪ Thames Estuary and Marshes Ramsar - 1640 SPRING/ AUTUMN ▪ 6% of combined site overwinter pop = (250/(957+1699+1504))*100 ▪ 25% of combined site spring/autumn pop = (590/(721+1640))*100 ▪ 15% of the Thames Estuary and Marshes SPA overwinter population=(250/1699)*100		

	Similar approach (group all qualifying species together) to determine contribution to an "assemblage"??
QF peak count in ZoI as % N2K pop	Use the peak count (the surveys relevant to the ZoI) to determine the % of the "combined European site" population and of each European Site.
QF spp - months recorded in ZoI	Use graphs of survey data to illustrate the use of the ZoI across the year and with different tidal states. Display data as combined all QF species and individual QF species.
Obligatory use?	Looking at the use by months – no pattern suggests not obliged to use that area and alternative habitat likely to be used.
Alt hab within 300m of the ZoI	On a map show the phase 1 data/magic "supporting habitat layers" within the next 300m from the ZoI. Calculate the hectares
Alt hab along the Estuary within 20km of the European Sites (Greater Thames Complex)	Map based exercise to illustrate where the available supporting habitat is present within 20km of these sites (assumed foraging range). Calculate the hectares
Alt hab within the 20km EoS (include all European Sites screened in)	Map based exercise to illustrate where the available supporting habitat is present. Calculate the hectares
% of affected habitat within ZoI	Calculate % at the varying scales described above to provide an indication of significance of temporary loss if all birds were permanently excluded during the construction phase.
Mitigation	Possible measures to attenuate at source are available – e.g. engine silencer, hoardings. Possible measures to attenuate effect – timing constraints: work every other low tide, avoiding night time work, avoiding peak months, avoiding work during severe weather events (cold) when birds are more vulnerable **Measuring effectiveness** Method/ assumptions when measuring the reduction/avoidance – numerical when considering source but anecdotal when considering effect. Professional judgement supported by literature evidence, technical discussion with stakeholders.
AEI ?	Professional judgement using the various determining factors described above to assess how the conservation objectives could be affected.

Annex M2 02 April 2020 Feedback received from Natural England

Noise and Visual Disturbance Methodology

AIM – To set out the proposed process to determine how the Project may disturb key species as a result of the changes in noise and vibration and visual stimuli impact pathway and whether this effect (disturbance) will result in an adverse effect on the integrity of the European sites.

As the road is in tunnel under the Thames we do not believe there is a pathway to effect as a result of operational noise change.

Effect: Disturbance to key Species from changes in construction noise, vibration and visual stimuli.

Key Species: SPA/Ramsar qualifying birds

European Sites Screened in:

- Benfleet and Southend Marshes SPA and Ramsar
- Crouch and Roach Estuaries (Mid Essex Coast phase 3) SPA & Ramsar
- Lee Valley SPA & Ramsar
- Medway Estuary and Marshes SPA & Ramsar
- Thames Estuary and Marshes SPA & Ramsar
- The Swale SPA and Ramsar SPA & Ramsar

Information used to determine magnitude and extent of the impact			
Location of impact	Maps to illustrate overlaps where changes in noise, vibration or visual stimuli interface with areas of the Project that are used by SPA/RAMSAR birds		
Timing of impact	Indicate the months **when** the construction activities are programmed that will result in changes in noise and vibration and visual stimuli		
Duration of impact	Indicate **how long** the construction activities that will result in changes in noise and vibration and visual stimuli, will take. E.g. weeks/months. Timing on each day		
Impact source type	**Construction Noise**	**Construction Vibration**	**Construction Visual Stimuli**
Impact source magnitude (DMRB LA111 Noise and Vibration)	The changes in noise will be provided by the specialists in the form of contours to illustrate the noise level in decibels (dB) anticipated when the construction activities are in progress	The changes in vibration as a result of piling operations will be provided by the specialists	The assumption will be that when a construction activity is occurring there will be both people and plant present within immediate area of the activity.
Impact source ZoI (DMRB LA111 Noise and Vibration)	USE THE 55dB contour to determine ZoI	USE THE LOAEL 0.3mm/s contour	A precautionary 300m based on the Cutts et al (2013) mitigation tool kit.

Commented [BJ(1]: We assume this only relates to the area of road that is within tunnel, not the approach roads?

Commented [PI2]: Need a similar table for SAC Pinipeds.

Commented [BJ(3]: It would be helpful to understand why the Crouch & Roach Estuaries SPA and Ramsar is screened in, but nearer sites are not.

Commented [BJ(4]: Same here, if this is purely about construction noise, its not clear why this site is listed.

Commented [HS5]: Given the construction period for this project, the impacts across years will also need to be considered.

Commented [HS6]: Whilst not specifically related to the construction stimuli, we have expressed concern previously that the construction works and their longevity could mean that people visiting the coast are displaced which could result in increased recreational disturbance to species and habitats associated with the designated sites and this would need to be considered within the HRA process.

Commented [HS7]: In addition to noise contours, which are often an average, there may be more some short-term duration activities which occur regularly which ,might be particularly impactful and these need to be considered as part of the HRA process.

Commented [HS(8]: It is not clear from the document whether the ZoI will encompass functionally linked land – this is referenced below but it would be helpful to clarify whether it is included within the ZoI.

Commented [BJ(9]: This figure needs an accompanying explanation. There should be reference to baseline noise levels, and 3dB above this is deemed to be significant, for HRA purposes. If this is above 300m then a greater distance should be used.

Commented [PI10]: Site specific work by Liley and Fearnley (2011) work indicated that the ZoI would not be any larger and was often much less with major flight often occurring at about 50m

	If 55dB is < 300m then use 300m If 55dB is >300m then we will extend to that distance.	Use the 300m distance (precautionary as study area is only 100m)	
Habitat types present in the ZoI	Using the Phase 1 data, list the habitat types and hectares within each ZoI		
Information used to explore magnitude/significance of the effect (disturbance)			
Map of functionally linked habitat	Provide GIS map of areas considered to be used by SPA/Ramsar QF birds i.e. functionally linked habitat – from survey results and consultation advice.		
QF species present in areas surveyed	List all the qualifying feature (QF) species recorded by the following field surveys: VP surveys (5 points) day VP survey (1 point) night FLL transects – day and night		
QF species present in ZoI	Provide a list of the QF species recorded at survey locations within each ZoI. For example – the proposed jetty location ZoI of 300m would display the data collected from VP – NW, VP Jetty, and FLL transect		
QF species peak counts	Graphs/Maps of peak counts recorded in the 6 VP areas Combine all species Individual species	FLL transects DAY Graphs/Maps of peak counts recorded along each transect. In each transect area	FLL transects and Jetty VP NIGHT Graphs/Maps of peak counts recorded along each transect. In each transect area
QF species peak count in ZoI	Filter the graphs/maps to just illustrate the peak counts recorded with the ZoI		
QF peak count as % N2K pop Population numbers as described on the Natura 2000 form for each site	Use the peak count (from all survey records) to determine the % of the "combined European site" population and of each European Site. For example, Black-tailed godwit – peak count recorded from field survey work – 590 (August), 250 (Jan) Listed as a QF on European Sites: ▪ Medway Estuary and Marshes SPA – 957 OVERWINTER ▪ Thames Estuary and Marshes SPA – 1699 OVERWINTER ▪ The Swale Ramsar - 1504 OVERWINTER ▪ Medway Estuary and Marshes Ramsar - 721 SPRING/AUTUMN ▪ Thames Estuary and Marshes Ramsar - 1640 SPRING/ AUTUMN ▪ 6% of combined site overwinter pop = (250/(957+1699+1504))*100 ▪ 25% of combined site spring/autumn pop = (590/(721+1640))*100 ▪ 15% of the Thames Estuary and Marshes SPA overwinter population=(250/1699)*100		

Commented [BJ(11]: Needs to include the Waterbird Assemblage feature as well, which is not just the qualifying species. & below, where relevant.

Commented [HS12]: It would also seem sensible to supplement this data with additional resources such as the Local Environmental Record Centre information and the WeBS sector counts where these provide an appropriate spatial survey area.

Commented [HS13]: Whilst peak counts will allow the assessment of the greatest impact, it may not provide useful information in relation to the temporal impacts as the timing of the peak count is likely to change each year driven by a number of factors such as weather conditions. If the timing of the peak count is to be used to assist in the impact assessment by correlating these with the timing of works, that may not lead to a full understanding of the impacts.

	Similar approach (group all qualifying species together) to determine contribution to an "assemblage"??
QF peak count in ZoI as % N2K pop	Use the peak count (the surveys relevant to the ZoI) to determine the % of the "combined European site" population and of each European Site.
QF spp - months recorded in ZoI	Use graphs of survey data to illustrate the use of the ZoI across the year and with different tidal states. Display data as combined all QF species and individual QF species.
Obligatory use?	Looking at the use by months – no pattern suggests not obliged to use that area and alternative habitat likely to be used.
Alt hab within 300m of the ZoI	On a map show the phase 1 data/magic "supporting habitat layers" within the next 300m from the ZoI. Calculate the hectares
Alt hab along the Estuary within 20km of the European Sites (Greater Thames Complex)	Map based exercise to illustrate where the available supporting habitat is present within 20km of these sites (assumed foraging range). Calculate the hectares
Alt hab within the 20km EoS (include all European Sites screened in)	Map based exercise to illustrate where the available supporting habitat is present. Calculate the hectares
% of affected habitat within ZoI	Calculate % at the varying scales described above to provide an indication of significance of temporary loss if all birds were permanently excluded during the construction phase.
Mitigation	Possible measures to attenuate at source are available – e.g. engine silencer, hoardings. Possible measures to attenuate effect – timing constraints: work every other low tide, avoiding night time work, avoiding peak months, avoiding work during severe weather events (cold) when birds are more vulnerable **Measuring effectiveness** Method/ assumptions when measuring the reduction/avoidance – numerical when considering source but anecdotal when considering effect. Professional judgement supported by literature evidence, technical discussion with stakeholders.
AEI ?	Professional judgement using the various determining factors described above to assess how the conservation objectives could be affected.

Commented [BJ(14]: See above – I understood the assemblage to be more than just the qualifying features, and also included all waterbird species (exc. Gulls). So the assessment should consider impacts to the individual qualifying species and the assemblage

Commented [HS15]: Whilst this will provide a helpful comparison of the peak count compared to the population at the time the sites were classified, it should also reflect the background trends in bird numbers which may change the significance of the assessment.

Commented [BJ(16]: We are unclear what is meant here

Commented [BJ(17]: Need to distinguish "supporting habitat" from "functionally linked land" as the two are different. Supporting habitat is typically within the N2K site, functionally linked land is outside.

Commented [PI18]: Benfleet & Southend Marshes, Thames, Medway and Swale
NE – Site Improvement Plan

Commented [BJ(19]: I have not come across this amalgamation of N2K sites before. Suggest caution around its use, as it doesn't take into account the importance of local distribution (i.e. it seems to allow for 'all birds flee to kent' type of argument. HRA is tested at the site level.

Commented [BJ(20]: The availability of alternative habitat within 20km is not the key driver as to whether it will be used. Proximity to the N2K site is key so some spatial application needs to be made. It is probably unreasonable to assume 20km represents availability of realistically available alternative habitat. This needs more tailoring to species requirements. Not all ha within 20km will be used equally.
Additional point around how to account for variable cropping regimes.

Commented [HS(21]: Natural England has previously expressed concern about 'temporary loss' as a term for the assessment of impacts given the duration of the construction period. If these 'temporary losses' span more than one season then it may not be appropriate to consider these temporary (even more so if they span several years)

Commented [HS(22]: Whilst it is accepted that there needs to be a degree of professional judgement in the assessment, it would be helpful to understand the criteria/approach that will be used based upon the information summarised in this document to inform the consideration of the adverse effect on integrity test.

On a general note, it is also difficult to provide advice on the appropriateness of the approach proposed in the absence of any draft impact assessment or survey dat ...

Annex N1 8 March 2020 Groundwater Assessment Methodology briefing note

Groundwater Methodology

AIM – To set out the proposed process to determine how the Project may result in habitat degradation as a result of the changes in groundwater impact pathway and whether this effect (loss of habitat area) will result in an adverse effect on the integrity of the European sites.

Assessment of likely significant effect (LSE) and adverse effect on integrity of the European sites		Guidance / Methodology
Does the project have a potential hydrological or hydrogeological linkage to a European site containing a groundwater dependent terrestrial ecosystem (GWDTE) which triggers the assessment of European sites in accordance with LA 113 (Highways England, 2019)[1]?	No – No LSE / no further assessment required. Record decision.	DMRB LA115 (Highways England, 2019) DMRB LA 113 (Highways England, 2019)
Yes – simple assessment to be undertaken to determine: ▪ whether there is a hydrological link with GWDTE; ▪ the importance of the GWDTE; ▪ the magnitude of any potential impact on the GWDTE; and ▪ thereby the overall significance of risk to the GWDTE.	-	DMRB LA 113 (Highways England, 2019)
Step 1 Is there a linkage between the potential impacts from the road and the GWDTE?	No – Negligible risk / no further assessment required	Site specific conceptual hydrogeological model[2] to provide overview of interactions between groundwater, surface water and to identify potential linkages between potential impacts from the road and GWDTE (construction/ operation).
Yes - Is the habitat affected either a qualifying feature, or does it support a qualifying feature of the European Site?	No – Conclude no adverse effect on integrity of European site	
Yes – Move on to Steps 2-4	-	-
Step 2 Determine the groundwater dependency of affected vegetation within European site.		UKTAG wetland task team (WTT) guidance on National Vegetation Classification (NVC) – groundwater

[1] For the purposes of HRA, where the established risk to GWDTE is assessed to be above negligible, further assessment in accordance with LA 113 may be required

[2] Hydrological model to take into account groundwater flow paths, groundwater levels and the proximity of GWDTE.

		dependency scores (3=low, 2=moderate, 1=high) (UK TAG, 2004 updated 2009)
Step 3 Assess potential impacts for groundwater quantity (groundwater flow/flux, groundwater level, soil saturation/moisture) and groundwater quality (nutrients, metalloid and organic compounds). Use results of assessments to determine magnitude of impact (Major adverse, moderate adverse, minor adverse or negligible).	-	Use **qualitative** assessment methodologies detailed in LA113 (Table B.2) to determine potential impacts (Highways England, 2019). Magnitude of impact definitions provided in LA113 (Table B.3).
Step 4 Combine the importance (step 2) with the magnitude of the potential impact (step 3) to establish risk to GWDTE (Significant, Moderate or Negligible risk) **Is the risk considered Negligible?**	Yes – No LSE / Conclude no adverse effect on integrity of European site	Risk matrix provided in LA113 (Table B.4) (Highways England, 2019)
No (i.e. moderate or significant) – **Can mitigation be incorporated to address the risk?**	Yes – No LSE / Conclude no adverse effect on integrity of European site	Generic mitigation measures may be used for the physical protection of receptors or management of water levels as detailed in LA113 (Highways England, 2019).
No – detailed assessment required to establish more precise assessment of the significance of the risk and aid identification / design of mitigation measures. Following detailed assessment, taking into account significance of risk and mitigation measures would there still be a likely significant effect on the GWTDE?	No – Conclude no adverse effect on integrity of European site	As set out in LA113 (Table B.2) with **quantitative** analysis. Groundwater quantity – quantify the departure from the required environmental supporting conditions within GWDTE. Groundwater quality – quantification of any departure from defined GWDTE threshold values established by UKTAG. (Highways England, 2019)
Yes - Conclude there would be an adverse effect on the integrity of the European site (proceed to stages 3-5)	-	-

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Highways England, 2019. *DMRB Vol. 11, Section 3, Part 10, LA 113 Road drainage and the water environment.* [Online]
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UK TAG, 2004 updated 2009. *Guidance on the Identification and Risk Assessment of Groundwater Dependent Terrestrial Ecosystems.* s.l.:UK Technical Advisory Group on the Water Framework Directive.

Example of mitigation measures lifted from DMRB LA 113:

Generic mitigation measures for the physical protection of receptors

1) replacement or alteration of water supply by connection to new sources or construction of new wells out of the impact zone;
2) installation of low permeability cut-off walls around engineering works or particular receptors to reduce groundwater level and flow impacts;
3) installation of temporary low-permeability cut-off walls that can be removed or degrade over time to prevent long term level or flow alterations;
4) relocation or modification works to protect underground structures against any imposed changes;
5) limits to the scale, depth and time of temporary dewatering or abstractions by change of method or by division of works to reduce the zone of influence of dewatering;
6) reduction in the use of damaging construction methods to aquifer physical properties such as blasting or over consolidating;
7) avoidance of sensitive aquifers or aquifer boundaries such as confining layers.

The following generic mitigation measures may be used for the management of water balance:

1) provision of (compensatory) discharges to GWDTEs to support water level and flows where these may be reduced;
2) provision of (compensatory) discharges to surface water bodies that are groundwater fed or feeding to support water level and flows and groundwater recharge;
3) provision of discharges to groundwater using infiltration to maintain level and flows for abstraction and to protect against settlement;
4) abstraction of groundwater to prevent increases in levels and flows that may lead to damage or flooding;
5) provision of monitoring of water levels in nearby wells or surface water to enable/ identify further mitigation measures when needed.

