ENVIRONMENTAL STATEMENT: 6.1 CHAPTER 3: CONSIDERATION OF ALTERNATIVES

DECARBONISATION

Cory Decarbonisation Project

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The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations (2009) - Regulation 5(2)(a)

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3. CONSIDERATION OF ALTERNATIVES

3.1. INTRODUCTION

3.1.1. This chapter sets out the consideration of alternatives in accordance with Regulation 14(2)(d) of the EIA Regulations[1] which states that an Environmental Statement (ES) should contain:

"A description of the reasonable alternatives studied by the applicant, which are relevant to the proposed development and its specific characteristics and an indication of the main reasons for the option chosen, taking into account the effects of the development on the environment."

3.1.2. In accordance with Planning Inspectorate Advice Note Seven[2], this chapter includes information about the alternatives considered within the design of the Proposed Scheme.

3.1.3. The Proposed Scheme has evolved in its design. The following alternatives have been considered and are set out in the following sections below:

- The 'Do Nothing' Scenario (**Section 3.2**);
- Alternative Development Zones (**Section 3.3**);
- Alternative layouts (**Section 3.4**);
- Alternative technologies (**Section 3.5**);
- Alternative water supply and discharge (**Section 3.6**);
- Alternative transport routes (**Section 3.7**); and
- Alternative construction compound areas (**Section 3.8**).

3.1.4. The design of the Proposed Scheme is detailed in **Chapter 2: Site and Proposed Scheme Description (Volume 1)**. Options that have been considered and discounted are described within this chapter.

3.2. DO NOTHING SCENARIO

3.2.1. The 'Do Nothing' scenario is the continued operation of Riverside 1 and Riverside 2 (when constructed and operational) without the addition of carbon capture technology. At the time of writing, construction works for Riverside 2 are underway.

3.2.2. The generation of electricity through the combustion of residual municipal waste using Riverside 1 and Riverside 2 will generate up to 1.5 million tonnes per annum of CO_2. The addition of carbon capture technology would avoid at least 95% of these CO_2 emissions entering the atmosphere and is therefore preferable from a CO_2 reduction perspective.

3.2.3. The 'Do Nothing' scenario would be contrary to the UK's commitment to achieve net zero carbon emissions by 2050[3]. Consequently, it is not considered further.

3.2.4. The 'Do Nothing' scenario would also be contrary to Government policy in NPS EN-1[4], which establishes the critical national priority for carbon capture technology to meet the net zero challenge. Further information on the need for the Proposed Scheme is provided in **Section 1.2** of **Chapter 1: Introduction (Volume 1)**, in the **Planning Statement (Document Reference 5.2)** and in the **Project Benefits Report (Document Reference 5.4)**.

3.3. ALTERNATIVE DEVELOPMENT ZONES

3.3.1. A detailed narrative of the alternative site options evaluation process undertaken by the Applicant in respect of the development zones for the Carbon Capture Facility and the siting of the Proposed Jetty is reported in the **Terrestrial Site Alternatives Report (Document Reference Number 7.5)** and **Jetty Site Alternatives Report (Document Reference Number 7.6)**.

3.3.2. As those reports explain, consideration of potential development zones for the Carbon Capture Facility occurred in conjunction with iterative design development and the Applicant gaining greater understanding of the Proposed Scheme's footprint, the baseline position of the environmental constraints such as Crossness LNR, and operational requirements, developing further from the position at the time of the Preliminary Environmental Information Report.

3.3.3. The reports explain that the following were important considerations in the terrestrial site selection process:

- as a starting point, the functional imperative for the Proposed Scheme is to capture carbon from Riverside 1 and Riverside 2 and enable its transportation by ship. As such the site locations need to be in proximity to those facilities;
- the location of Riverside 1 and Riverside 2 (currently under construction) was a primary factor in the identification of the initial Proposed Scheme siting options for the Carbon Capture Facility. The close proximity of the Carbon Capture Facility would minimise the length of the connection required into the existing flue gas lines of Riverside 1 and Riverside 2, as required to transfer CO_2;

- provision of sufficient land available to house all of the aspects of the Carbon Capture Facility as described in **Chapter 2: Site and Proposed Scheme Description (Volume 1)**, based on a footprint of approximately eight hectares;
- analysis of engineering (including connectivity to the Proposed Jetty once the location of that had been determined); environment (including impacts to Crossness LNR and MOL); planning (including impacts to Accessible Open Land); and third party land impacts; and
- application of the principles for design set out in the **Design Principles and Design Code (Document Reference 5.7)**.

3.3.4. The site options considered in the reports are presented in **Figure 3-1: Terrestrial Site Alternatives Plan (Volume 2)**, and **Figure 3-2: Jetty Site Alternatives Plan (Volume 2)**.