Annex N2 02 April 2020 Feedback received from Natural England

Groundwater Methodology

AIM – To set out the proposed process to determine how the Project may result in habitat degradation as a result of the changes in groundwater impact pathway and whether this effect (loss of habitat area) will result in an adverse effect on the integrity of the European sites.

Assessment of likely significant effect (LSE) and adverse effect on integrity of the European sites		Guidance / Methodology
Does the project have a potential hydrological or hydrogeological linkage to a European site containing a groundwater dependent terrestrial ecosystem (GWDTE) which triggers the assessment of European sites in accordance with LA 113 (Highways England, 2019)[1]?	No – No LSE / no further assessment required. Record decision.	DMRB LA115 (Highways England, 2019) DMRB LA 113 (Highways England, 2019)
Yes – simple assessment to be undertaken to determine: ▪ whether there is a hydrological link with GWDTE; ▪ the importance of the GWDTE; ▪ the magnitude of any potential impact on the GWDTE; and ▪ thereby the overall significance of risk to the GWDTE.	-	DMRB LA 113 (Highways England, 2019)
Step 1 Is there a linkage between the potential impacts from the road and the GWDTE?	No – Negligible risk / no further assessment required	Site specific conceptual hydrogeological model[2] to provide overview of interactions between groundwater, surface water and to identify potential linkages between potential impacts from the road and GWDTE (construction/ operation).
Yes - Is the habitat affected either a qualifying feature, or does it support a qualifying feature of the European Site?	No – Conclude no adverse effect on integrity of European site	
Yes – Move on to Steps 2-4	-	-
Step 2 Determine the groundwater dependency of affected vegetation within European site.		UKTAG wetland task team (WTT) guidance on National Vegetation Classification (NVC) – groundwater

[1] For the purposes of HRA, where the established risk to GWDTE is assessed to be above negligible, further assessment in accordance with LA 113 may be required
[2] Hydrological model to take into account groundwater flow paths, groundwater levels and the proximity of GWDTE.

Commented [BJ(1]: "loss" and "degradation" are not the same thing. When does degradation lead to loss?

Commented [HS2]: Whilst this is primarily a road scheme, there are additional operations which have the potential to lead to impacts such as the utility diversions and the ground preparation tunnel. As such, we would expect the potential impacts from the scheme in the round to be referenced here.

Commented [HS3]: Throughout this assessment table, there is no contingency for when a potential impact is 'uncertain'. In these situations, the precautionary approach should be adopted and an assessment undertaken to more fully understand whether the project will result in an adverse effect on the integrity of the international site(s)

Commented [HS4]: This scenario is unlikely to occur as it is very unusual for an international site to be designated and not support the qualifying species or habitat. If the interest feature has been lost, then the conservation objectives are likely to require restoration of the habitat/species population so in these circumstances this approach could hinder the site reaching its conservation objectives.

Commented [HS5]: For wetland plants, as part of a Ramsar Site assemblage, for example, the consideration of vegetation which will be impacted appears appropriate. However for wetland invertebrate species associated with the grazing marsh ditch habitat for wintering birds the vegetation composition is likely to be less critical than other factors such as the availability of water.
Whilst we have been informed by the Project Team that it is thought that there is little linkage between the ground and surface water along the length of the route, we have yet to have detailed results from the monitoring to understand whether this is genuinely the case. As such, there could be impacts resulting from changes to surface water by any drawdown in ground water and this should be considered

		dependency scores (3=low, 2=moderate, 1=high) (UK TAG, 2004 updated 2009)
Step 3 Assess potential impacts for groundwater quantity (groundwater flow/flux, groundwater level, soil saturation/moisture) and groundwater quality (nutrients, metalloid and organic compounds). Use results of assessments to determine magnitude of impact (Major adverse, moderate adverse, minor adverse or negligible).	-	Use **qualitative** assessment methodologies detailed in LA113 (Table B.2) to determine potential impacts (Highways England, 2019). Magnitude of impact definitions provided in LA113 (Table B.3).
Step 4 Combine the importance (step 2) with the magnitude of the potential impact (step 3) to establish risk to GWDTE (Significant, Moderate or Negligible risk) **Is the risk considered Negligible?**	Yes – No LSE / Conclude no adverse effect on integrity of European site	Risk matrix provided in LA113 (Table B.4) (Highways England, 2019)
No (i.e. moderate or significant) – **Can mitigation be incorporated to address the risk?**	Yes – No LSE / Conclude no adverse effect on integrity of European site	Generic mitigation measures may be used for the physical protection of receptors or management of water levels as detailed in LA113 (Highways England, 2019).
No – detailed assessment required to establish more precise assessment of the significance of the risk and aid identification / design of mitigation measures. Following detailed assessment, taking into account significance of risk and mitigation measures would there still be a likely significant effect on the GWTDE?	No – Conclude no adverse effect on integrity of European site	As set out in LA113 (Table B.2) with **quantitative** analysis. Groundwater quantity – quantify the departure from the required environmental supporting conditions within GWDTE. Groundwater quality – quantification of any departure from defined GWDTE threshold values established by UKTAG. (Highways England, 2019)
Yes - Conclude there would be an adverse effect on the integrity of the European site (proceed to stages 3-5)	-	-

Commented [HS6]: See comments above regarding the linkage between features such as ditches and wet grassland and whether these are surface or ground water dependent and if there is any interaction between the ground and surface water which could be impacted by the scheme.

Commented [HS7]: If mitigation measures are required to mitigate the impacts, then a LSE cannot be ruled out and an appropriate assessment will be required to understand whether these mitigation measures will ensure there is no adverse effect on the integrity of the site (as per the People over Wind ruling which clarifies that mitigation measures cannot be considered at the LSE stage).

Commented [HS8]: If a LSE cannot be ruled out, then an appropriate assessment will be required (it is unclear whether this is what is meant by a 'detailed assessment' here). The test at this stage is whether the project will have an adverse effect on the integrity of the site, not revisiting whether there will be an LSE as that has already been established. This is especially so at the decision aiding question refers to more detailed assessment to 'aid the identification/design of mitigation measures' which would require consideration through an appropriate assessment as per the requirements of the People over Wind judgement.

Commented [HS9]: It would be helpful to understand what stages 3-5 are.

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6) reduction in the use of damaging construction methods to aquifer physical properties such as blasting or over consolidating;
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The following generic mitigation measures may be used for the management of water balance:

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4) abstraction of groundwater to prevent increases in levels and flows that may lead to damage or flooding;
5) provision of monitoring of water levels in nearby wells or surface water to enable/ identify further mitigation measures when needed.

Annex O1 08 April 2020 Epping Forest detailed botanical survey briefing note

Epping Forest Detailed Botanical Survey and Assessment of Nitrogen Deposition Sensitivity Methodology

AIM – To set out the proposed methodology for a detailed botanical survey to determine if a predicted increase in Nitrogen deposition (0.4kgN/ha/yr) in 0.02ha area of Epping Forest is likely to lead to the loss of 1 species, by determining species composition and sensitivity of species to nitrogen deposition change.

Desk study	**Guidance/ References**

Review existing information:
▪ Epping Forest SAC Citation
▪ Epping Forest SAC Conservation Objectives & Supplementary Advice
▪ Condition of SSSI unit (Unit 105 - Epping Thicks)
▪ APIS data for site and habitat type
▪ JNCC/ European Commission habitat definitions
▪ Interim habitat survey results (LTC)
Identify species that are associated with SAC designated habitat / SSSI citations (or equivalent):
▪ List species that are indicative of the habitat or are indicative of good condition in light of air quality conservation objective:
  ▪ SAC citation – 9210
  ▪ UK habitat classification – W1c5
  ▪ National Vegetation Classification – W14/W15
	▪ Citation (English Nature, 2005)
	▪ Conservation objectives (Natural England, 2018) and (Natural England, 2019).
	▪ SSSI site condition (Natural England, 2010)
	▪ Air Pollution Information System Website (APIS, 2016).
	▪ SAC Habitat definition (9210) (JNCC, 2020) (European Commission, 2013)
	▪ UK habitat classification (W1c5) (UK Habitat Classification Working Group, 2018)
	▪ National Vegetation Classification (NVC) habitat definition (W14/W15) (Hall, et al., 2004)

Identify area for detailed site investigation: Five 15m x 15m quadrat locations at 100m intervals along a 400m transect (moving further south) would provide data for the affected area as well as an additional 4 samples for comparative purposes (progressively further away from affected area). ▪ Quadrat 1 (affected area) = 15m x 15m area where nitrogen deposition change is equal to or above the threshold that could bring about loss of 1 species (0.4 kgN/ha/yr): - Area comprises 0.02ha in northwest corner of SSSI Unit 105 (Epping Thicks). ▪ Quadrats 2 to 5 (buffer) = One 15x15m area per 100m interval along 400m transect directly south of quadrat 1.	DMRB LA105. Figure 2.98 (Highways England, 2019) Natural England commissioned report NECR210 (particularly Table 21) (Caporn, et al., 2016)
Detailed site investigation	**Guidance/ References**
Botanist to undertake UK Habitat Classification survey to Level 5 (Habitat Directives Annex I habitats) within each of the five quadrats detailed above.[1]	(UK Habitat Classification Working Group, 2018)

[1] NVC habitat classification to also be noted (Hall, et al., 2004).

In addition, all species present to be recorded (DAFOR scale separately in each quadrat), including vascular and non-vascular plants (i.e. bryophytes and lichens). Survey to be undertaken in early May 2020.	
Nitrogen sensitivity assessment	**Guidance/ References**
Determine sensitivity of species identified to changes in nitrogen deposition: ▪ Consider species recorded in survey and compare with species associated with SAC designated habitat / SSSI citation. ▪ Are species recorded particularly sensitive to nitrogen deposition e.g. oligotrophic (prefer nutrients poor soils) / eutrophic (prefer nutrient rich soils) or nitrophilous? [2] ▪ Consider results from quadrats 2-5 in comparison to quadrat 1. Are there changes in trends in species composition / abundance along the transect (as they move progressively further away from affected area)? Use professional judgement to identify species that are present in the affected area that could be expected to be lost in that area in light of: • the predicted increase of nitrogen deposition (magnitude of effect in context of species sensitivity) • the existing levels of deposition that have exceeded critical loads for many years (degree of resilience established) • the distribution of the species in the affected area (quadrat 1) and buffer zone (quadrats 2-5) (likely level of change / loss already occurred through deposition from main source i.e. M25)	▪ Air Pollution Information System Website (APIS, 2016). ▪ Natural England commissioned report NECR210 (particularly Section 7.3) (Caporn, et al., 2016) ▪ NVC User's Handbook (Rodwell, 2006) ▪ NVC Woodland Guide (Hall, et al., 2004) ▪ Ellenberg's indicator values for British plants (Hill, et al., 1999) ▪ Forest floor vegetation response to nitrogen deposition in Europe (Dirnbock, et al., 2014) ▪ Lichen nitrogen sensitivity (Field Studies Council, 2016)
Conclusion	
Are there species located in the area that could be expected to be lost with a further increase in nitrogen deposition (i.e. the nitrogen deposition might be expected to lead to the loss of 1 species)? i.e. are there any species present that are considered particularly sensitive to a further increase in nitrogen deposition?	No – No likely significant effect

[2] Expect decline in cover of species which prefer nutrient-poor soils (oligotrophic species) as N dep exceeds critical load. Would expect a gradual replacement of oligotrophic species by eutrophic species (Dirnbock, et al., 2014).

Yes – **Will a Project Air Quality Action Plan (PAQAP) be effective in reducing the impact of the Project so the N deposition increase does not trigger a loss of 1 species?**[3]	Yes - No likely significant effect
No – Impact on Epping Forest to be taken to Appropriate Assessment	

[3] Next stage detailed in Figure 2.98 in DMRB LA105 Air Quality (Highways England, 2019)

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Annex O2 30 April 2020 Feedback received from Natural England

NE Summary of LA 105 Comments

Please find below an outline of the key concerns and queries that have been raised both internally and externally with regard to the recently published LA 105 air quality guidance. NE would like to reiterate that at this time we are not able to endorse the current approach proposed but are keen to work toward an agreed position we can share with staff.

1) Applying NECR210 and "Table 21".
    a. NE area teams and external consultants have questioned the proposal to rely on a value which "brings about loss of 1 species" in identifying adverse effect on integrity I.e. defining deposition as insignificant if it causes the loss of less than one species.
    b. We consider that this approach could be open to challenge, particularly in light of the Dutch Nitrogen Judgement (Cooperatie Mobilisation/ Dutch Nitrogen Case Joined Cases C-293/17 and C-294/17) which points to the limitations in allowing further environmental loading when sites are in unfavourable status.
    c. The evidence brought together in NECR210 was intended for use on a specific, case-by-case basis. In our view, the value based on loss of one species was not intended as a universally applied assessment tool but instead as just one piece of evidence as part of an appropriate assessment.
    d. We have concerns that the increases in N deposition allowed by this approach does not consistently align with restore or maintain objectives. For example, for proposals effecting Upland Heath habitat with a target to restore condition and CLo of 10-20Kg N/ha/yr, loading up to 1.7kg N/ha/yr (17% of the lower CLo) would be permitted.
    e. NECR210 also considered additional parameters to total species richness, which may be more and less sensitive. The thresholds using in LA 105 may not be the most precautionary option. For example, the data indicates a loss in species richness may occur at levels lower than those leading to the "loss of 1 species" (see example (i) below. This reduction in species richness is an indicator of damage which is not considered in LA 105.
        i. For example, (Annex 5 of NECR210) an additional emission of 0.5 kg to Upland Heath (TU 2009) at a background of 20 kg N - a 0.7% predicted loss in species richness equates to 0.29 "of a species" (0.7/100 x 42 spp.). Therefore, 1.7 kg of N would lead to the loss of an entire species (1 species /0.29 = 3.4, 0.5 Kg x 3.4 = 1.7 kg). If you were to consider lichen species richness using the same method under the same conditions, 6.5 kg of N would be needed to lose 1 lichen species – this is well beyond damaging for other measures, suggesting that following this method could unintentionally generate extreme additional loading.
    f. The following habitats were not considered appropriate in using NECR210 but this is not mentioned in the guidance;
        i. Upland heath (MRS – one of the two datasets): the authors of the report recommended that this dataset should not be used in any calculations because the surveys it is based on were carried out differently to the TU2009 dataset.
        ii. Bog (TU2009): the observed relationship between species richness and nitrogen depositions is not curvi-linear. Bog specialists do not believe species richness is an appropriate metric to use in assessing change at bog sites because there are very few species present in this habitat type.
        iii. Sand dunes: the authors of the report recommended that the sand dunes (TU2009, all sites) dataset should be used in threshold calculations. The other sand dune datasets are subsets of this dataset.

2) HE Screening Criteria.
    a. Concerns have been raised regarding certain AADT screening triggers used by HE. NE has provided evidence to suggest these would be inadequate thresholds.
    b. This relates to the use of the following criteria;
        i. Heavy duty vehicle flows (HDV) will change by 200 AADT or more.
        ii. Daily average speed will change by 10 km/hr or more.
    c. Analysis by NE found that these scenarios resulted in a change of > 1% of critical/load level on certain road types; a) where there was a speed increase of 10km/h there was a change of > 1% critical loads/levels for all road types except minor roads and b) where

there was an HDV AADT increase of 200 there was change of > 1% critical loads/levels on all road types except motorways.

3) In-combination assessment.
    a. No reference is made to in-combination assessment of impacts in the LA 105 guidance. The importance of this critical element of assessment has been underlined by the Wealden Judgement.
    b. It is understood that in-combination assessment is an intrinsic element of the DMRB model, however more clarity is needed regarding what those assessments include and is considered “reasonably foreseeable”. These issues have arisen, not just in major schemes, but also with considerations of Local Plan housing allocations.

4) HRA process and terminology.
    a. No reference to HRA (or LA 115) is made in guidance LA 105 document which currently follow the EIA process/ terminology. Human health impacts and impacts upon designated sites are also frequently combined. This could cause confusion for users.
    b. We understand that the HE stance remains that Appropriate Assessment should be triggered **where there are** Likely Significant Effects or where there is sufficient uncertainty.” To align with HD requirements, this should be phrased as “…Appropriate Assessment should be triggered where Likely Significant Effects **cannot be ruled out**…”
    c. We appreciate the clarification given at the meeting on February 24th about the reasons for HE preferring different forms of wording relating to significant effects judgements, and your reassurance that the outcome for the environment would remain the same. We look forward to receiving your further clarification of the basis for HE concerns and the outcome of the approach. .