3.3.5. The location of the Proposed Jetty was confirmed first, and Jetty Site A (east of Middleton Jetty) was selected as:

- it is most suitable from a navigational perspective. Its location downriver of Middleton Jetty would result in the least interference with the existing operations, as vessels navigate predominantly upriver both to and from Middleton Jetty;
- it does not require the modification or relocation of the Applicant's existing infrastructure (with Jetty Option B requiring an extension to Middleton Jetty, and Jetty Option C requiring the relocation of the Applicant's barge mooring points) or Thames Water infrastructure (Option D);
- it has the advantage of being independent from other structures, which allows it to be designed specifically for the needs of an export jetty; and
- although environmental factors indicated that reuse of existing jetties would be preferable, this would not be possible or preferred for operational, navigation or third party impacts reasons (Options B and D) and Option A performs better environmentally than Option C, as it is further away from Crossness LNR.

3.3.6. Following the establishment of that Proposed Jetty location, the process selected South Zone 1 as the appropriate location for the Carbon Capture Facility development zone. In summary, and with reference to the **Design Principles and Design Code (Document Reference 5.7)**, this zone was selected as:

- South Zone 1 forms a single homogenous area with sufficient space for the necessary footprint of the Carbon Capture Facility;
- close proximity to Riverside 1 and Riverside 2 for connection of the Flue Gas Supply Ductwork;
- ability to restrict the direct loss of Crossness LNR land, Erith Marshes SINC land and land designated as MOL to a single area. It would avoid the creation of isolated areas such as Eastern Paddock being surrounded by development. The retention of these designated area as a single entity provides great opportunities for enhancement; and

- avoiding adverse environmental impacts associated with works within the River Thames above and beyond those required for the Proposed Jetty.

3.4. ALTERNATIVE LAYOUTS

3.4.1. Following these decisions being made, alternative site layouts for each of the Carbon Capture Facility and the Proposed Jetty have been considered. This is set out further below.

THE CARBON CAPTURE FACILITY

Plant Layout

3.4.2. The required plant for the Carbon Capture Facility is described in **Chapter 2: Site and Proposed Scheme Description (Volume 1)**.

3.4.3. Three alternative plant layouts have been considered. These are summarised below and shown on **Figure 3-3: Alternative Layouts for the Carbon Capture Facility (Volume 2)**. Further detail on these options, and the reasons for the preferred layout, is presented in the **Design Approach Document (Document Reference 5.6)**.

- Option 1 – Diffuse Layout: In this option, the Carbon Capture Facility is fractured and spread out, which allows for some of the existing ditches and east-west habitat corridors to be retained within the land for the Carbon Capture Facility. As the extent of the Carbon Capture Facility would make full use of the land up to the boundaries (including where Crossness LNR is adjacent to the Carbon Capture Facility), there would be no land available to provide significant buffer planting at the boundaries of the Carbon Capture Facility.
- Option 2 - Compressed Layout: There is a smaller land take associated with a more compact Carbon Capture Facility, which results in land being made available for the provision of buffer planting at the boundaries of the Carbon Capture Facility (including where Crossness LNR is adjacent to the Carbon Capture Facility). This will support the Proposed Scheme's integration with the naturalistic landscape character of the Crossness LNR and Accessible Open Land and address views directly into the lower portions of the Carbon Capture Facility as well as provide an attractive boundary with Norman Road and the adjoining PRoW. Option 2 would impact the hydrology of the Site due to the loss of ditches, mitigation of which is set out in the **Outline LaBARDS (Document Reference 7.9)**.
- Option 3 – Retention of Munster Joinery: In light of ongoing engagement, which was also reflected in statutory consultation feedback, the Applicant has sought to understand whether it is feasible, or not, to have a layout that retains Munster Joinery. As a starting point, in order to maintain the eight hectares operational requirement, such a layout would involve development within the Norman Road Field (Accessible Open Land) and thus outside the chosen development zone. If this was sought to be avoided this would mean all the operational requirements will not be able to be met within the Carbon Capture Facility. Even with this said, an arrangement that retains Munster Joinery (0.8 hectares) would lead to a

fractured development whereby much of the Supporting Plant is separated from the rest of the Carbon Capture Facility. Severance would compromise operational efficiency, site security and safety and reduce the potential for enhancement within/at the edges of the Carbon Capture Facility. For example, lack of visibility from the Control Room to the Carbon Capture Facility and also a lack of safe and secure access from the Gatehouse to the Carbon Capture Facility.

3.4.4. Option 2 (Compressed Layout) has been selected, providing a contiguous plant layout that optimises opportunities for buffer planting, and environmental mitigation.

Location of LCO_2 Buffer Storage

3.4.5. Consideration was given to locating LCO_2 Buffer Storage to the north of the Site, to be closer to the Proposed Jetty. This option was not considered viable as the cost and process benefit of reducing the length of the interconnecting ductwork (steam, condensate, flue gas) between Riverside 1 and Riverside 2 and the Carbon Capture Facility is much greater than reducing the length of LCO_2 pipework from LCO_2 Buffer Storage to the Proposed Jetty. The increased LCO_2 pipework solution is more cost-effective and less technically challenging to install compared to the interconnecting ductwork. A further benefit is that the LCO_2 pipework is less obtrusive compared to the interconnecting ductwork, leading to potential space savings for the Site.