5) Ammonia Consideration.
    a. Ammonia emissions from road traffic could make a significant difference to nitrogen deposition close to roads. As traffic composition transitions toward more petrol and electric cars (i.e. fewer diesel cars on the road) – catalytic converters may aid in reducing NOx emissions but result in increased ammonia emissions – therefore consideration is needed (see [redacted])
    b. We will look into this issue as agreed at the meeting on 24 February, and may wish to discuss further.

Annex O3 12 May 2020 Feedback received from Natural England

Annex 2 Methodologies for root and shoot analyses and tree health surveys

A) Analysis of summer foliar N/P ratio in beech tree leaves

A sample of 100 mg of dried leaf is to be ground up, and then digested overnight with 1 Kjeldahl catalyst tablet (Se) and 3ml of concentrated H_2SO_4. The sample is then heated at 250°C for 30minutes, before increasing to 400°C for 2hours. After cooling, 10ml of distilled water is to be slowly added and the solution mixed thoroughly. The digestate is then to be filtered, then made up to 25ml with distilled water and stored at 5°C, pending analysis of total N and P by autoanalyser. A standard reference material (NCS DC 73349 'Bush branch and leaves') should also be tested to assess the accuracy of the analysis.

B) Analysis of summer soil Ca/Al ratio

Several augered samples are to be taken in summer from a depth of 10cm at 1.5m from the base of each of a number of beech trees, then aggregated for each location. One gram of powdered oven-dried soil is to be placed into a conical flask with 25 ml of 0.05 M ethylene diamine tetracetic acid solution. This solution is to be shaken for 4 hours at 150 rpm, and then centrifuged at 3000 rpm for 10 minutes. Decanted samples are to be stored at 5 °C pending analysis by GCMS or Inductively Coupled Plasma Atomic Emissions Spectrometer (ICP-AES).

C) Analysis of summer health of beech tree roots

Augered samples are to be taken in summer from a depth of 10cm at 1.5m from the base of beech trees, as described above. About 100cm^3 of each aggregated sample is to be hand-homogenised, sealed in plastic bags and stored at 3-4 °C. The weight of each sample is to be recorded and water added to aid removal of soil. The solution is then to be poured into a 0.5 mm sieve and soil washed away. The root and humus remainder are to be washed out from the sieve into a tray where the remaining soil is to be rubbed off the roots by hand and the stone and sand content sedimented out. The root-humus fraction is to be poured back into the sieve, re-washed and then roots to be chopped into 0.5 cm sections. These are to be stored in polythene bottles at 3-4 °C, and analysed within two days. Each prepared root sample is to be weighed and three 15% sub-samples placed in three separate square 100 cm^2 petri dishes over a 1 cm^2 grid. Water is to be added to the sub-samples to distribute the root tips evenly over the surface, and then the water removed to prevent root tips moving during microscopy. Forty randomly assigned 1 cm^2 grid squares to be analysed and the root tips to be classified as:

- live: if the tip is turgid and light in colour;
- dead: if the tip is shrivelled and dark in colour.

D) Analysis of mycorrhiza of beech tree roots

To be based on microscopic examination of root samples prepared as described above. The presence or absence of a live mycorrhizal sheath is to be noted; being assumed alive if turgid in appearance, rather than shrivelled and degraded. *Cenococcum geophilum* is the dominant beech mycorrhizal species and relatively easy to distinguish; therefore, mycorrhizae should be separated into *C. geophilum* and other species.

E) Analysis of summer foliar N/P ratio in *Calluna vulgaris* shoot tips

Calluna shoot tips are to be collected during the summer, then dried and ground up. A 200 mg sample is to be digested overnight in 3ml of concentrated H_2SO_4 with 1 Kjeldahl catalyst (Se) tablet. The sample is then heated at 250°C for 30minutes, before increasing to 400°C for a further 2.5hours. After cooling, 10ml of distilled water is to be slowly added and mixed thoroughly. The digestate is to be filtered, then made up to 25ml with distilled water and stored at 5°C, pending analysis of total N and P by autoanalyser. A standard reference material (NCS DC 73349 'Bush branch and leaves') should also be tested to assess the accuracy of the analysis.

F) Summer survey of crown thinness of beech trees

Summer survey of crown thinness of standard beech trees is to be carried out to standard Forestry Commission/Imperial College methodology:
The canopy is to be observed with binoculars in late July or early August. A healthy tree has a dense canopy; with very little light visible between the overlapping layers of leaves. A very unhealthy tree has a much less dense canopy, and with the leaves often smaller than a healthy tree; resulting in a much more open appearance. Crown thinness is judged with the use of a picture guide (Bosshard, 1986) (*[3]), and scored on a scale of 0 to 3:

0 = 0-10% leaf loss = healthy
1 = 11-25% leaf loss;
2 = 26-65% leaf loss;
3 = 66-99% leaf loss = very unhealthy.
(4 = trees which have died since the previous survey.)

G) Winter survey of crown architecture of beech trees

Winter survey of crown architecture of standard beech trees is to be carried out to standard Forestry Commission/Imperial College methodology:
The uppermost part of the crown is to be observed with binoculars in January or February. A healthy tree has extensive apical and lateral twig growth; resulting in feathery branches, which together form a rounded canopy. A very unhealthy tree has stunted and deformed twigs which often develop into a clawed form and which are more brittle and prone to breakage; resulting in a ragged, open, canopy. Canopy architecture and twig structure are scored on a scale of 0 to 3, according to the method devised by Roloff (1985) (*[4]):

0 = no damage, rounded crown, feathery twig structure = healthy;
1 = slight damage, ragged crown, spiky twigs with reduced lateral growth;
2 = medium damage, thinning of middle of crown and large gaps in crown, clawed twigs with reduced lateral and apical growth;
3 = severe damage, sparse crown with dieback of top growth = very unhealthy.
(4 = trees which have died since the previous survey.)
(As an added refinement, intermediate scores such as 1.5 may be assigned.)

H) Summer survey of crown chlorosis of beech trees

Summer survey of crown chlorosis of standard beech trees is to be carried out to standard Forestry Commission/ Imperial College methodology:
The canopy is to be observed with binoculars in late July or early August, normally concurrently with the crown thinness survey. A healthy tree has a dense canopy, with very little light visible between the overlapping layers of leaves. A very unhealthy tree has a much less dense canopy, and with the leaves often smaller than a healthy tree; resulting in a much more open appearance. Chlorosis, leaf roll and biotic damage are scored on a scale of 0 to 3:

0 = none = healthy;
1 = moderate occurrence in small patches or thinly distributed over whole tree;
2 = significant occurrence in patches or moderate occurrence over whole tree;
3 = considerable occurrence over whole tree = very unhealthy.
(4 = trees which have died since the previous survey.)

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*[3] Bosshard, W. (ed.) (1986). *Sanasilva*. Federal Institute for Forest Research, Birmensdorf.

*[4] Roloff, A. (1985). Schadstufen bei der Buche – Vorschlag für eine bundeseinheitliche Einordnung der Buche in 4 Schadstufen bei terrestrichen Aufnahmen. *Der forst. und holzwirt* 40, 5, 25-34. (The classifications of damage in the beech. A proposal for a standardised national classification of the beech into four categories of damage based on terrestrial photographs. Translated from the German by Central Electricity Generating Board Translating Section Overseas Service).

Table 2-2 Habitat Features – Air Quality Objectives

Extent - Dynamic balance	To maintain the designated habitats in favourable condition, which is defined in part in relation to the levels of atmospheric pollutants to which they are exposed (air quality attribute). Favourable condition is defined at this site in terms of the following site-specific standards:
	On this site favourable condition requires a regime whereby atmospheric pollutants and/or nitrogen and acid deposition do not exceed the internationally agreed standards for the protection of the interest features. Maintenance implies reduction of pollutant inputs if the standards are being exceeded and/or if evidence from condition assessment suggests that harm to the interest features is occurring.

Habitat Feature (BAP Broad Habitat level, or more detailed level if applicable)	Estimated extent (ha) and date of data source/estimate	Site Specific Target range and Measures	Comments	Use for CA?
Veteran trees + Lowland wood pastures and parkland + Broadleaved, mixed and yew woodland	Air pollution - evidence of eutrophication	Tree trunks and larger branches should not have >20% cover of green algal 'gunge' deposits.	Eutrophication can result in a build-up of algal deposits on the trunks and larger branches of trees. This excessive nutrient input leads to the demise of bryophytes and lichens with a lower tolerance of high nutrient-status conditions.	**YES**
Lowland wood pastures and parkland + Broadleaved, mixed and yew woodland	Air pollution - evidence of eutrophication	Summer foliar N/P ratio in beech tree leaves to be within range 10.0 - 25.0 [The methodology for this analysis is given in Annex 2 (A).]	**(To be used for monitoring whenever sufficient recent survey data is available.)** A Nitrogen/Phosphorus ratio outside the specified range is indicative of an unbalanced nutritional status. High nitrogen levels are likely to be the result of eutrophication due to nitrogen deposition.	**(YES)**

Habitat Feature (BAP Broad Habitat level, or more detailed level if applicable)	Estimated extent (ha) and date of data source/estimate	Site Specific Target range and Measures	Comments	Use for CA?
Lowland wood pastures and parkland + Broadleaved, mixed and yew woodland	Air pollution - evidence of acid deposition	Less than 20% of soil samples in the vicinity of beech trees to have Ca/Al ratio below 1.0, and none to have Ca/Al ratio below 0.2 [The methodology for this analysis is given in Annex 2 (B).]	**(To be used for monitoring whenever sufficient recent survey data is available.)** A low Calcium/Aluminium ratio is indicative of a high level of mobilisation of Aluminium ions, generally associated with a very low pH. Research has shown that Al ions are toxic to fine roots and can also interfere with the nutritional uptake of phosphorus and of base cations. Research also indicates that damage to trees may occur where soil Ca/Al ratios are below 1.0 and that damage is virtually certain to occur at ratios below 0.2	**(YES)**
Lowland wood pastures and parkland + Broadleaved, mixed and yew woodland	Air pollution - evidence of harm to tree roots	At least 75% of beech tree root tips to be live. [The methodology for this analysis is given in Annex 2 (C).]	**(To be used for monitoring whenever sufficient recent survey data is available.)** A low proportion of live root tips is indicative of a poor state of tree health, probably resulting from the toxic effects of a high level of mobilisation of Aluminium ions and/or a low level of mycorrhizal fungi.	**(YES)**
Lowland wood pastures and parkland + Broadleaved, mixed and yew woodland	Air pollution - evidence of harm to mycorrhizal fungi	At least 50% of live beech tree roots to have live mycorrhizal infection. *Cenococcum geophilum* not to exceed 70% of total mycorrhizal presence. [The methodology for this analysis is given in Annex 2 (D).]	**(To be used for monitoring whenever sufficient recent survey data is available.)** A low level of mycorrhizal infection of roots or an excessive dominance of a single mycorrhizal species is indicative of an unbalanced system, probably resulting from the effects of eutrophication and/or acidification.	**(YES)**

Habitat Feature (BAP Broad Habitat level, or more detailed level if applicable)	Estimated extent (ha) and date of data source/estimate	Site Specific Target range and Measures	Comments	Use for CA?
Dwarf shrub heath	Air pollution - evidence of eutrophication	Summer foliar N/P ratio in *Calluna vulgaris* shoot tips not to exceed 16.0 [The methodology for this analysis is given in Annex 2 (E).]	**(To be used for monitoring whenever sufficient recent survey data is available.)** A high Nitrogen/Phosphorus ratio is indicative of unbalanced nutritional status and is likely to be the result of eutrophication due to nitrogen deposition.	**(YES)**
Lowland wood pastures and parkland + Broadleaved, mixed and yew woodland	Health of beech trees - crown thinness	Less than 2% of standard trees assessed as being in Category 3, and less than 25% in Categories 2+3. [The methodology for this survey is given in Annex 2 (F).]	Thinning of the crown is a sign of stress. (A 1987-89 survey of 1728 trees at 72 sites across southern and central Britain yielded overall results of 1.6% in Category 3 and 23.0% in Categories 2+3. As of 1991, 47.8 % of sampled trees in Epping Forest were assessed as being in Category 3, with **all** trees being in Categories 2 + 3.)	(No)
Lowland wood pastures and parkland + Broadleaved, mixed and yew woodland	Health of beech trees - crown architecture	Less than 6% of standard trees assessed as being in Category 3, and less than 30% in Categories 2+3. [The methodology for this survey is given in Annex 2 (G).]	Reduced vigour in pattern of twig growth in the crown is a sign of stress. (A 1987-89 survey of 1728 trees at 72 sites across southern and central Britain yielded overall results of 4.4% in Category 3 and 27.8% in Categories 2+3. As of 1991, over 90% of sampled trees in Epping Forest were assessed as being in Categories 2+3.)	(No)
Lowland wood pastures and parkland + Broadleaved, mixed and yew woodland	Health of beech trees - crown chlorosis	Less than 1% of standard trees assessed as being in Category 3, and less than 5% in Categories 2+3. [The methodology for this survey is given in Annex 2 (H).]	Chlorosis of the crown (yellowing of leaves) is a sign of stress. (A 1987-89 survey of 1728 trees at 72 sites across southern and central Britain yielded overall results of 0.8% in Category 3 and 4.7% in Categories 2+3. As of 1991, no sampled trees in Epping Forest were assessed as being in Categories 2 or 3.)	(No)

Habitat Feature (BAP Broad Habitat level, or more detailed level if applicable)	Estimated extent (ha) and date of data source/estimate	Site Specific Target range and Measures	Comments	Use for CA?
Standing open water and canals (Ponds important for Amphibia assemblage or Odonata assemblage)	pH of water - evidence of acid deposition	pH of water bodies listed as being important for Amphibia assemblage (see Annex 5) or for Odonata assemblage (see Annex 8) to be 5.0 or higher. For quick checks, aquarist's pH paper may provide a cheap and easy method of measurement. Any borderline results should be verified using a properly calibrated pH meter.	**(To be used for monitoring whenever sufficient recent survey data is available.)** Some of the characteristic species comprising the Amphibia and Odonata assemblages do not normally occur in water bodies with pH values less than 5.0. (The water bodies within Epping Forest have naturally acidic waters due to the acid soils present over most of the Forest. However, the resultant limited buffering capacity may make them more vulnerable to pH changes caused by acid deposition from air pollution.)	**(YES)**

Audit Trail
Rationale for habitat extent attribute (Include methods of estimation (measures), and the approximate degree of change which these are capable of detecting).
Targets for foliar N/P ratio, soil Ca/Al ratio, proportion of live roots and health of mycorrhizal flora are to be applied only if and when recent data, produced to a comparable specification, becomes available. It is expected that health surveys of beech trees will be repeated periodically by Imperial College and/or City of London; however these targets have not been made mandatory as they may well also be affected by other factors such as climate change. [Exceedance of internationally agreed critical levels (for atmospheric pollutants) and/or of critical loads (for acid deposition and nitrogen deposition) is recorded separately via the 'at risk' function on ENSIS; based upon modelled data from the Air Pollution Information System (www.apis.ac.uk). The accuracy of this modelled data may from time to time be verified using measured data from the UK National Air Quality Archive (www.airquality.co.uk) and/or measured data for specific parts of the Forest whenever such data becomes available as a result of student projects or 'one-off' studies such as those associated with road schemes or other proposed developments. In order to avoid duplication of the 'at risk' function, no targets based upon critical levels or loads have been included in these objectives.]
Rationale for site-specific targets (including any variations from generic guidance)
(Standards apply to whole site, except where otherwise specified within the text.) Standards are based upon indicator and threshold values derived from scientific papers by recognised authorities in this field of work. Standards for pH of water bodies are based upon expert advice from Jim Foster (NE - amphibians), David Heaver (NE - invertebrates) and Katharine Parkes (British Dragonfly Society Conservation Officer). Standards for beech tree health have not been made mandatory due to the uncertainty surrounding the future of beech in SE England as a result of climate change.
Other Notes
Epping Forest is known to be subject to very high levels of air pollution both because of its location downwind from London, and because of the heavy volume of traffic using the numerous roads which pass through or close to the Forest. Air pollution, and the associated nitrogen deposition and acid deposition, is known to be a serious problem across almost all of the Epping Forest SSSI. Historically, air pollution, mostly by SO_2 and soot, is generally recognised to have been responsible for the loss of many of the more sensitive species of Bryophytes and lichens from the Forest. Although levels of these particular pollutants are now much lower, recovery of the Bryophyte and lichen flora has been much slower and less complete than hoped for, and is believed to currently be limited by the high levels of NO_x and the related nitrogen deposition and acid deposition. There are also particular concerns relating to tree health, especially of beech trees, which is considered to be amongst the worst in the UK.

Annex P1 06 May 2020 HRA Briefing Note Defining functionally linked land

Defining Functionally Linked Land

European sites that have been included within the HRA for the Lower Thames Crossing (the Project) include sites that have been designated primarily for their importance for birds. They are:

- Benfleet and Southend Marshes SPA and Ramsar
- Medway Estuary and Marshes SPA & Ramsar
- Thames Estuary and Marshes SPA and Ramsar
- The Swale SPA and Ramsar,

The reason they are being assessed is because the potential effects of the Project coincide with areas of habitat (out with the SPA/Ramsar) used by birds that are potentially designated features of the European sites (the potential extent of sensitivity for overwintering birds used for screening is up to 20km from a site).