3.4.6. The proposed location of the LCO_2 Buffer Storage is within the centre of the Carbon Capture Facility (as seen on the **Works Plans (Document Reference 2.3)**) this has been informed by process safety considerations as the location that best keeps risks As Low As Reasonably Practicable.

Two Plant vs. Single Plant Design

3.4.7. The Carbon Capture Facility could be delivered with the construction of two separate Carbon Capture Plants, one each for Riverside 1 and Riverside 2; or the construction of a single Carbon Capture Plant.

3.4.8. A single Carbon Capture Plant will have the same capacity as two Carbon Capture Plants; it would be sized to process the flue gas from both Riverside 1 and Riverside 2. **Chapter 2: Site and Proposed Scheme Description (Volume 1)** sets out the plant requirements for each of the single plant or two plant scenarios. Whilst the amount of each type of equipment might change the remaining equipment will need to be sized to meet that capacity i.e. you would require one larger (in length and width, but not height) version of each type of equipment to meet the same capacity if only one carbon capture plant is brought forward. As such the eight hectare size requirement for the Carbon Capture Facility remains the same.

3.4.9. Engagement with Carbon Capture Technology Vendors has confirmed a single Carbon Capture Plant is able to supply the required capacity and would be suitable for the operating modes of Riverside 1 and Riverside 2. The benefit of a single Carbon Capture Plant is a reduced capital expenditure (CAPEX) and thus overall construction cost may be able to be reduced, subject to detailed design. One potential benefit of two Carbon Capture Plants is increased reliability. If one Carbon Capture Plant suffers an outage, then only half of the capacity becomes unavailable and the other can continue to operate, capturing the CO_2 from either Riverside 1 or Riverside 2. With a single Carbon Capture Plant, any outage would result in no capacity to capture CO_2.

3.4.10. The design parameters (as described in **Section 2.3** of **Chapter 2: Site and Proposed Scheme Description (Volume 1)**) and secured in a Schedule in the DCO and **Works Plans (Document Reference 2.3)** allow for both a single plant and two plant design.

3.4.11. The optimum solution will be agreed post Carbon Capture Technology Vendor selection as part of the detailed design of the Proposed Scheme.

Phased Construction Options

3.4.12. There are two options for construction of the Carbon Capture Facility:

- Option 1 – Two-Phase Construction: First, one Carbon Capture Plant and CO_2 Processing Plant is constructed along with the LCO_2 Buffer Storage and Piping and Utilities to Jetty, the Supporting Plant, Proposed Jetty, and Ancillary Infrastructure. Then the second Carbon Capture Plant and CO_2 Processing Plant is constructed sequentially (expected duration 60 months).
- Option 2 – Single-Phase Construction: All elements of the Carbon Capture Facility, the Proposed Jetty and the Ancillary Infrastructure are constructed in parallel (expected duration 42 months). Option 2 encapsulates either two plant design or a single plant design[a].

3.4.13. Option 2 (Single-Phase Construction) benefits from having a lower CAPEX (a shorter programme results in lower mobilisation costs/reduced hire costs for plant and equipment, and shorter duration of staff on Site) whereas a two-phase construction provides operational flexibility and the option of a phased development approach. A two-phase construction spreads investment in the Proposed Scheme over a longer period and would enable the lessons learned as part of construction and commissioning of the first Carbon Capture Plant to be incorporated as part of the construction and commissioning of the second Carbon Capture Plant. Commencing operation of one Carbon Capture Plant prior to starting construction of the second has the added benefit of enabling CO_2 to be captured earlier, albeit at reduced quantities,

[a] A two-plant design will be the worst case scenario, requiring a larger quantity of plant and equipment in comparison to the single-plant design and having a longer duration at 42 months. A single-plant design will have a duration of 36 months.

prior to the second Carbon Capture Plant coming forward. However, the downsides of such an approach are the requirement to construct the second Carbon Capture Plant alongside the first resulting in increased hazard from performing construction activities next to an operational plant, and potential cost escalation between construction of the first and second Carbon Capture Plant, in addition to an overall reduction in the quantity of CO_2 that is captured prior to the commencement of commercial operation of the second Carbon Capture Plant.

3.4.14. There is a difference in the construction durations between the two programmes. With respect to Option 1 (Two-Phase Construction), the magnitude of construction will be reduced, for example increasing the construction programme would reduce the intensity and the number of construction vehicles per day. Conversely, the magnitude of construction traffic would be greatest with the single-phase construction programme (Option 2 (Single-Phase Construction)).

3.4.15. Each chapter of this ES has assessed the worst case preliminary construction programme for each technical topic. The preferred construction phasing option will be identified as part of the detailed design of the Proposed Scheme and confirmed as part of the full CoCP(s) and Traffic Management Plan.

Flue Gas Ducting Routes

3.4.16. The selected site for the Carbon Capture Facility is located to the south of Riverside 1 and Riverside 2. Whilst the stack for Riverside 1 is located at the south end of the building and so easily connectable to the Carbon Capture Facility, the stack for Riverside 2 is located at the north end of the facility, adjacent the River Thames. Consequently, four different routes were considered for the flue gas ducting from Riverside 2 to the Carbon Capture Facility which are shown on **Figure 3-4: Alternative Flue Gas Routes For Riverside 2 (Volume 2)**. These include:

- Route Option A – southwest around Riverside 2 with all of the ducting to be located within the Site;
- Route Option B – southwest around Riverside 2, with a section of the ducting to be located outside of the operational areas of Riverside 2 and within Crossness LNR;
- Route Option C – northeast of Riverside 1 and Riverside 2, with all of the ducting to be located within the Site; and
- Route Option D – northeast of Riverside 1 and Riverside 2, along the same alignment as Option C, then heading further north east and running along the southern bank of the River Thames, with ducting substantially located outside of the operational areas of Riverside 1 and Riverside 2.

3.4.17. The preferred route, Option B: avoids existing buried utilities in Riverside 1 and Riverside 2 operational areas; avoids locating ducting between the two facilities, where it will impact existing operations and maintenance activities; does not require the location of infrastructure in the River Thames; and avoids the public safety risk of crossing or routeing along any PRoW which would be required for Options C and D. Whilst Option B would be located on the periphery of the Crossness LNR (in this location comprising reedbed and bramble scrub, both of moderate condition and providing some water vole habitat), these areas already experience a degree of disturbance due to being adjacent to Riverside 2.

3.4.18. Furthermore, there will be opportunities through detailed design (see the **Outline LaBARDS (Document Reference 7.9)**) to maintain and improve functional habitat within the Crossness LNR. The **Outline LaBARDS (Document Reference 7.9)** also outlines a programme of translocation to move animals (largely water voles) present within the works areas to newly created compensatory habitats, as well as how operational design has been optimised to reduce effects of shading. This route is also the shortest of the four options, and therefore will have the least visual impact on the surrounding area in comparison to Option A, C and D.

3.4.19. The stack for Riverside 1 is located at the south end of Riverside 1, consequently, connection to the Carbon Capture Facility is comparatively simple and the consideration of alternative routes was not required.

THE PROPOSED JETTY

Jetty Types

3.4.20. Three types of jetty structure have been considered:

- solid quay wall;
- solid jetty structure; and
- open pile structure.

3.4.21. A solid quay wall would require the construction of a quay and landside structure on the riverbank, alongside the England Coast Path (FP3/NCN1). This would require reclamation to form land to support the various components for the LCO_2 loading process. Given the intertidal nature of the bank of the River Thames, a large volume of dredging would be required within the intertidal zone to achieve the required berth pocket depth in addition to the encroachment associated with reclamation. It was concluded that this type of jetty is not suitable, and this option was not progressed.

3.4.22. A solid jetty structure positioned further into the River Thames was considered. This type of jetty would avoid intensive construction within the intertidal zone and dredging volumes would be reduced when compared to a solid quay wall. However, this form of construction is not well suited to support the loading of LCO_2. A solid jetty structure means that an expansive deck area would be required, resulting in a large amount of unused space, excess construction materials and an unnecessarily large footprint in the River Thames. This option would also have a potentially large impact on tidal flows and sediment deposition in the area. It was concluded that this type of jetty is not suitable and was not progressed.

3.4.23. An open pile structure consisting of a main loading platform with dolphins, for berthing and mooring of vessels, is typical for liquid bulk handling operation and thus LCO_2. This type of jetty provides the infrastructure required for berthing and loading operations and has the advantage of minimal material and capital requirements compared to other jetty types. In addition, the open piles would have less impact on tidal flow and sedimentation, with reduced footprint in the River Thames. It was concluded that this type of jetty is suitable and as such, was selected as the preferred option by the Applicant.

Proposed Jetty Arrangement

3.4.24. Following the selection of the open pile structure as the preferred jetty type, three different arrangement options were considered, which are shown on **Figure 3-5: Proposed Jetty Arrangement Alternatives (Volume 2)**. Essential structural elements such as a loading platform, breasting and mooring dolphins, catwalks etc. are all required for this type of jetty, and each must conform to relevant design codes and standards in order for vessels to berth safely.

3.4.25. Relevant factors (such as the platform usage, range in dimensions of design vessels, access/navigation, landing) and site conditions (such as riverbed level) were considered to develop the jetty arrangement options:

- Option 1 – aligned with Middleton Jetty and the closest to the southern bank of the River Thames;
- Option 2 – furthest into the channel of the River Thames; and
- Option 3 – halfway between Option 1 and 2 positions.

3.4.26. Option 1 location is characterised by close proximity to the bank of the River Thames, which would require portions of the required vessel berth pocket to be dredged within the intertidal zone. Activity of this nature will result in an adverse effect on the marine habitats and species present in this area. On that basis Option 1 was discarded at an early stage of the Proposed Scheme development.

3.4.27. Option 2 has the lowest dredging volume requirements (approximately 100,000m^3) and the easiest marine access from the main channel. However, stakeholder consultation undertaken as part of the development of the **Appendix 19-1: Preliminary Navigation Risk Assessment (Volume 3)** identified some navigational risks. Operational limitations mean that some commercial vessels have to utilise the southern extent of the authorised channel. The Proposed Jetty location Option 2 is in proximity to the navigational channel and poses a risk to passing vessels.