We are considering functionally linked land in the following way. Figure 18 (attached) illustrates the habitats that are likely to support the birds from these SPA/Ramsars within the extent of sensitivity for overwintering species. The habitat data on the figure is sourced from the Priority Habitat Inventory (Natural England, 2019) and the Thames Estuary intertidal mudflats mapping (Thames Estuary Partnership, 2003) (Natural England, 2003), with the habitats that could be considered as supporting the birds (Taken from Natural England's Supplementary advice for the identified sites) displayed on the Figure.

The inset on Figure 18 illustrates the potential supporting habitat areas that could be affected by the Project through disturbance or habitat loss.

Figure 20 illustrates the areas surveyed for birds (all species regularly 2017-2019) and highlights were SPA/Ramsar qualifying species were recorded. The River Thames and the land immediately adjacent have the most use by these species. This, in combination with the information collated on functionally linked/supporting habitat in Figure 18 and the Project ZoI has defined the HRA area of interest (AoI), which is shown on the inset on Figure 20. The coincidence of habitat within the AoI is considered to be functionally linked land/supporting habitat and this area will be assessed in the HRA with regards to disturbance to birds and the effects of habitat loss.

References

Natural England. (2003, 12 31). *GB001072 Intertidal mudflats layer for England.* Retrieved April 15, 2020, from https://www.emodnet-seabedhabitats.eu/access-data/download-data/?gui=GB001072

Natural England. (2019, Jul 29). *Priority Habitat Inventory (England).* Retrieved from https://data.gov.uk/dataset/4b6ddab7-6c0f-4407-946e-d6499f19fcde/priority-habitat-inventory-england

Thames Estuary Partnership. (2003, 12 01). *GB000331 Thames estuary intertidal mudflats map.* Retrieved 04 15, 2020, from https://www.emodnet-seabedhabitats.eu/access-data/download-data/?gui=GB000331

Benfleet and Southend Marshes

Thames Estuary & Marshes

Medway Estuary & Marshes

The Swale

Thames

River Medway

0 5 10 Kilometers

0 5 10 15 Kilometers

Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01.1	S0	29/04/2020	Draft for Consultation	IP	RC	RC

LEGEND

- Ramsar
- Special Protection Areas
- Holehaven Creek SSSI
- Extent of sensitivity - overwintering populations (20km)
- Order Limits
- Area within 600m of Order limts/ construction haul routes

Potential areas of supporting habitat (functionally linked land)

- Coastal and floodplain grazing marsh
- Coastal saltmarsh
- Coastal vegetated shingle
- Good quality semi-improved grassland
- Intertidal mudflats
- Reedbeds
- Saline lagoons

Client: highways england

Project: LOWER THAMES CROSSING
5TH FLOOR BEAUFORT HOUSE
15 ST BOTOLPH STREET
LONDON EC3A 7DT

Status: Draft for Consultation

Original Size: A3

Revision:

Scale:

Drawing title: Identification of functionally linked land/ supporting habitats for the qualifying birds of the identified SPA and Ramsar sites

Drawing number: FIGURE 18

MXD Location: M:\Ber\Ecology\Jobs\LTC\LTC HRA\GIS\HRA_Fig18.mxd

Benfleet and Southend Marshes

Thames Estuary & Marshes

Thames Estuary & Marshes

Medway Estuary & Marshes

The Swale

0 1 2 Kilometers

0 5 10 Kilometers

Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

LEGEND

- Ramsar
- Special Protection Areas
- Holehaven Creek SSSI

Project Ornithology Survey Locations

- Vantage point survey location
- Nocturnal transect areas

All diurnal transect areas

SPA/Ramsar Species recorded

Season

- Breeding
- Passage
- Winter

Potential areas of supporting habitat (functionally linked land)

- Coastal and floodplain grazing marsh
- Coastal saltmarsh
- Coastal vegetated shingle
- Good quality semi-improved grassland
- Intertidal mudflats
- Reedbeds
- Saline lagoons
- Order Limits
- Area within 600m of Order limts/ construction haul routes
- HRA Area of Interest

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01.1	S0	15/04/2020	Draft for Consultation	IP	RC	RC

Client: highways england

Project: LOWER THAMES CROSSING
5TH FLOOR BEAUFORT HOUSE
15 ST BOTOLPH STREET
LONDON EC3A 7DT

Status: Draft for Consultation

Original Size: A3

Revision

Scale

Drawing title: Distribution of records of SPA/Ramsar species in relation to the wider ornithology survey area and the area of interest for the Stage 2 assessment

Drawing number: FIGURE 20

MXD Location M:\Ben\Ecology\Jobs\LTC\LTC HRA\GIS\HRA_Fig20.mxd

Annex P2 18 May 2020 Feedback received from Natural England

From: [redacted]
To: [redacted]
Cc: [redacted]
Subject: Re: LTC HRA Document Pack - Defining Functionally Linked Land
Date: Monday, May 18, 2020 3:16:17 PM
Attachments: image002.png
image001.png
LTC HRA - DefiningFunctionallyLinkedLandBrief_May2020.pdf
Importance: High

Dear [redacted]
Thank you for sharing the Defining Functionally Linked Land briefing paper which [redacted] and I have now had the opportunity to review and we have a few observations to make which we hope are helpful.

In terms of the proposed approach, using the Natural England priority habitat inventory dataset is a useful tool for identifying habitats of conservation value but it is unclear whether this has been supplemented with the habitat survey information gathered through the studies undertaken for the Project. It would seem appropriate for these to be compared to ensure that the habitats mapped are reflective of those on the ground. The 2015 Land Use Cover dataset from the Centre for Ecology and Hydrology also provides an additional useful source of information to assist with the consideration of functionally linked land. At the scale the maps are presented, the areas of grazing marsh and semi-improved grassland appear to be under represented. This may however be a reflection of the scale and it would be helpful if plans at a more appropriate scale could be provided (also see below for further comments in relation to the plans).

Whilst priority habitats are important for species associated with the designated sites, arable and horticultural land is also important for feeding and roosting for a variety of species. The Habitats Regulations Assessment (HRA) area of interest detailed on Map 20 does not seem to include areas of arable or horticultural land. We would therefore recommend that the approach to understand and agree the extent of functionally linked land considers whether the horticultural and arable land along the route is likely to be used by species associated with the designated sites.

The scale of the plans, the amount of information they are displaying and in some cases the shading/hatching make them difficult to interpret. As discussed during our meeting last week, it would be helpful if a series of plans with less information on each could be provided at a more appropriate scale. This will allow us to better understand (and be able to advise on) the appropriateness of the areas of land that are considered to be functionally linked to the designated sites.

The bird survey information is presented at a scale which is difficult to interpret with no information included on the species or year they were recorded, only the season they were recorded. It would be helpful if plans at an appropriate scale with the species distribution information could be provided along with more information on the number of individuals recorded. In addition, it would seem appropriate for the information to be supplemented with other survey information such as the Wetland Bird Survey and Local Environmental Record Centre data to help ensure that a robust assessment is provided. We note that the survey information covers 2017-19 so assume that no further surveys were undertaken in the winter of 2019/20, if further surveys were undertaken it would be sensible for these to be included.

Given the lack of species survey information provided, it is unclear whether the individual qualifying species and the waterbird assemblage are being considered in mapping the areas of functionally linked land. It would be helpful if clarity could be provided since both the qualifying species and the assemblage will need to be considered.

The Development Consent Order boundary does not appear to reflect the most recent boundary shared as part of the supplementary consultation (for example, the Tilbury Link Road is still shown) so it would be helpful with the revised plans suggested above if the current boundary could be used.
I hope these comments are helpful and we will of course be happy to provide further advice once the additional information/revised plans can be shared with us.

[redacted]

Direct dial [redacted]
Please note: I work compressed hours and am not generally in the office on a Friday. During the current coronavirus situation, Natural England staff are working remotely to provide our services and support our customers and stakeholders. All offices and our Mail Hub are closed, so please send any documents by email or contact us by phone or email to let us know how we can help you. See the latest news on the coronavirus at http://www.gov.uk/coronavirus and Natural England's regularly updated operational update at https://www.gov.uk/government/news/operational-update-covid-19.
Stay alert, control the virus, save lives
www.gov.uk/natural-england

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Annex Q1 04 June 2020 Technical Note North Portal drainage discharge options

Lower Thames Crossing

North Portal Discharge Assumptions

Document Number: HE540039-CJV-EGN-S07-TNT-ENV-00002

Aims of the paper

- To explain why the Lower Thames Crossing project would need to manage site run off from the North Portal compound to discharge into the Thames
- Introduce the reasonable worst-case viable option proposed by LTC to manage construction and operational site run off waters
- Provide high level design assumptions to facilitate EIA and HRA assessments, and marine licencing

Introduction

The Lower Thames Crossing project (the Project) proposes to link the M2 in Kent to the M25 in Essex via the construction of a tunnel between Gravesend and Tilbury.

A large compound (CA05) would be established to the north of the River Thames and would support the key activities associated with the tunnel and North Portal construction. The North Portal compound (CA05) is presented in Plate 1.

Compound CA05 will house critical facilities the Tunnel Boring Machine launch structures, concrete segment factory, slurry treatment plants, site welfare and offices and substantial earthwork and material management. Workforce requirements in this construction area are substantially higher than the South Portal compound (CA03).

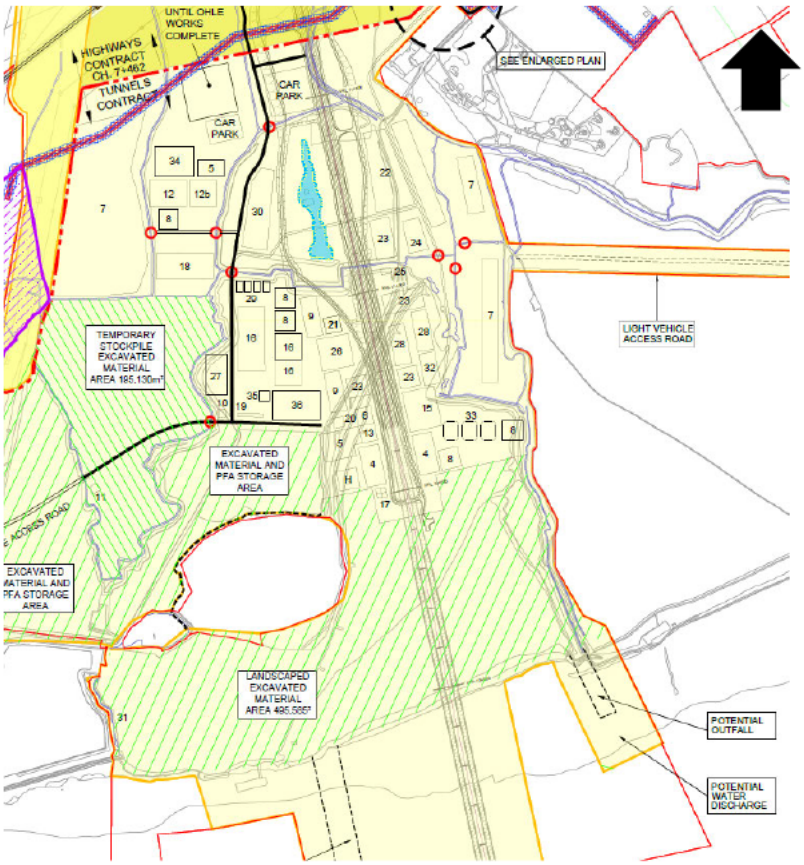

Plate 1 The proposed North Portal Compound

Operational phase water management

It is envisaged that operational drainage would be managed via discharges to the local Tilbury Main network, and as such the construction solution would be decommissioned.

Construction phase water management

Although the compound CA05 is situated approximately 400m inland from the north bank of the Thames estuary, a direct connection to the River Thames is possible. The site and activities would produce a considerable amount of water resulting from the high demand associated with the tunneling activities, active dewatering required at the North Portal excavation, increased demand for welfare associated with the larger workforce and the surface area of the compound.

The construction water management requirements relate to the following aspects of construction works:

- Foul, or sewage – Subject to agreement the sewage would, via a dedicated pumping station, be connected to existing infrastructure at the North of the site and flow to the Anglian Water treatment works to the East of Port of Tilbury 2. Discussions on this approach are ongoing with Anglian Water and as such foul water is not considered further in this note.
- Process wastewater and rainwater runoff – Produced by industrial processes such as washout, dewatering, cleaned waste slurry from the TBM tunneling, and the portion of rainwater runoff that cannot be harvested and reused for site processes such as greywater flushing, dilution of TBM slurry and dust suppression.

The temporary drainage requirements discussed in this paper relate to the management of process wastewater and rainwater runoff for the duration of the construction programme 2022 to 2028. There may be a requirement for the infrastructure to remain in place following the completion of main construction works to allow for the final landscaping and placement of excavated material stockpiles.

Process wastewater types

Process wastewater comprises the following:

- dewatering water
- TBM slurry
- concrete washout
- rainwater runoff

Table 1 provides the estimated upper discharge volumes of process wastewater (and has been used as one of the parameters to determine the maximum diameter required for the outfall pipe).

The rainfall values that have been used are based on conservative calculations from the LTC Utilities team of a 1 in 30-year rain event falling at peak rate for 24 hours over the entire site. It assumes no water flows away via the existing ditch network or is absorbed by the ground so is very conservative. It also ignores any effects of potential attenuation/storage which may be included in the system. Similarly, the volume of process wastewater is a reasonable worst-case.

Table 1 Estimated volumes of process wastewater

Type of discharge	Cu.m/day (l/s)*
Potential TBM slurry discharge	4140
Dewatering water	5529.6
Process/washout etc	25
Rainwater run-off*	52444.8 (607l/s)
TOTAL (worst case)	**62,139.40 (719l/s)**

*based on a 1 in 30-year rain event falling at peak rate for 24 hours over the entire site

Due to the potential volume of water and the capacity of the local Tilbury Main drainage network (also noting that the Tilbury Main is tide locked), it is not considered feasible to discharge site drainage into the local drainage network.

The viable alternative is to discharge the treated site wastewater into the tidal Thames Estuary. The peak volumes and predicted duration of the discharge (6 years) are such that the water could not be discharged directly onto the foreshore without risking erosion of the receiving area. To avoid this, the discharge point will be located subtidally and will include a suitably designed diffuser head to avoid scour and maximise mixing. The discharge volume presented in Table 1 would require a pipe of no more than 1000 mm diameter to ensure effective drainage of the site in a reasonable worst case.

To avoid the potential for the release of contaminants to the River Thames, the discharge would be treated in line with discharge consent conditions set by the Environment Agency. Various treatment trains may be required for the different water groups. For example, dewatering water is likely to be free of solids but may contain chemical pollutants requiring extraction; the waste TBM slurry would require filtration against fines and chemical pH adjustment via acid addition. Concrete washout may require filtration and pH adjustment before discharge. Sufficient land has been made available within the Order Limits to allow a variety of treatment options to be implemented.

Rainwater run-off volumes during a large storm will be substantial and will require careful management. Where possible, water falling onto roofs may be harvested and recirculated as grey water. The ground upon which the site is built will most likely be of limited permeability as it is predominantly clay arisings. This water may be directed, as currently, to the local ditch network (subject to Environment Agency discharge consent conditions).

The position and length of the drainage infrastructure has yet to be fixed within the reserved area of the Order Limits boundary and is expected to be discussed and agreed with the EA, PLA, MMO and NE.

Management of runoff during construction

As a worst case scenario it has been assumed that all rainfall runoff during a 1 in 30 year storm event would be captured and managed, it is likely that large amounts of the rainfall falling on the areas of the site which haven't been given over to hardstanding and/or buildings would percolate through the existing ditch network unchanged from the existing scenario. The harvesting of clean rainwater would be encouraged to supplement the tunnelling machine water requirement for the slurry circuit. Grey water (potentially also including dewatering output) use within the welfare and accommodation would also be encouraged to reduce the volumes being discharged via the Thames Estuary discharge.

The most significant water management required is rainfall run-off during storm events falling on any chalk stockpiles and areas where chalk is being deposited. This will need to be collected via specifically dug ditches and fed to a treatment plant where the very fine fraction

is removed by various stages of gravitational settlement using approved flocculants to accelerate sedimentation. The treatment plant may be designed in conjunction with the slurry treatment plant to balance the treatment capacity, for example the extra capacity within the slurry treatment plant could be used to supplement run-off treatment during extreme storm events. It is undesirable, however, for significant weather risk to be introduced into the production cycle except in extreme circumstances.

The Main Works contractor and/or sub-contractor will be required to excavate collector ditches at the toe of any material stockpile subject to run-off. These will be in such orientation to maximise gravity flow towards treatment plants thus minimising the need for pumping. The alignment and location of the collector ditch networks are likely to change throughout the construction phase as the material handling locations and volumes change.