3.4.28. Option 3 has slightly higher dredge volume requirements compared to Option 2 (approximately 110,000m^3). However, being located closer to the riverbank and so further from the navigational channel, reduces the navigational risk in comparison to Option 2.

3.4.29. Considering the impact of the Proposed Jetty on navigational safety, the Applicant chose to proceed with Option 3 as the preferred option. Consequently, Option 2 has been eliminated from further consideration and the design evolution of the Proposed Scheme.

Jettyless Transfer

3.4.30. An alternative method of transferring the LCO_2 from shore to vessel is to use a jettyless transfer system; a floating, manoeuvrable jetty head which can be moved between the shore and a vessel moored in the River Thames. The floating jetty head is then connected to the shore with floating pipes.

3.4.31. While this option eliminates the need for a fixed jetty structure, and its associated effects, it is not particularly well suited to support the proposed operation and particular site conditions of the Proposed Scheme. Not least, the flexible nature of the jettyless transfer system is not likely to be appropriate for the tidal patterns of the River Thames, with variations in tide levels approximately 7.5m Highest Astronomical Tide to Lowest Astronomical Tide (HAT to LAT).

3.4.32. This option does not eliminate the need for a berthing pocket for vessel access and some form of mooring structure. The floating pipes would have to cross the intertidal zone and England Coast Path (FP3/NCN1). Furthermore, a structure would still be required to prevent the pipes from sitting on the bank of the River Thames in the intertidal zone, and a bridge would be required over England Coast Path (FP3/NCN1).

3.4.33. The jettyless transfer system currently only has a 25 year design life, whereas the Proposed Jetty has a minimum 50 year design life.

3.4.34. The jettyless transfer system was concluded to not be appropriate and has not been considered further in the design evolution of the Proposed Scheme.

Belvedere Power Station Jetty (disused)

3.4.35. The Proposed Jetty will be located downstream of Middleton Jetty on the southern bank of the River Thames, in front of the Belvedere Power Station Jetty (disused). This existing structure has been inactive since the 1980s and accordingly has fallen into a state of disrepair.

3.4.36. The selected location of the Proposed Jetty means the Belvedere Power Station Jetty (disused) will obstruct construction of the Access Trestle. As such, two options are being considered to deal with this:

- Full demolition; or
- Retention of the Belvedere Power Station Jetty (disused) (with potential removal of obstructive non-structural elements and associated modifications to the design of the Access Trestle as discussed in **Chapter 2: Site and Proposed Scheme Description (Volume 1)**).

3.4.37. Appended to the **Jetty Site Alternatives Report (Document 7.6)** is the Belvedere Power Station Jetty (disused) Technical Note, which sets out the different considerations which inform the choice of which option will be taken forward. It is noted that the Belvedere Power Station Jetty (disused) Technical Note references the possibility of the structure, if it was retained, being used for ecological enhancements, or if it was removed, the existing piles being cut to above water level to enhance marine habitat. Overall, the Applicant considers that the impacts for the demolition or retention (with modifications) are balanced, and in light of the conclusions of the topics in this ES, considers that it would be environmentally appropriate for either option to be able to be brought forward, with relevant mitigation measures in place as described within the **Outline CoCP (Document Reference 7.4)**.

3.4.38. The matter of demolition or retention (with modifications) of the Belvedere Power Station Jetty (disused) was considered as part of the statutory consultation process (comments and responses included In **Table X-3** of each technical chapter and in the **Consultation Report (Document Reference 5.1)**). As described within the **Consultation Report (Document Reference 5.1)** there was no clear preference expressed on the demolition or retention (with modifications) of the Belvedere Power Station Jetty (disused).

3.4.39. As a result, the **Draft DCO (Document Reference 3.1)** does not mandate either one of these two options to be brought forward, this ES and the **Appendix 7-1: Biodiversity Net Gain Report (Volume 3)** do not assume delivery of the ecological enhancements of the Belvedere Power Station Jetty (disused) as discussed above. The **Draft DCO (Document Reference 3.1)** includes a requirement for the Applicant to confirm the choice it has made to LBB as part of the detailed design.

3.5. ALTERNATIVE TECHNOLOGIES

SOLVENT TYPES

3.5.1. Three liquid solvent options were considered ahead of selection of the carbon capture technology (with the Carbon Capture Technology Vendor to be selected as part of the detailed design of the Proposed Scheme):

- Option 1 – amine-based solvent: amine-based solvent absorption is the industry standard technology for carbon capture, with technology providers offering proprietary solvent systems and having examples of large-scale facilities successfully operating internationally. Further, amine-based solvents are currently the only solvent type proven to be successful at the necessary scale of operation for the Proposed Scheme. The solvent binds to the CO_2 and the concentration of CO_2 in the gas phase is progressively decreased as it rises through the absorber column. This type of solvent has lower CAPEX and operational expenditures (OPEX) than other technologies, with higher CO_2 removal efficiency. Finally, through usage of amine-based solvents, it is possible to control environmental emissions so that they are within allowable limits.

- Option 2 – Chilled Ammonia Process (CAP): The CAP utilises an aqueous solution of ammonia at chilled conditions to absorb the CO_2 from the flue gas. The basic chemistry and process is much like amine-based solvents, with the captured CO_2 bonding to ammonium carbonate to form ammonium bicarbonate in the absorber column. Unlike amine-based solvents, CAP is more chemically stable thus it does not produce degradation products, leading to less harmful emissions.
- Option 3 – Hot Potassium Carbonate (HPC): The HPC process involves cooling and compressing the flue gas prior to the use of the HPC solvent to capture the CO_2 from the pressurised flue gas. Compared to an amine-based solvent, HPC does not produce degradation products, resulting in less harmful emissions; also potassium carbonate is low-cost and readily available.

3.5.2. Option 2 (CAP) was dismissed as a potential option due to never having been proven at the scale required for the Proposed Scheme, therefore increasing the risk that it fails to meet its performance targets and thereby not achieve the desired reduction in CO_2 emissions. Nor has it been selected for commercial-scale projects currently under development. In comparison to amine-based technologies and given the conclusions of **Chapter 5: Air Quality (Volume 1)**, there was no benefit advantageous enough to justify a first-of-a-kind selection.

3.5.3. Option 1 (amine-based) and Option 3 (HPC) were compared based on utilities consumption, proven track record, layout and environmental considerations such as emissions and waste produced. The primary requirements in terms of utilities are power and steam. The diversion of steam from Riverside 1 and Riverside 2 to the Carbon Capture Facility reduces the power generated at the EfW facilities, as less steam flow would reach the steam turbine. Reducing steam and power demand from the Proposed Scheme maximises the potential for power exported to the grid and/or heat to the district heating network. Option 1 was identified as having a lower utilities consumption in comparison to Option 3. Option 1 (amine-based) produces spent liquid solvent waste, and results in amine degradation products that are emitted within the treated flue gas. The spent solvent waste is contained, stored on site then taken off site for disposal; it is not considered to present an environmental risk unless there is a loss of containment.

3.5.4. Whilst Option 3 (HPC) potentially has fewer emissions and waste streams, it has not been proven at commercial scale in a post-combustion capture application (such as that of the Proposed Scheme), having historically been used within pre-combustion capture in hydrogen and ammonia production facilities.

3.5.5. Overall, Option 1 (amine-based) was selected as the preferred option due to the number of successfully operational plants; multiple, established technology providers; and the benefit of reduced utilities consumption.

3.5.6. Air quality modelling has been undertaken to demonstrate compliance with environmental limits, particularly with regard to the amine degradation products in the flue gas for Option 1 (amine-based) (further details are provided in **Chapter 5: Air**

Quality (Volume 1)). The results of this modelling indicate that the height of the Stack (to be located on top of the Absorber Column, in both the one and two plant solutions)) must be at least 30m above the top of the Absorber Column in order to prevent the wake from the Absorber Column resulting in the downwash of pollutants (Nox, SO_2 and nitrosamines) to ground level. This height has been incorporated within the design parameters as described in **Section 2.3** of **Chapter 2: Site and Proposed Scheme Description (Volume 1)** and secured through the DCO, has a minimum 100m height for the Absorber Stack(s). Further measures are outlined further in **Appendix 5-2: Operation Phase Assessment (Volume 3)** and will be secured via the Environmental Permit for the Proposed Scheme.

STEAM SOURCE

3.5.7. The Carbon Capture Facility requires steam; three source options were considered:

- Option 1 – Steam supply from existing Riverside 1 and Riverside 2:
  - Option 1a – extraction from the steam turbines; and
  - Option 1b – redirecting the high-pressure steam line upstream of the steam turbines.
- Option 2 – Use of an auxiliary steam boiler.

3.5.8. Option 1a, steam extraction from the respective steam turbines of Riverside 1 and Riverside 2 is not possible due to the steam conditions not being aligned to requirements on either mass, pressure, or temperature conditions for the Carbon Capture Facility.

3.5.9. Option 2, an auxiliary steam boiler was discounted because operation of the boiler would result in additional CO_2 emissions as a suitable low carbon fuel is not yet available. It would be possible to capture the CO_2 emissions from the auxiliary boiler. However, this would increase the footprint required for the Carbon Capture Facility and even at high capture rates (95%) there would still be additional emissions of CO_2.

3.5.10. Consequently, Option 1b has been selected as the preferred option with the steam required for the Carbon Capture Facility to be sourced from the high-pressure steam lines upstream of the steam turbines for Riverside 1 and Riverside 2, respectively. The steam conditions (pressure, temperature, flowrate) upstream of the steam turbine exceed the requirements of the Carbon Capture Facility; thus, are suitable for this use. Sourcing steam from Riverside 1 and Riverside 2 will reduce the gross power output from Riverside 1 and Riverside 2 by approximately 40% since less steam will be passing through the steam turbines.