Pipeline design for construction water discharge

A buried pipeline would be installed within a circa 300-400m long shallow sheet pile trench across the intertidal zone to the west of Rivershoal Groyne 4 as presented in Plate 2. Plate 3 shows a similar design pipeline being laid in a sheet piled trench prior to being sunk into place.

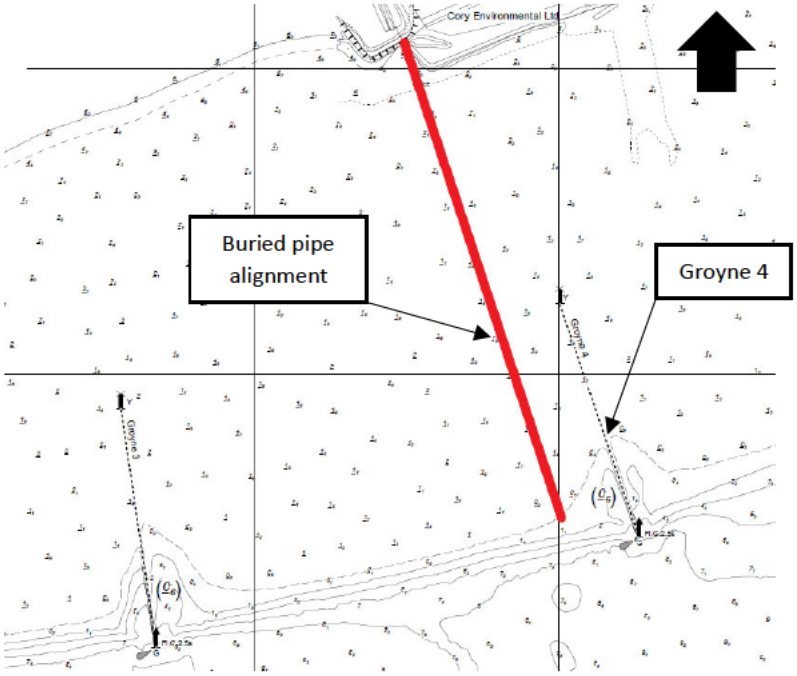

Plate 2: Position of proposed outfall pipe

Plate 3: Example of a pipeline within a sheet piled trench prior to being submerged and backfilled. Note the concrete anchor collars.

Outfall head / diffuser design

The buried pipeline would terminate in a precast outfall or diffuser head on the subtidal riverbed slope to the west of Rivershoal Groyne. An illustrative precast outfall arrangement within the subtidal zone is presented in Plate 4, whilst Plate 5 provides an indicative precast outfall design.

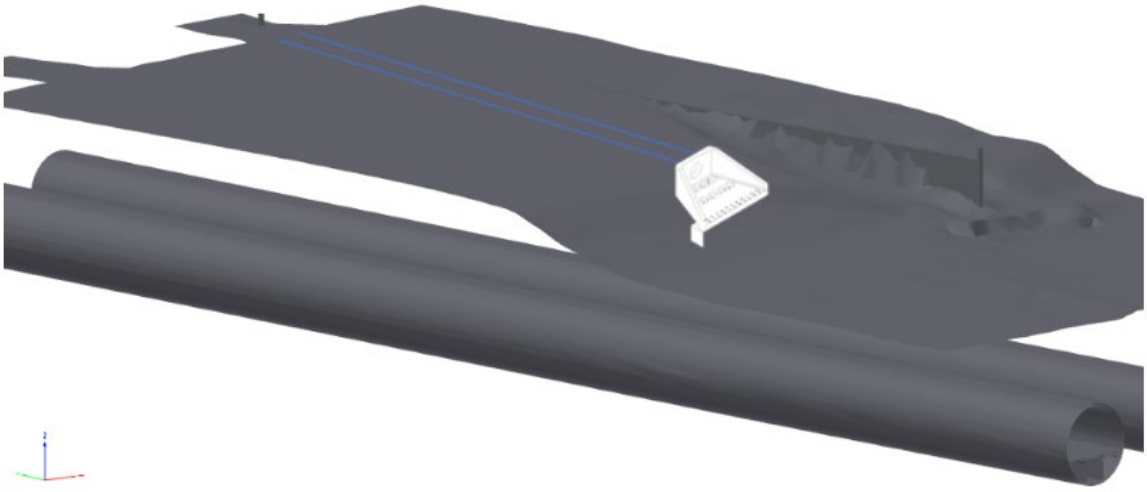

Plate 4: Position of outfall with Groyne 4, tunnels (for illustration purposes only) below and sloping subtidal bed (NTS).

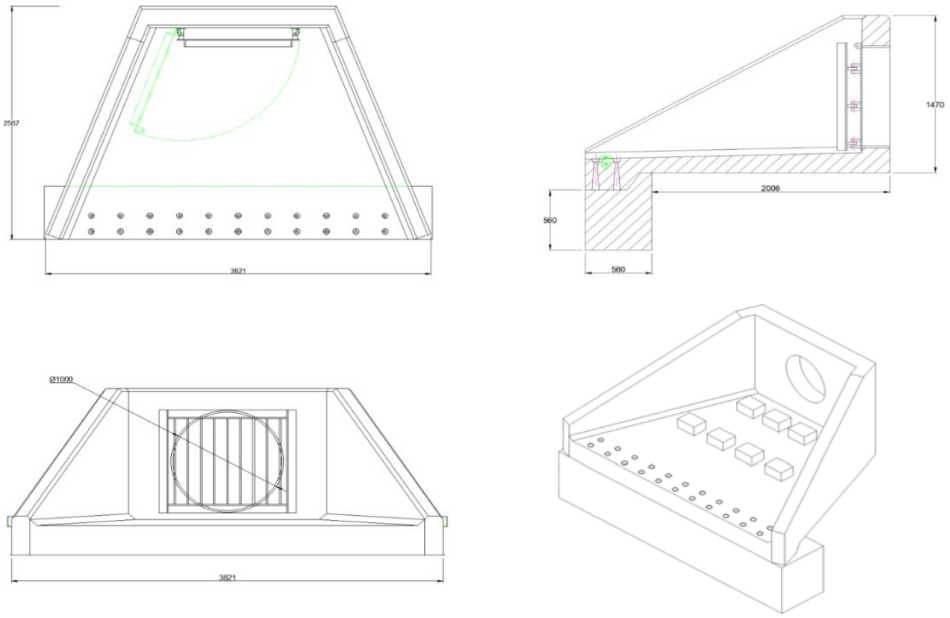

Plate 5: Indicative outfall head design

Construction Method

The following sections describe the envisaged construction method required for the installation of the pipeline and outfall. It is envisaged that in total construction would be up to 8 weeks in duration.

It is assumed that all works within the intertidal area would be restricted to periods of low water.

Pipeline

Piling works would be undertaken from a dumb barge with spud legs or anchors on winches, with a 30 to 50 tonne 360 excavator and a multi cat that has a 5 tonne lifting capacity to set anchors as required. The main piling barge would be serviced by a second dumb feeder barge carrying sheet piles, pipe sections and headwall /diffuser unit.

The pipeline trench is assumed to be circa 2m deep to accommodate the 1m diameter pipe. The short sheet piles would be vibro-piled into place (circa 6m “driven” in 4m below trench base) with small vibrating hammer (https://www.omsvibro.com/products/vibratory-hammers/excavator-mounted/). Piles would be driven to, or cut off at, riverbed, and left in situ until decommissioning. Sheet piling would be installed along either side of the trench 1.5-2m clear separation) for the full length of the pipeline route across the intertidal area. Work would be completed from shore to channel, over a 3-4 week period, assuming a 7 day working week.

Once the sheet piles have been installed, material would be excavated over an approx. 40m length and the pipe placed in the trench (total lineal meterage would be dependent on pipe lengths and complexity of connections). Concrete anchor collars are likely to be installed along the length of the pipeline. Excavated arisings would be side cast and then backfilled once the pipe has been installed. This would be a cyclic process as the pipeline progresses-ie excavate, pipe installation and backfill. The process assumes that excess material would be redistributed during subsequent tidal cycles. The pipe laying process would be completed over a 2 week period, assuming a 7 day working week.

The width of the trench would be approx. 2m, and the maximum working width to accommodate side casting would be approx. 10m.

Outfall / diffuser

The installation of the outfall/diffuser head may require the construction of a minor cofferdam. The headwall/diffuser head may be placed on top of mono-piles for support or be connected to longer piles used for the cofferdam driven closely around the plan-perimeter (footprint) of the headwall unit. Installation works would be completed over a 2 week period, assuming a 7 day working week.

Decommissioning

As a worse case, it is assumed that the pipeline and outfall structure would be decommissioned and removed once the asset is no longer required. The decommissioning process is the reverse of the construction process described above and is therefore assumed to be completed over 8 weeks, working 7 days a week. The working constraints described for the construction activities would also apply to decommissioning activities within the intertidal area.

Key commitments/constraints to works

- Discharge waters would be treated to the level stipulated in the discharge consent issued by the Environment Agency.
- All works would be completed at periods of low water.
- All piling works would be completed during periods of low water to avoid transmission of underwater noise.
- All piling works would utilise soft start piling and other best practice techniques as per the JNCC guidance to help avoid noise and vibration impacts.

Annex Q2 25 June 2020 Feedback received from Natural England

Date: 26 June 2020
Our ref: 320576
Your ref: -

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BY EMAIL ONLY

Dear [redacted]

Jetty Design & Construction Assumptions Paper

Thank you for seeking Natural England's views on the Lower Thames Crossing Jetty Design & Construction Assumptions high level briefing paper. This advice is being provided as part of Natural England's Discretionary Advice Service and the advice is based upon the information within the Document Number: HE540039-CJV-EGN-S07-TNT-ENV-00001.

I note that LTC intends to retain the option to use the jetty at the discretion of the contractor, and so the submission DCO must allow for this possibility and undertake appropriate impact assessment and identify and secure any appropriate mitigation measures as if this option were to be taken forward. The existing jetty at Goshem's Farm currently benefits from a series of its own permissions, including the planning application referenced in the paper (17/00224/FUL) but also the associated marine licence (MLA/2017/00055). It would be useful to capture and summarise these regulatory permissions and controls within the paper for easy reference, as equivalent controls and provisions are likely to be required for LTC's consent.

The paper makes a number of working assumptions including in particular that no additional 'substantial construction works' will be needed. Should this assumption prove not to be the case, Natural England reserves the right to provide additional advice and in my view should additional works be required beyond those accounted for within the DCO then additional permissions should be required with appropriate impact assessment and mitigation.

Nevertheless 'improvements' to the jetty are set out and described, with a duration of 3 months, targeting the 'summer of the first year of construction.' Whilst it might be expected that these improvement works to extend the life span of the jetty will be less disruptive to the local environment than either a replacement or physically extended structure, nevertheless in my view it would be helpful to undertake relevant impact assessment for the construction phase to understand likely significant effects including (but not exclusively) those related to noise; lighting; and pollution. The paper does not outline whether any of the activities described will introduce significant effects within these areas of concern. Generally I welcome the intention to preferentially undertake these construction activities during the summer months, but it should be noted that the adjacent SPA is notified for passage birds (in particular ringed plover) in addition to over-wintering birds, and so seasonal avoidance should include the month of September in addition to October – March inclusive. If avoidance measures cannot be achieved then further assessment and mitigation measures may be required. The conservation objectives and supplementary advice package will be helpful points of reference in this respect.

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context and detail regarding the range of impact pathways that might be expected and should be considered. The letter also contains the baseline working position that the area of foreshore extending from Coalhouse Fort westwards to Tilbury Fort provides functionally linked habitat to the Thames Estuary and Marshes Special Protection Area (SPA), and that Natural England's advice to relevant planning and marine licence consultations has sought to consistently highlight this feature of the area and secure appropriate impact assessment and mitigation measures. The planning application and marine licence background at the Goshem's Farm jetty should therefore be reviewed in this context.

For the jetty operation, the assumptions set out are stated to be under a worst case scenario of two barge unloading cycles per day (one movement per tide cycle), and therefore any activities above this level (associated with any future proposal to extend the jetty) will require further comment from Natural England and impact assessment as appropriate. This should include associated activities linked to the jetty, such as HGV vehicle movements and associated effects (noise, air quality including dust, and pollution pathways).

I suggest that the scope of use of the jetty and the assumptions made in the paper (or any future revision agreed with relevant stakeholders) are suitably described within the DCO, such that future impact assessment as described above (for construction, operation, or decommissioning phases) trigger the relevant consenting regime with appropriate consultation.

Operational phase impacts and assessments should cover similar impact pathways as described above including lighting; noise; and pollution. It will be important for LTC to review the various monitoring requirements of the existing jetty permissions, in order to provide an assessment of likely significant effects against the permitted baseline usage. In particular a review of the bird and sedimentation monitoring reports will be important. It is my opinion that (on a precautionary basis) the ongoing usage of the jetty is likely to prolong a level of disturbance of this stretch of foreshore and therefore limit its ability to provide the functional linkage it offers to the nearby SPA. This prolonged disturbance effect should be examined through the Habitats Regulations Assessment process, and I anticipate appropriate coverage of this specific impact pathway in this general location, and will provide separate comments on the HRA screening report (version 2) shared with us in due course.

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I hope that the above comments are helpful to you at this stage, but if you have any queries relating to the advice in this letter please contact me on [redacted] or [redacted]

Yours sincerely

[redacted]
[redacted]

Annex R 18 May 2020 Epping Forest detailed botanical survey briefing note – Revision 1

Update on response to advice on the 'Epping Forest Site Detailed Botanical Survey and Assessment of Nitrogen Deposition Sensitivity Methodology'

Below is an outline of how LTC have responded to Natural England's advice on the draft methodology. As the survey needed to be carried out very shortly after the advice was received, we have been able to incorporate some of the suggestions into the survey, but not all due to constraints of survey seasonality and the DCO application process. We have indicated below our response for each issue.

Backdrop of organisational differences of position as to which guidance to use for the purposes of the air quality assessment & HRA requirements - including "NE Summary of LA 105 Comments"

These issues are being addressed through national discussions between NE/HE.

The importance of a ground-truthed air quality assessment

Ground-truthing through transects of diffusion tubes has been carried out for a number of sites that were identified early on in the development of the Project that would be likely to be affected by air quality effects. Unfortunately, Epping Forest was not identified in time to set up such monitoring.

In the absence of ground-truthing data, the botanical survey is designed to collect baseline data on transects up to 500m from the affected road (i.e. twice the distance of elevated NO_2 noted in the forest). This will provide an understanding of the sensitivity of the receiving habitat within areas likely and not likely to be affected. The assessment relies on both the predicted environmental change and the sensitivity of the receptor to such change and so a good understanding of the sensitivity should provide some alleviation of any limitations from the lack of ground-truthing air quality data.

If required to validate conclusions in the HRA Screening report (that will be based on the data collected so far), air quality ground-truthing could be undertaken at a later date and submitted as supplementary information during Examination.

Whether the effect of the LTC contribution is prolonging the existing effect and preventing recovery to suitable critical level and load thresholds that enable favourable status to be achieved.

The assessment will be considering the existing N sensitivity and the likely exacerbation of existing effects or delay of future recovery. The HRA Screening in-combination assessment will take into account other projects that would contribute to nitrogen deposition in ways other than traffic (e.g. industrial process or intensive agricultural units). The draft In-combination methodology is also being shared with NE.