EMISSIONS POINT

3.5.11. Two options were considered for the optimum location for the release of flue gas from the Carbon Capture Facility:

- Option 1 – Release of flue gas from the top of the new Absorber Column(s); and

- Option 2 – Returning the flue gas through ducts back to the Riverside 1 and Riverside 2 exhaust stacks.

3.5.12. Option 1, the release of flue gas from the top of the new absorbers was the preferred option for the following reasons:

- Riverside 1 has three separate flue gas exhaust ducts, known as flues, incorporated within a single stack, and the future Riverside 2 has two separate flues leading to two separate exhaust stacks. The Riverside 1 flue gas exhaust ducts do not join up prior to the stack, and Riverside 2 has two separate exhaust stacks. Thus; five separate tie-ins, one to each flue would be required for the return of treated flue gas from the Carbon Capture Facility to the Riverside 1 and Riverside 2 exhaust stacks, increasing engineering complexity and capital costs.
- The flue gas ducting between the Carbon Capture Facility and Riverside 1 and Riverside 2 is approximately 260m and 540m, respectively. Routing the flue gas back to Riverside 1 and Riverside 2 exhaust stacks would require routeing the flue gas ducting across long distances. This would result in higher capital costs, and a requirement for additional flue gas fans due to the pressure drop across the ducting.
- Option 1 would increase the height of the Proposed Scheme to a maximum of 113m (for the Absorber Column(s) and Stack(s)) as well as introduce up to two new Absorber Column(s) and Stack(s) within the Site and surrounding area. However, these columns would be required irrespective of the selected emissions point and would not be dissimilar in nature to those associated with Riverside 1, Riverside 2 and the disused sludge incinerator at the Crossness Sewage Treatment Works.

3.5.13. Option 2 would require extensive ducting back to Riverside 1 and Riverside 2 exhaust stacks which would result in an increased power requirement for the flue gas fan. This would increase the pressure of the flue gas to overcome the pressure drop through the ducting. The result being an increased engineering complexity and cost in terms of tying back into the separate flues of each Riverside 1 and Riverside 2.

COOLING OPTION

3.5.14. There is no spare capacity within the cooling systems for either Riverside 1 or Riverside 2. Consequently, a new, standalone Cooling System will be required for the Carbon Capture Facility.

3.5.15. The following technology options were considered:

- Option 1 – Air Cooling: Using fin-fan air coolers to cool the process streams;
- Option 2 – Cooling Towers: Combining a cooling tower with a cooling water circuit, pumps and heat exchangers:
  - Option 2a – dry closed circuit: no evaporative heat transfer or contact between the working fluid and air; or

  - Option 2b – wet open circuit: utilises evaporative cooling to transfer heat, requiring top-up of the water loop.
- Option 3 – Wet-Dry (Hybrid) Cooling: wet open circuit cooling tower with a dry section; and
- Option 4 – Once-Through Cooling: abstraction from, and outfall to, the River Thames.

3.5.16. Option 1 was disregarded as not being a viable cooling solution. Its operation is limited by ambient temperature conditions, meaning the Carbon Capture Technology Vendors' cooling requirements could not be met during certain weather conditions. However, the Applicant will still look to explore opportunities to employ local air cooling in certain specific applications on site where this is possible, thereby reducing the cooling load on the cooling water circuit and cooling towers. However, even if this is possible, it would not allow Option 2 to 4 to be completely eliminated.

3.5.17. In Option 2a, operation of the dry closed circuit cooling towers is limited by ambient temperature conditions, unless a chiller package is provided to further cool the cooling water to the required supply temperature. They also require a greater footprint in comparison to wet-dry cooling, due to having a relatively low cooling capacity per unit. However, dry cooling eliminates the requirement for make up water and blowdown, together with any potential concerns over a visible plume. Option 2a is therefore taken forward as a potential approach.

3.5.18. Option 2b, wet open circuit cooling towers, and Option 3, wet-dry cooling towers, were identified as two technically feasible options.

3.5.19. Option 3, wet-dry (hybrid) cooling has multiple advantages over Option 2b, and consequently was identified as a preferred solution:

- it has a lower water consumption due to reduced evaporation losses and blowdown in the system, therefore limiting the required make up water amount;
- it provides plume abatement as the wet air mixes with, and is heated by, the dry air prior to exiting the cooling towers, therefore negating plume visibility; and
- it provides better operational flexibility in varied environmental conditions, with the potential to use the wet section in isolation, if required.

3.5.20. Option 4 was disregarded as not being a viable cooling solution due to not being able to abstract the required high volumes of water. It was also not considered appropriate to return water to the River Thames at an elevated temperature due to potential impacts on marine habitats and species. Increased water temperatures can result in increased habitat viability for INNS, which may cause the degradation or loss of native benthic species.

3.5.21. Therefore, both Option 2a and Option 3 have been taken forward to the detailed design stage as the two most suitable cooling options for the Carbon Capture Facility.