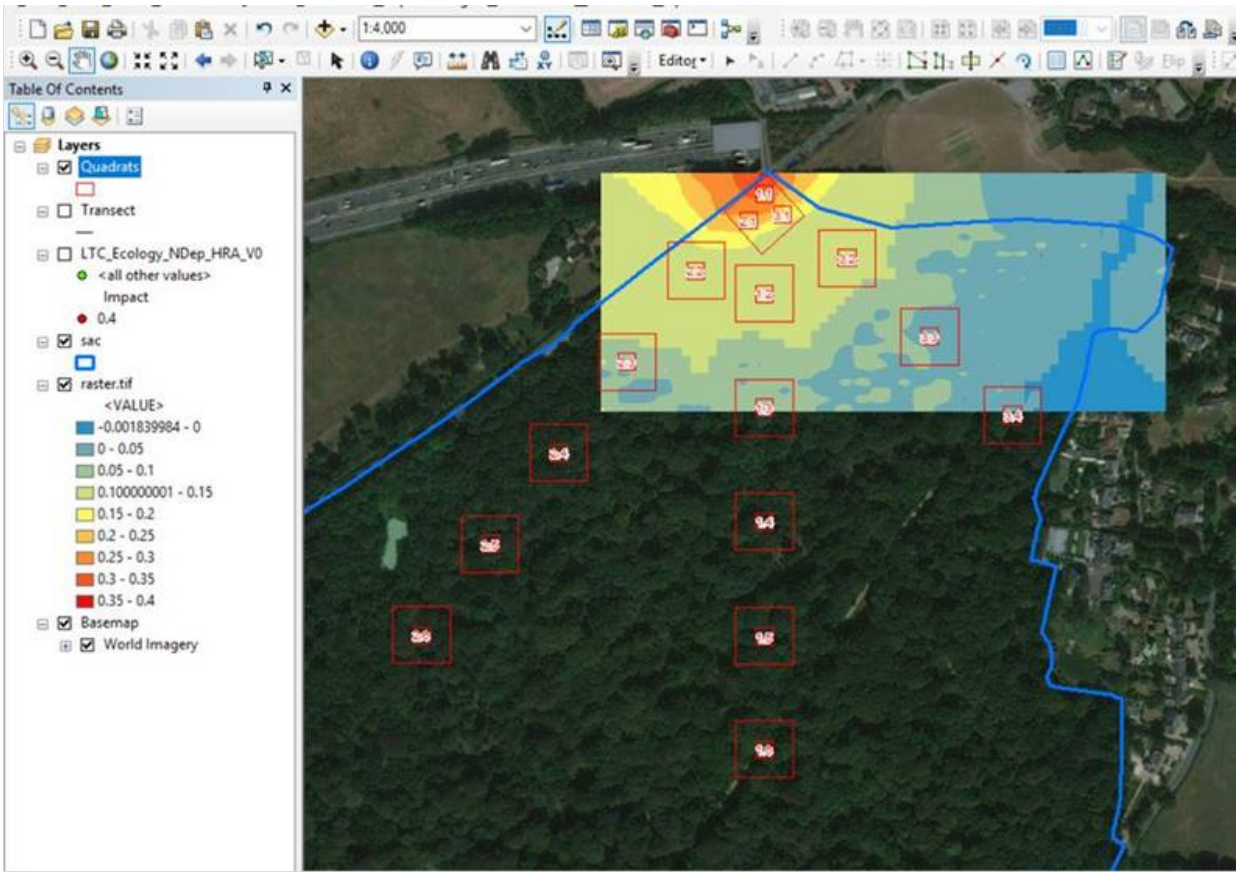
Adjustment of the field surveys of habitat within the SAC

Revised 'Likely Affected Area'

The area affected is defined in the Screening assessment and is based on predicted change in N deposition from the Project. The SAC habitat threshold relates to all woodland in the SAC. Only woodland is present within the affected area. The survey method is designed to include data collection within the area predicted to have change to the degree requiring detailed assessment in the assessment methodology. The use of transects allows comparison of that area with areas further afield from the road where change in N is predicted to be lower than the assessment thresholds.

Use of 3 transects, possibly over a greater distance and increase the number of quadrats

The survey methodology has been updated to include 3 transects starting at the point of exceedance (1x 500m northwest, 1x 500m south and 1x 300m southeast to the boundary of SAC). A 50m x 50m quadrat will be spaced at 100m intervals along each transect. Each quadrat will have a nested 15m x 15m plot, except for the first quadrat (at point of exceedance) where three 15m x 15m plots will be assessed within the quadrat (to provide a better understanding on the likely affected area). This configuration has 16 plots within 14 quadrats. Plants within the canopy layers will be recorded within the 50m x 50m quadrats with vascular plants recorded in the 15m x 15m plots.



Sensitive habitat features to be assessed

Veteran Trees

The survey methodology has been updated to include an assessment of tree health and quality of woodland within each quadrat using suitable indicators at the time of survey i.e. canopy condition, epicormic growth and bark algae/ moss growth.

Tree Species Assemblage

The survey methodology has been updated to include an assessment of tree health and quality of woodland within each quadrat including tree species assemblage. Abundance will be broken down into age classes using

number of individuals, percentage cover and DAFOR. Analysis of data will include % cover nitrophile vs non-nitrophile, age structure, etc.

Ground Flora

Species abundance will be recorded by vegetation layer / microhabitat as well as with a percentage for field and ground layers. Abundance will be scored by number of individuals, percentage cover and DAFOR. Analysis of data will include % cover nitrophile vs non-nitrophile, etc.

Bryophytes

Bryophytes will be recorded in both the quadrats and plots as for the vascular plants they will be broken down by microhabitat and abundance scored using DAFOR, with percentage cover for terrestrial species. Analysis of data will include % cover nitrophile vs non-nitrophile, etc.

Lichens

Lichens and fungi will not be assessed as part of this survey due to seasonality constraints. If required to validate conclusions in the HRA Screening report (that will be based on the data collected so far), such surveys could be undertaken in the autumn of 2020 and submitted as supplementary information during Examination.

Soil quality

Soil sampling and testing (for chemical and mycorrhizal infection) will not be assessed as part of this survey due to timing constraints. If required to validate conclusions in the HRA Screening report (that will be based on the data collected so far), such surveys could be undertaken in the autumn of 2020 and submitted as supplementary information during Examination.

Snapshot of 'sensitive' features that are likely to change

This is considered to be the purpose of the survey: to identify the degree to which nitrogen sensitive species are present. The detailed assessment in the Screening report will then consider the likelihood of sensitivity to the predicted change in N deposition.

Assessment focus more than loss of one species

The 'detailed assessment' step of the Screening assessment in LA105 will consider the consequences of the predicted change in AQ on achieving the conservation objectives for the qualifying features present. This assessment will use the results of the survey to understand existing (baseline) sensitivity of the habitat feature. The use of the 'predicted loss of one species' step is only used in identifying whether a 'detailed assessment' is required and will not be a consideration of that assessment.

Further background information

Background information used to support the assessment will be reported in the second draft of the Screening report. Where it has not been possible to incorporate all suggested sources of information due to time constraints in the DCO application programme, it is possible these can be incorporated at a later date and submitted during Examination, where required to validate conclusions in the HRA Screening.

Annex S1 04 June 2020 Jetty Refurbishment Use and Decommissioning Paper

Lower Thames Crossing

Jetty Design and Construction Assumptions Paper

Document Number: HE540039-CJV-EGN-S07-TNT-ENV-00001

Aims of the paper

- Provide the assumptions for consideration within the core DCO assessments related to the jetty activities

Introduction

The construction area CA05, as presented on Plate 1, is located to the North of the River Thames. CA05 would facilitate the works associated with the excavation of the North Portal, launching of the Tunnel Boring Machine and servicing the tunnelling works. Within CA05, alongside the River Thames, there is an existing jetty structure. The jetty is currently used as part of the material import operation, for Ingrebourne Valley Limited (IVL). LTC propose to extend the operational life of this jetty to facilitate the importation of materials throughout the construction programme.

The purpose of this paper is to outline the assumptions regarding the possible re-design, refurbishment, maintenance and decommission works. These are to be considered as part of the key DCO assessments, should the Contractor wish to utilise the facilities, as part of the Project's construction strategy.

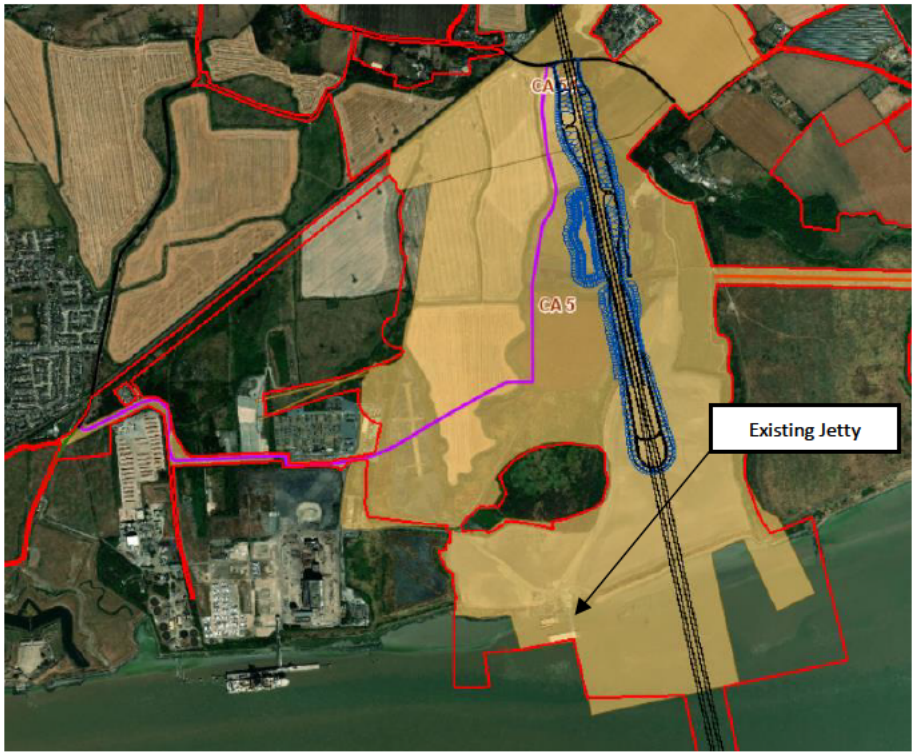


Plate 1 Construction Area CA05 and existing jetty infrastructure

This paper defines the assumptions to be used during the following life stages of the jetty:

- Jetty refurbishment/maintenance – the works associated with any refurbishment/maintenance required for the jetty to ensure appropriate design to support the LTC construction strategy.
- Jetty operation – the activities associated with the use of the jetty to support the LTC construction programme and works
- Jetty decommission – the works associated with the demolition of the jetty following the completion of the LTC construction programme and works

Design of existing jetty infrastructure

Retaining/extending the planning permission relating to the IVL jetty would provide LTC with a solution for material movement via the River Thames. The current designed structure, operated by Laing O'Rouke, is for importation of excavated material.

The existing jetty has a design life of 5 years and is licensed to operate until 2022. Information on the design of the existing jetty infrastructure can be found in planning application: 17/00224/FUL. It is assumed LTC would operate using the existing structure and would not require any substantial construction works to extend its use.

Jetty refurbishment/maintenance

Given the Project assumes the use of the existing infrastructure, there would be limited "construction works" completed to the jetty by LTC, however, there may be a requirement to complete minor refurbishment/maintenance works to ensure the jetty is fit for purpose and achieves an extended design life for the LTC works.

Activities

In order to continue to use the jetty beyond 2022, improvements would need to be made to the corrosion protection. These works are likely to take a maximum of 3 months (restricted to low tide) and would include:

- Replace / upgrade capping plates to pile
- Denso wrap the piles
- Improve cathodic protection
- Re-paint platforms

Activities associated with the refurbishment/maintenance would take place during daylight hours and would commence in the summer of the 1st year of construction.

Plant and equipment

Light plant and equipment would be used during the refurbishment/maintenance works including:

- Portable generator
- Portable welding set
- Paint
- Denso wrapping tape
- Scaffold platform hung from top of jetty to reach below water areas (low tide)

Jetty operation

It is assumed that the operation of the jetty would be used for the import of concrete segments to supply the tunnelling only. The barge movements would be constrained

by the tide and would coincide with high tide. It is assumed that barge movements would be limited to two a day (one movement per tide cycle).

In the event that the Contractor imports all circa 36,000 segments required during the 18 month tunnelling programme via the jetty (and thus providing a worst case scenario for barge movements) and assuming a maximum of 40 segments per load, it is envisaged that a total of 1,800 barge movements would be required.

Movement of segments are likely to be facilitated via lorry, transporting segments to a storage facility within the North Portal compound. It is envisaged that delivery of segments would generate up to 80-90 two-way HGV trips per day.

Plant and equipment

Activities during the operation of the jetty are related to the offloading and transport of incoming materials. The operational activities would likely to require the usage of heavy plant and machinery to offload barges. Movements would be limited to transport of material from the jetty to the construction area CA05. The activities would be required to align with the tide cycles and therefore may require 24-hour operation. Plant and machinery would include:

- Crane unit / grab
- Trucks, tractor units and flatbed trailers
- Task lighting
- Mobile generators for power for task lighting for work to suit tide cycle

Jetty decommission

The extension of the of the jetty design life beyond its current five years means the assessments of ecological effects is required to consider the land take of the infrastructure as permanent. For the purposes of the LTC assessments, and in order to establish the worst-case scenario, it is assumed that the jetty would be decommissioned on completion of the LTC construction programme. The area would be returned to intertidal habitat. Decommissioning activities would involve:

- Dismantling of pontoon
- Lifting and removal of steelwork
- Removal of accessible piles
- Burn off section of piles below mud level and leave remaining in situ

It is assumed that the duration of decommissioning activities would be approximately 3 months with 24hour working. Works would be completed during periods of low water and using a supporting barge as working platform.

Plant and equipment

Plant and equipment associated with the decommissioning activities would include:

- Crane/supporting barge
- Heavy lifting equipment
- HGVs for material removal
- Mobile generators for power
- Task Lighting (for tidal work)

Annex S2 26 June 2020 Feedback received from Natural England

Date: 26 June 2020
Our ref: 320576
Your ref: -

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BY EMAIL ONLY

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Yours sincerely

[redacted]
[redacted]

Annex T1 04 June 2020 Technical Note North Portal Discharge Construction

Lower Thames Crossing

North Portal Discharge Assumptions

Document Number: HE540039-CJV-EGN-S07-TNT-ENV-00002

Aims of the paper

- To explain why the Lower Thames Crossing project would need to manage site run off from the North Portal compound to discharge into the Thames
- Introduce the reasonable worst-case viable option proposed by LTC to manage construction and operational site run off waters
- Provide high level design assumptions to facilitate EIA and HRA assessments, and marine licencing

Introduction

The Lower Thames Crossing project (the Project) proposes to link the M2 in Kent to the M25 in Essex via the construction of a tunnel between Gravesend and Tilbury.

A large compound (CA05) would be established to the north of the River Thames and would support the key activities associated with the tunnel and North Portal construction. The North Portal compound (CA05) is presented in Plate 1.

Compound CA05 will house critical facilities the Tunnel Boring Machine launch structures, concrete segment factory, slurry treatment plants, site welfare and offices and substantial earthwork and material management. Workforce requirements in this construction area are substantially higher than the South Portal compound (CA03).

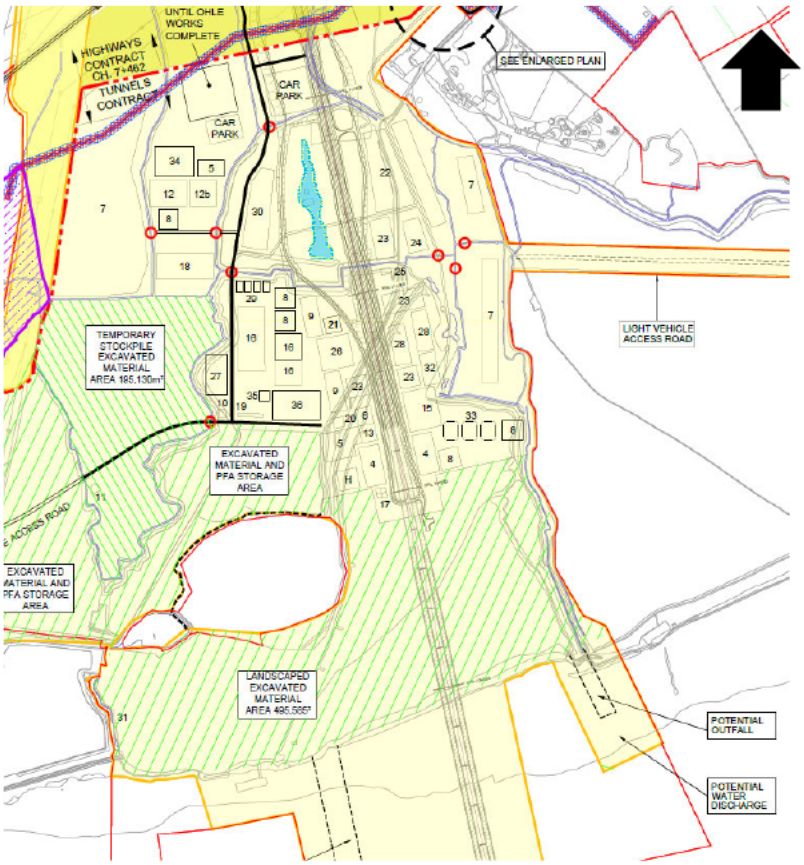

Plate 1 The proposed North Portal Compound

Operational phase water management

It is envisaged that operational drainage would be managed via discharges to the local Tilbury Main network, and as such the construction solution would be decommissioned.

Construction phase water management

Although the compound CA05 is situated approximately 400m inland from the north bank of the Thames estuary, a direct connection to the River Thames is possible. The site and activities would produce a considerable amount of water resulting from the high demand associated with the tunneling activities, active dewatering required at the North Portal excavation, increased demand for welfare associated with the larger workforce and the surface area of the compound.

The construction water management requirements relate to the following aspects of construction works:

- Foul, or sewage – Subject to agreement the sewage would, via a dedicated pumping station, be connected to existing infrastructure at the North of the site and flow to the Anglian Water treatment works to the East of Port of Tilbury 2. Discussions on this approach are ongoing with Anglian Water and as such foul water is not considered further in this note.
- Process wastewater and rainwater runoff – Produced by industrial processes such as washout, dewatering, cleaned waste slurry from the TBM tunneling, and the portion of rainwater runoff that cannot be harvested and reused for site processes such as greywater flushing, dilution of TBM slurry and dust suppression.

The temporary drainage requirements discussed in this paper relate to the management of process wastewater and rainwater runoff for the duration of the construction programme 2022 to 2028. There may be a requirement for the infrastructure to remain in place following the completion of main construction works to allow for the final landscaping and placement of excavated material stockpiles.

Process wastewater types

Process wastewater comprises the following:

- dewatering water
- TBM slurry
- concrete washout
- rainwater runoff

Table 1 provides the estimated upper discharge volumes of process wastewater (and has been used as one of the parameters to determine the maximum diameter required for the outfall pipe).

The rainfall values that have been used are based on conservative calculations from the LTC Utilities team of a 1 in 30-year rain event falling at peak rate for 24 hours over the entire site. It assumes no water flows away via the existing ditch network or is absorbed by the ground so is very conservative. It also ignores any effects of potential attenuation/storage which may be included in the system. Similarly, the volume of process wastewater is a reasonable worst-case.

Table 1 Estimated volumes of process wastewater

Type of discharge	Cu.m/day (l/s)*
Potential TBM slurry discharge	4140
Dewatering water	5529.6
Process/washout etc	25
Rainwater run-off*	52444.8 (607l/s)
TOTAL (worst case)	**62,139.40 (719l/s)**

*based on a 1 in 30-year rain event falling at peak rate for 24 hours over the entire site

Due to the potential volume of water and the capacity of the local Tilbury Main drainage network (also noting that the Tilbury Main is tide locked), it is not considered feasible to discharge site drainage into the local drainage network.

The viable alternative is to discharge the treated site wastewater into the tidal Thames Estuary. The peak volumes and predicted duration of the discharge (6 years) are such that the water could not be discharged directly onto the foreshore without risking erosion of the receiving area. To avoid this, the discharge point will be located subtidally and will include a suitably designed diffuser head to avoid scour and maximise mixing. The discharge volume presented in Table 1 would require a pipe of no more than 1000 mm diameter to ensure effective drainage of the site in a reasonable worst case.

To avoid the potential for the release of contaminants to the River Thames, the discharge would be treated in line with discharge consent conditions set by the Environment Agency. Various treatment trains may be required for the different water groups. For example, dewatering water is likely to be free of solids but may contain chemical pollutants requiring extraction; the waste TBM slurry would require filtration against fines and chemical pH adjustment via acid addition. Concrete washout may require filtration and pH adjustment before discharge. Sufficient land has been made available within the Order Limits to allow a variety of treatment options to be implemented.

Rainwater run-off volumes during a large storm will be substantial and will require careful management. Where possible, water falling onto roofs may be harvested and recirculated as grey water. The ground upon which the site is built will most likely be of limited permeability as it is predominantly clay arisings. This water may be directed, as currently, to the local ditch network (subject to Environment Agency discharge consent conditions).

The position and length of the drainage infrastructure has yet to be fixed within the reserved area of the Order Limits boundary and is expected to be discussed and agreed with the EA, PLA, MMO and NE.

Management of runoff during construction

As a worst case scenario it has been assumed that all rainfall runoff during a 1 in 30 year storm event would be captured and managed, it is likely that large amounts of the rainfall falling on the areas of the site which haven't been given over to hardstanding and/or buildings would percolate through the existing ditch network unchanged from the existing scenario. The harvesting of clean rainwater would be encouraged to supplement the tunnelling machine water requirement for the slurry circuit. Grey water (potentially also including dewatering output) use within the welfare and accommodation would also be encouraged to reduce the volumes being discharged via the Thames Estuary discharge.

The most significant water management required is rainfall run-off during storm events falling on any chalk stockpiles and areas where chalk is being deposited. This will need to be collected via specifically dug ditches and fed to a treatment plant where the very fine fraction

is removed by various stages of gravitational settlement using approved flocculants to accelerate sedimentation. The treatment plant may be designed in conjunction with the slurry treatment plant to balance the treatment capacity, for example the extra capacity within the slurry treatment plant could be used to supplement run-off treatment during extreme storm events. It is undesirable, however, for significant weather risk to be introduced into the production cycle except in extreme circumstances.

The Main Works contractor and/or sub-contractor will be required to excavate collector ditches at the toe of any material stockpile subject to run-off. These will be in such orientation to maximise gravity flow towards treatment plants thus minimising the need for pumping. The alignment and location of the collector ditch networks are likely to change throughout the construction phase as the material handling locations and volumes change.

Pipeline design for construction water discharge

A buried pipeline would be installed within a circa 300-400m long shallow sheet pile trench across the intertidal zone to the west of Rivershoal Groyne 4 as presented in Plate 2. Plate 3 shows a similar design pipeline being laid in a sheet piled trench prior to being sunk into place.

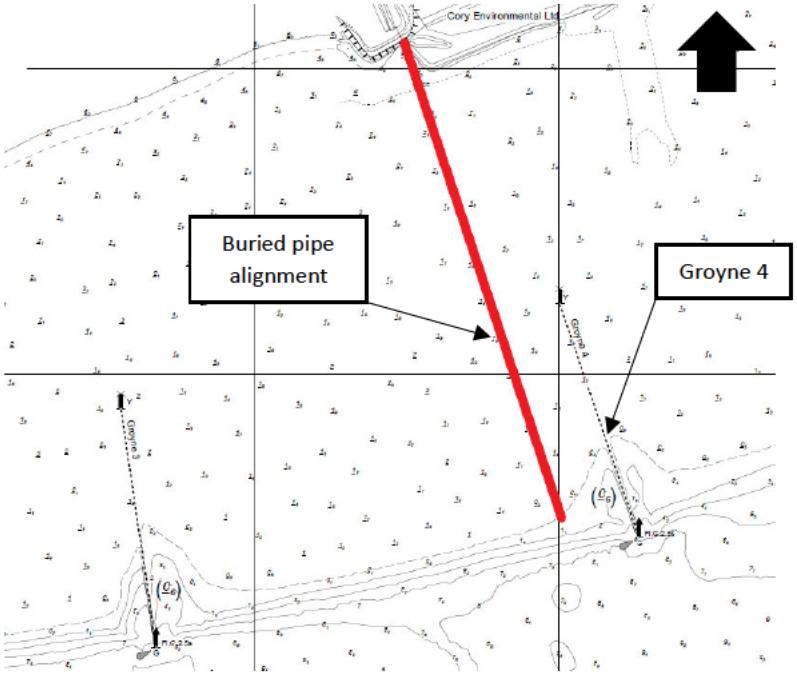

Plate 2: Position of proposed outfall pipe

Plate 3: Example of a pipeline within a sheet piled trench prior to being submerged and backfilled. Note the concrete anchor collars.

Outfall head / diffuser design

The buried pipeline would terminate in a precast outfall or diffuser head on the subtidal riverbed slope to the west of Rivershoal Groyne. An illustrative precast outfall arrangement within the subtidal zone is presented in Plate 4, whilst Plate 5 provides an indicative precast outfall design.

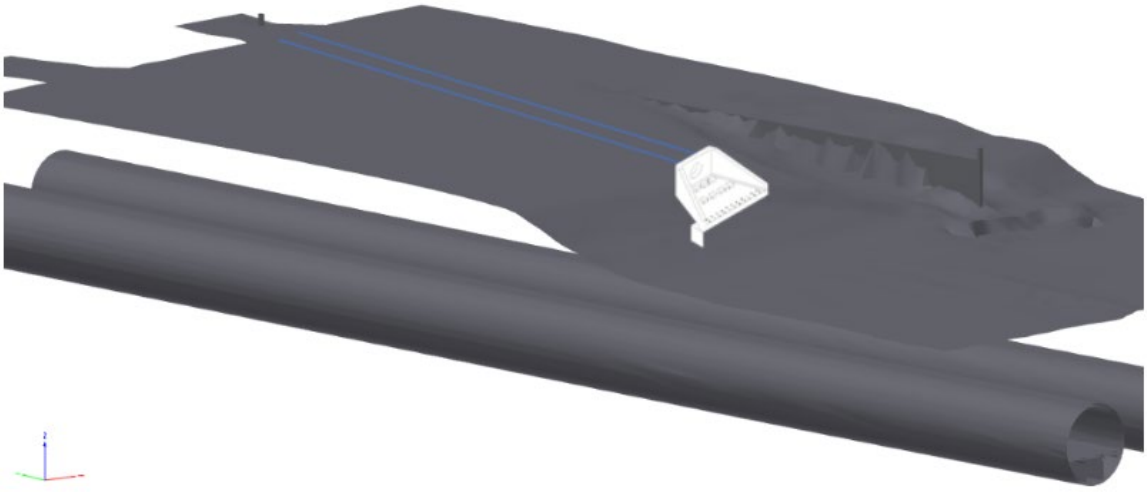

Plate 4: Position of outfall with Groyne 4, tunnels (for illustration purposes only) below and sloping subtidal bed (NTS).

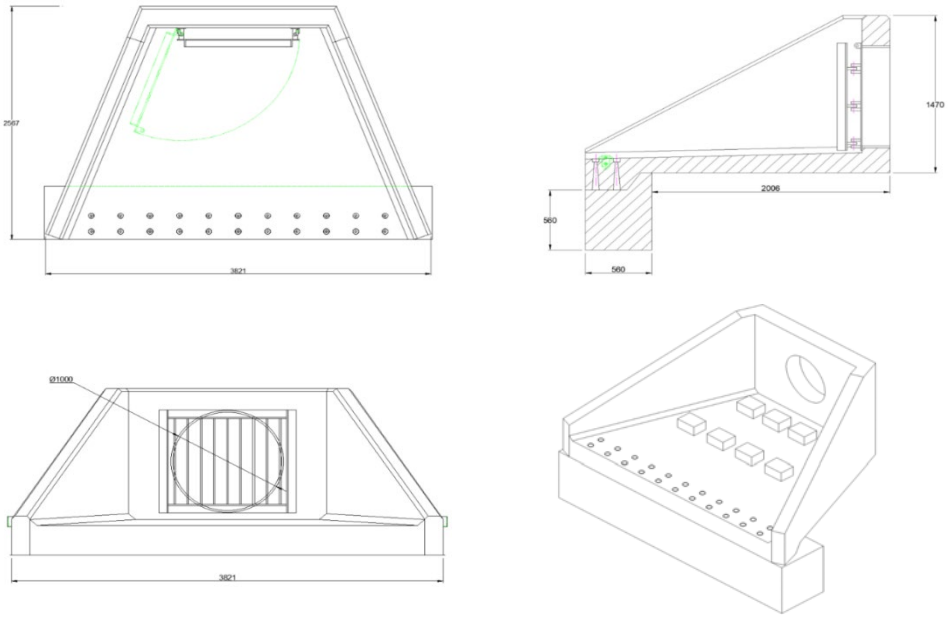

Plate 5: Indicative outfall head design

Construction Method

The following sections describe the envisaged construction method required for the installation of the pipeline and outfall. It is envisaged that in total construction would be up to 8 weeks in duration.

It is assumed that all works within the intertidal area would be restricted to periods of low water.

Pipeline

Piling works would be undertaken from a dumb barge with spud legs or anchors on winches, with a 30 to 50 tonne 360 excavator and a multi cat that has a 5 tonne lifting capacity to set anchors as required. The main piling barge would be serviced by a second dumb feeder barge carrying sheet piles, pipe sections and headwall /diffuser unit.

The pipeline trench is assumed to be circa 2m deep to accommodate the 1m diameter pipe. The short sheet piles would be vibro-piled into place (circa 6m “driven” in 4m below trench base) with small vibrating hammer (https://www.omsvibro.com/products/vibratory-hammers/excavator-mounted/). Piles would be driven to, or cut off at, riverbed, and left in situ until decommissioning. Sheet piling would be installed along either side of the trench 1.5-2m clear separation) for the full length of the pipeline route across the intertidal area. Work would be completed from shore to channel, over a 3-4 week period, assuming a 7 day working week.

Once the sheet piles have been installed, material would be excavated over an approx. 40m length and the pipe placed in the trench (total lineal meterage would be dependent on pipe lengths and complexity of connections). Concrete anchor collars are likely to be installed along the length of the pipeline. Excavated arisings would be side cast and then backfilled once the pipe has been installed. This would be a cyclic process as the pipeline progresses-ie excavate, pipe installation and backfill. The process assumes that excess material would be redistributed during subsequent tidal cycles. The pipe laying process would be completed over a 2 week period, assuming a 7 day working week.

The width of the trench would be approx. 2m, and the maximum working width to accommodate side casting would be approx. 10m.

Outfall / diffuser

The installation of the outfall/diffuser head may require the construction of a minor cofferdam. The headwall/diffuser head may be placed on top of mono-piles for support or be connected to longer piles used for the cofferdam driven closely around the plan-perimeter (footprint) of the headwall unit. Installation works would be completed over a 2 week period, assuming a 7 day working week.

Decommissioning

As a worse case, it is assumed that the pipeline and outfall structure would be decommissioned and removed once the asset is no longer required. The decommissioning process is the reverse of the construction process described above and is therefore assumed to be completed over 8 weeks, working 7 days a week. The working constraints described for the construction activities would also apply to decommissioning activities within the intertidal area.

Key commitments/constraints to works

- Discharge waters would be treated to the level stipulated in the discharge consent issued by the Environment Agency.
- All works would be completed at periods of low water.
- All piling works would be completed during periods of low water to avoid transmission of underwater noise.
- All piling works would utilise soft start piling and other best practice techniques as per the JNCC guidance to help avoid noise and vibration impacts.

Annex T2 25 June 2020 Feedback received from Natural England

Date: 25 June 2020
Our ref: 320528
Your ref: -

[redacted]

BY EMAIL ONLY

Customer Services
Hornbeam House
Crewe Business Park
Electra Way
Crewe
Cheshire
CW1 6GJ

T 0300 060 3900

Dear [redacted]

North Portal Discharge Assumptions Paper

Thank you for seeking Natural England's views on the Lower Thames Crossing North Portal Discharge Assumptions high level briefing paper. This advice is being provided as part of Natural England's Discretionary Advice Service and the advice is based upon the information within the Document Number: HE540039-CJV-EGN-S07-TNT-ENV-00002.

We have reviewed the document and have the following initial comments and requests for further information. We have focussed our comments on priority ecological receptors, noting that other stakeholders (in particular the Environment Agency) will have comments on other aspects of the discharge project. In particular we are concerned about impacts to the ditch network (receptors include aquatic macro-invertebrates and water voles); the seawall (terrestrial invertebrates and vascular plants); and the inter-tidal area (saltmarsh and mudflats) including their function as supporting habitat to birds associated with the Thames Estuary & Marshes SPA. Please note we have not covered marine interests in this response, which may require further assessment and mitigation (fish; MCZ; cetaceans).

We would like to request further information, as some details are unclear from the briefing note provided. Our comments are therefore at a high level at this stage:-

- A figure showing the entirety of proposed / indicative layout construction compound CA05, including areas safeguarded for ecology (this was requested at a previous design workshop). This should indicate those areas where ecology cannot be safeguarded, so it is clear which aspects are to be retained in-situ and which will be lost.
- A clearer location map of the proposed area for the pipeline. It is not clear where Rivershoal Groyne 4 is located for us to advise on proximity to sensitive habitats.
- Details of the permeability of ground conditions relative to a baseline. This will help to better understand the 'flashiness' of the ditch system affecting ecological receptors.
- It is not clear why 'It is undesirable, however, for significant weather risk to be introduced into the production cycle except in extreme circumstances.'
- Confirmation that surveys of affected areas have been completed or will be undertaken (including for water voles; reptiles; aquatic macro-invertebrates; vascular plants; Phase 1 habitat; and inter-tidal / saltmarsh as appropriate).

Regarding foul water, we note that discussions are ongoing with Anglian Water to link into existing treatment works and associated discharge. Whilst these discussions are ongoing, it is not clear whether sufficient capacity exists within current facilities, and what headroom exists under the

discharge permit. As the discharge is in proximity to the Thames Estuary & Marshes SPA, this issue should be addressed within the HRA screening report.

We will defer to the Environment Agency on matters including whether the worst-case rainfall event is sufficiently precautionary, and on the appropriate Environmental Quality Standards that will need to be achieved through the treatment and discharge process.

The need for ditch excavations near stock piled areas is likely to have impacts to ecological receptors (in particular water voles; aquatic macro-invertebrates; and vascular aquatic plants). Appropriate surveys should be undertaken to inform appropriate mitigation measures. As a general point regarding aquatic macro-invertebrates, species in this group are likely to have variable tolerance levels to changes in salinity, noting their proximity to the sea wall and likely brackish conditions. Thus, adjustments to the surface water drainage patterns may affect optimal conditions even where direct impacts can be avoided. Water quality (chemical parameter) studies will help to better understand these conditions.

The position and length of the discharge outfall are yet to be determined, so it is not possible for us to advise on specific ecological effects. The selection process should however seek a route which avoids areas of high ecological sensitivity where possible, but it is not clear what latitude the project has on this point to micro-site the pipeline appropriately.

It will be important for the routing of the pipeline to carefully manage the interaction with the seawall, which is likely to hold ecological interest including notable vascular plants and protected species (in addition to those present within adjacent borrow dykes). The route of the pipeline should be surveyed (if it has not already) to understand these impacts and mitigate accordingly.

We note and broadly welcome the intention to avoid foreshore erosion by installing the pipeline to discharge sub-tidally. This does however introduce additional construction phase effects which will need to be carefully considered. In particular, this area of the foreshore is understood to support functionally linked land to the Thames Estuary & Marshes SPA, used by both passage and over-wintering birds. The project should therefore preferably seek to avoid sensitive seasonal periods (September – March inclusive). The range of disturbance effects (in particular the stated 4 week programme of sheet piling) should be screened for likely significant effects as part of the HRA screening report.

We also note the intention for the side-cast excavated arisings to be naturally dispersed via tidal effects, however the effects of sedimentation smothering adjacent photosensitive habitats should be considered as an impact pathway and assessed accordingly.

Similar comments will apply to the de-commissioning phase of the project, to return the area to its baseline condition.

We recognise that this aspect of the project will require a detailed method statement with specific measures linked to ecological mitigation and Natural England will be happy to work with LTC on this at the appropriate time.

If you have any queries relating to the advice in this letter please contact me on [redacted] or [redacted]

Yours sincerely

[redacted]

Annex U 18 May 2020 HRA Briefing Note Ornithology baseline

HRA Ornithology Baseline

This brief presents the baseline conditions of the SPA or Ramsar qualifying bird species for the area potentially affected by the Project.

SPA & Ramsar Qualifying Bird Features

The European site populations these species could contribute to are in Table 6-2.

Table 6-1 List of the SPA / Ramsar birds considered in this assessment and the European Sites for which they are qualifying features.
** SPA 3rd Review – SPAs with boundary review needs (Stroud, et al., 2016)

Qualifying Species	Benfleet and Southend Marshes SPA and Ramsar	Medway Estuary and Marshes SPA & Ramsar	Thames Estuary and Marshes SPA and Ramsar	The Swale SPA and Ramsar
Anas acuta, Northern pintail		Wi		Wi
Anas clypeata Northern shoveler		Wi		Wi
Anas crecca Teal		Wi		
Anas penelope Eurasian wigeon		Wi		Wi
Arenaria interpres Turnstone		Wi		
Anser albifrons albifrons White-fronted goose (European)			Wi**	Wi**
Branta bernicla bernicla Dark-bellied brent goose	Wi**	Wi**		Wi**
Calidris alpina alpina Dunlin	Wi	Wi	Wi	Wi
Calidris canutus islandica Red knot,	Wi	Wi	Wi	
Charadrius hiaticula Ringed plover	Wi	Wi	Pa	Pa
Circus cyaneus Hen Harrier			Wi	
Cygnus columbianus bewickii Bewicks Swan		Wi		
Haematopus ostralegus Oystercatcher		Wi		
Limosa limosa islandica Black-tailed godwit		Wi	Wi / Pa	Wi
Numenius arquata Curlew		Wi**		Wi**
Pluvialis apricaria Golden Plover				Wi**
Pluvialis squatarola Grey plover	Wi	Wi	Wi	
Recurvirostra avosetta Avocet		Br / Wi	Wi	
Sterna albifrons Little tern		Br		
Sterna hirundo Common tern		Br		
Tadorna tadorna Common shelduck		Wi		
Tringa nebularia Greenshank		Wi		
Tringa totanus Common redshank,		Wi	Wi	Wi
Vanellus vanellus Lapwing		Wi**	Wi**	Wi**
Waterfowl assemblage– over winter	Wi	Wi	Wi	Wi
Breeding bird assemblage		Br		

Natural England Commissioned Report NECR082

Natural England Commissioned Report NECR082 (Liley, 2011) provided a collation of existing baseline information relating to the Thames and Estuary Marshes, Medway Estuary and Marshes and The Swale European sites, summarising the designated interest features, their status and trends, habitat issues and potential threats. The baseline data collated for the SPA bird features used the British Trust for Ornithology (BTO) Webs counts which include those presented in Table 6-3. The report highlighted marked declines in for some wintering bird species, particularly with the Medway site, where 14 bird species had undergone recent declines of 25% or more. The reasons were not clarified, and the report highlighted the need to complete further work to determine the causes.

WeBS data

Table 6-3 sets out the Webs data collated for the SPA or Ramsar qualifying bird species that could be part of the populations for the European sites listed in Table 6-2.

Table 6-2 WeBS 5-year annual peak means for SPA/Ramsar qualifying features from WeBS count areas within 2km of the Project

WeBS survey area	Thames Estuary and Marshes SPA	Shorne Marshes	Shorne Marshes offshore	Higham Bight	Higham Marsh	Belhaus Woods Country Park
Years included within 5-year annual peak mean	2011/12 to 2015/16	2013/14 to 2017/18	2008/09, 2010/11, 2011/12	2011/12 to 2015/16	2011/12 to 2015/16	2011/12 to 2015/16
Species	5-year annual peak mean					
Avocet	1956			82		
Black-tailed Godwit	5195	16		19	37	
Common Tern	74					9
Curlew	953	67	4	143	48	
Dunlin	13300	0	100	684		
Gadwall	473	4			8	32
Greenshank	24					
Grey Plover	1321		28	128		
Knot	3244					
Pintail	186	0		13		
Redshank	639	18	6	132	2	
Ringed Plover	328					
Shelduck	914	7		2	5	
Shoveler	456	19			20	35
Teal	2133	14	13	520	35	31

The WeBS Alerts data (Woodward, et al., 2019) for the European sites listed in Table 6-2 provide the short, medium and long term trends in the numbers of qualifying species at each site as set out in Table 6-4 to Table 6-7. Woodward et al (2019) also comment on the trends for each of the sites and that commentary has been presented in the paragraphs following each table. This information provides some insight in to how the population trends at each site compare to that being experienced within the region and UK as a whole and sets the context for the baseline.

Table 6-3 WeBS Alerts: Thames Estuary and Marshes SPA

Species	Info	First Winter	Ref Winter	Short-term % Δ	Med-term % Δ	Long-term % Δ	Baseline Winter	% Δ since baseline
Avocet	–	91/92	16/17	14	73	645	95/96	247
Grey Plover	–	91/92	16/17	-41	-4	-18	95/96	-20
Ringed Plover	–	91/92	16/17	43	-37	-56	95/96	-37
Black-tailed Godwit	–	91/92	16/17	3	202	641	95/96	504
Knot	–	91/92	16/17	-63	20	342	95/96	-12
Dunlin	–	91/92	16/17	11	15	55	95/96	13
Redshank	–	91/92	16/17	-39	-49	-61	95/96	-57
Waterbird assemblage	–	91/92	16/17	-11	14	30	95/96	1

Woodward et al (2019) state that "Alerts have been triggered for four out of the seven species assessed for the Thames Estuary and Marshes SPA. For one of these species, Redshank, comparison of site trend with broadscale trends suggests that the declines underpinning Alerts status may be exacerbated by site-specific pressures."

Table 6-4 WeBS Alerts: Medway Estuary and Marshes SPA

Species	Info	First Winter	Ref Winter	Short-term % Δ	Med-term % Δ	Long-term % Δ	Baseline Winter	% Δ since baseline
Brent Goose (Dark-bellied - bernicla)	–	91/92	16/17	10	39	-66	88/89	-51
Shelduck	–	91/92	16/17	33	35	-51	88/89	-36
Pintail	–	91/92	16/17	2	-37	-39	88/89	-39
Avocet	–	91/92	16/17	81	47	755	88/89	2250
Grey Plover	–	91/92	16/17	-49	-65	-93	88/89	-92
Ringed Plover	–	91/92	16/17	72	42	-72	88/89	-81
Knot	–	91/92	16/17	-25	-14	24	88/89	29
Dunlin	–	91/92	16/17	68	75	-61	88/89	-56
Redshank	–	91/92	16/17	24	4	-77	88/89	-77
Waterbird assemblage	–	91/92	16/17	6	17	-46	88/89	-40

Woodward et al (2019) state that "Alerts have been triggered for eight of the nine species assessed for this site. In three cases (Pintail, Grey Plover and Redshank), comparison of site trend with broadscale trends suggests that the decline underpinning Alerts status may be driven or exacerbated by site-specific pressures. For another four species (Dark-bellied Brent Goose, Shelduck, Ringed Plover and Dunlin) the comparison suggests that conditions may have improved recently but numbers remain well below former levels following earlier declines in the 1990s which may have been driven by site-specific pressures. Alerts have also been triggered for the waterbird assemblage, reinforcing the supposition that site-specific pressures may be affecting waterbird numbers at this site."

Table 6-5 WeBS Alerts: The Swale SPA

Species	Info	First Winter	Ref Winter	Short-term % Δ	Med-term % Δ	Long-term % Δ	Baseline Winter	% Δ since baseline
Brent Goose (Dark-bellied - bernicla)	–	91/92	16/17	-6	-3	-8	88/89	16
Dunlin	–	91/92	16/17	-21	-18	-38	88/89	-38
Waterbird assemblage	–	91/92	16/17	-17	-30	-8	88/89	5

Alerts have been triggered for one of the two species assessed for The Swale SPA. For this, species, Dunlin, comparison of site trend with broadscale trends suggests that the declines underpinning Alerts status are more likely to be driven by broadscale changes rather than site-specific pressures. However, a medium-term Alerts has also been triggered for the waterbird assemblage as a whole, and declines have occurred for 22 of the 32 non-feature species over one or more timescales. Therefore, it would be prudent to closely monitor waterbird numbers in the coming winters to assess whether these declines may be due to site-specific pressures.

Table 6-6 WeBS Alerts: Benfleet and Southend Marshes SPA

Species	Info	First Winter	Ref Winter	Short-term % Δ	Med-term % Δ	Long-term % Δ	Baseline Winter	% Δ since baseline
Brent Goose (Dark-bellied - bernicla)	–	91/92	16/17	22	24	-22	87/88	-43
Grey Plover	–	91/92	16/17	16	22	-54	87/88	-39
Ringed Plover	–	91/92	16/17	-21	-66	-65	87/88	-64
Knot	–	91/92	16/17	-42	-39	-20	87/88	-25
Dunlin	–	91/92	16/17	5	-39	-20	87/88	-11
Waterbird assemblage	–	91/92	16/17	-10	-33	-23	87/88	-13

Alerts have been triggered for all five species assessed for Benfleet and Southend Marshes SPA. In two cases (Dark-bellied Brent Goose and Dunlin), comparison of site trend with broadscale trends suggests that the decline underpinning Alerts status are being driven by site-specific pressures. Alerts have also been triggered for the waterbird assemblage, reinforcing the supposition that site-specific pressures may be affecting waterbird numbers at this site.

Project field surveys

The land considered likely to be functionally linked to the European sites identified comprises the intertidal habitats of the River Thames and the land either side of the river including arable farmland, marshes and coastal grazing marsh, as well as areas of reedbed. Ornithological surveys have been completed for the Project and the results of these where they relate to the SPA and Ramsar qualifying bird features are presented in the following paragraphs.

Figure 20 illustrates the distribution of SPA/Ramsar species recorded during the Project field work. This clearly indicates that the majority of birds where recorded along and either side of the River Thames, and therefore these areas are considered as functionally linked land for the purposes of the assessment of effects on European sites. Table 6-8 and Figure 28 identify the survey areas/transects that are within the functionally linked land and the data collected at these location has been extracted from the wider Project data set for use within this assessment.

Table 6-7: Survey locations (shown on Figure 28) that are within the functionally linked land

Diurnal surveys	Nocturnal surveys (winter months only)	Intertidal vantage point surveys
Coles Farm	Bowaters Farm	NW
Coalhouse Fort	Cole Farm and scrap heap	NE
East Tilbury Battery	East Tilbury Battery	NE 2
East Tilbury Marshes	Inglebourne valley	SW
Filborough Marshes and firing range	Jetty	SE
Rochester Bridge	Mott Farm	
Shorne Marshes	South 1 – Firing Range	

Tilbury Fort	South 2 – Chalk	
Tilbury Power Station	Tilbury Fort	

Intertidal vantage point survey

The intertidal area on both the north and south side of the River Thames were subject to intertidal vantage point surveys. Figure 25 shows the location of the vantage points and the distribution of the species recorded in each season. Table 6-9 sets out the peak counts (all vantage points) for each of the SPA species in each season.

Table 6-8: Seasonal peak counts of Spa/Ramsar species recorded during the intertidal vantage point surveys

Species	Peak count per season					
	Br. 2017	Pa. 2017	Wi. 2017/18	Br. 2018	Pa. 2018	Wi. 2018/19
Avocet	59	1	141	44	300	830
Black-tailed godwit	306	40	286	594	1372	408
Common tern	2	35		7	42	50
Cormorant	3	3	5	4	4	4
Curlew	18	61	30	8	58	70
Dark-bellied brent goose			1			
Dunlin	1	120	807	2	450	1575
Gadwall				3		
Golden plover			2			
Great crested grebe	2		4	2		3
Grey plover		12	56		14	35
Greylag goose	1	2				67
Knot		15	21		1	
Lapwing	3	5	130	3		70
Little egret	5	3	2	2	8	3
Little grebe			1		1	
Mallard	15	4	20	6	7	28
Oystercatcher	8	16	5	7	6	9
Redshank	75	7	59	30	13	122
Ringed plover	15	162	75	10	98	52
Ruff	2					
Shelduck	27	15	49	82	20	129
Shoveler			3	2		11
Teal	16	18	277	143	75	641
Turnstone	8	7	16	1	1	7
Whimbrel	5	5	10	3	3	
Wigeon		8	483	8	22	623
Br. – breeding season (April to July, inclusive) Pa. – passage season (August to October, inclusive) Wi. – wintering season (November to March, inclusive)						

The main areas of importance for birds using the intertidal areas within the study area was around the mudflats and saltmarsh south and south east of Coalhouse Fort (VP NE2 on Figure 25). The mudflats to the east of Tilbury power station (VP NW on Figure 25) were also found to have good numbers of SPA birds, although much lower compared to those recorded around Coalhouse Fort.

On the Kent side of the River Thames, the mudflats around Shorne Fort had some good numbers of SPA birds, although much reduced in comparison with the Essex bank of the River Thames. The mudflats to the north of the Metropolitan Police firing range held no significant aggregations of birds.

Diurnal and Nocturnal surveys

Figure 26 illustrates the diurnal survey areas and the records of SPA/Ramsar species by season in relation to the Project Order limits. Figure 27 illustrates the nocturnal survey areas and the records of SPA/Ramsar species (winter survey season only) in relation to the Project Order limits.

Table 6-9: Seasonal peak counts of Spa/Ramsar species recorded during the diurnal and nocturnal surveys within the functionally linked land (as shown on Figure 26 and Figure 27)

Species	Diurnal Peak count per season						Nocturnal Peak count per season	
	Br. 2017	Pa. 2017	Wi. 2017/18	Br. 2018	Pa. 2018	Wi. 2018/19	Wi. 2017/18	Wi. 2018/19
Avocet			6			1	11	14
Black-tailed godwit			36		8	7	20	0
Common tern								
Cormorant	2	3	6	3	1	3		
Curlew	2		63	1		46	2	1
Dark-bellied brent goose								
Dunlin			1	8			800	320
Gadwall	2		4	7	6	113	3	1
Golden plover			20					
Great crested grebe			1	8				2
Grey plover							1	2
Greylag goose	23	70	117	12	62	120	5	96
Knot	1							
Lapwing	31	25	520	40	80	225	33	70
Little egret	2	2	2	6	7	10		
Little grebe	4	14	10	4	18	23	12	16
Mallard	30	12	40	10	30	120	20	20
Merlin				1				
Oystercatcher	3			3	10	1	1	1
Pintail			13	3		2		
Redshank	60		20	20		25	50	60
Ringed plover			21	1	27	16		1
Ruff	1							
Shelduck	8		26	20	6	40	5	10
Shoveler	18	4	42	19	2	60	7	31
Teal	9	17	70	12	18	160	15	60
Turnstone								

Species	Diurnal Peak count per season						Nocturnal Peak count per season	
	Br. 2017	Pa. 2017	Wi. 2017/18	Br. 2018	Pa. 2018	Wi. 2018/19	Wi. 2017/18	Wi. 2018/19
Whimbrel	1				3			
Wigeon	3		30			82	35	20

North of the River Thames the marshes around Tilbury Fort, approximately 1km west of the northern portal construction area, which were found to support a significant nocturnal roost for dunlin and other wading birds, including avocet, black-tailed godwit, redshank and ringed plover.

South of the River Thames, the Shorne Marshes, recorded the most significant numbers of SPA/Ramsar qualifying species, including: teal, shoveler, curlew, shelduck, redshank and wigeon. The Metropolitan Police firing range recorded very few species.

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