BACK-UP POWER GENERATION

3.5.22. A back-up power source is required to provide emergency power to the carbon capture plant(s) in the event of a loss of power supply. Three options were considered:

- Option 1 – Diesel-fuelled generator set;
- Option 2 – Natural gas-fuelled generator set; and
- Option 3 – Battery storage.

3.5.23. It is considered that Option 2 is not viable, since there is no existing natural gas supply to the Site.

3.5.24. It is considered that Option 3 is not viable, since the storage capacity of batteries, especially where multi-MW discharge rates are required, is limited to several hours without the ability to recharge until the mains power supply is restored. This is not acceptable for an emergency supply.

3.5.25. Therefore Option 1, an emergency diesel generator, has been selected as the preferred option for back-up power generation for the Proposed Scheme.

CO_2 LIQUEFACTION TECHNOLOGY

3.5.26. Two options for the liquefaction of CO_2 were considered:

- Option 1 – Open-cycle Liquefaction: Where CO_2 gas is compressed then cooled, with liquefaction achieved via expansion of the gas to the two-phase region (liquid-vapour state), with expansion undertaken via control valve or turbine; and
- Option 2 – Closed-cycle Liquefaction: Where CO_2 gas is compressed then cooled via an external refrigerant loop; the refrigerant is typically ammonia or propane.

3.5.27. It is considered that Option 2, closed-cycle liquefaction, is more energy efficient than Option 1, open-cycle liquefaction. Closed-cycle liquefaction presents associated hazards; ammonia is toxic, and propane is flammable and explosive. However, the risks are understood, these being typical refrigerants used across many process plants, and subject to standard management techniques are effectively reduced to as low as is reasonably practicable (ALARP). Additionally, ammonia is currently stored at Riverside 1 (and will be at Riverside 2 once operational), thus the existing operations team are familiar with safe handling of ammonia as a substance. Further, as the refrigerant loop is a sealed system there is a reduced risk of release to the environment. The liquefaction plant will be designed and constructed to appropriate standards, maintenance and inspection procedures will be in place and it will be operated by trained personnel.

3.5.28. The selection of a CO_2 liquefaction technology provider and thus the preferred CO_2 liquefaction technology (open-loop or closed-loop) will be undertaken as part of the detailed design of the Proposed Scheme. The technical topic assessments within this ES have been undertaken on the basis of a closed-cycle liquefaction technology as a worst case in terms of hazardous substances, footprint requirements, and design parameters (as described in **Section 2.3** of **Chapter 2: Site and Proposed Scheme Description (Volume 1)**) completed to encapsulate both solutions.

CO_2 DEHYDRATION TECHNOLOGY

3.5.29. Two options for the carbon dioxide dehydration technology were considered:

- Option 1 – Solid desiccant dehydration; and
- Option 2 – Triethylene glycol (TEG).

3.5.30. Option 1, solid desiccant dehydration uses adsorption to retain water on the surface of the desiccant particles, typically within dehydration vessels. Option 2 uses a concentrated TEG solution as the absorbing medium, capturing water particles that are subsequently removed in a regeneration unit to enable TEG reuse.

3.5.31. With Option 2, there is a risk of TEG carryover contributing an added impurity within the captured CO_2. The operator of the LCO_2 Geological Storage site (final end location for the captured CO_2) will have a specification requiring that a range of chemical impurities, including glycol, should be below detectable limits. On this basis, Option 1, solid desiccant dehydration has been selected.

3.5.32. The selection of the solid desiccant to be used (typically silica gel or molecular sieve) will be undertaken as part of the Carbon Capture Technology Vendor selection undertaken as part of the detailed design of the Proposed Scheme.

LCO_2 BUFFER STORAGE WITHIN THE SITE

3.5.33. There is a requirement to have LCO_2 buffer storage on site, prior to its export by ship to permanent storage. The LCO_2 will be stored in insulated, pressurised, Above Ground Storage Tanks. Three options have been considered for the LCO_2 Buffer Storage, two landside and one offshore:

- Option 1 – Multiple tall vertical Above Ground Storage Tanks located landside;
- Option 2 – Multiple short spherical Above Ground Storage Tanks located landside; and
- Option 3 – Floating offshore storage on the River Thames.

3.5.34. Option 1, tall vertical Above Ground Storage Tanks, has the potential to be fabricated offsite and delivered once complete/partially complete, thereby reducing onsite construction labour and associated construction costs and schedule. However, the tall, vertical tanks would have a greater visual impact in comparison to the shorter spherical Above Ground Storage Tanks.

3.5.35. Option 2, spherical Above Ground Storage Tanks, would be approximately half the height of the vertical tanks being considered, thus could have a reduced visual impact. Option 2 requires more labour intensive construction than Option 1, as these tanks need to be constructed in-situ taking more time and exposing the construction staff to a greater onsite risk of construction hazards.

3.5.36. Option 3, floating storage, was considered as an alternative to onshore storage given the space constraints and potential health and safety risks. While this option would take up less landside space, additional maritime works such as construction, dredging, and ongoing maintenance would be required that would increase adverse impacts to the marine environment. Option 3 would be permanently moored in the river and therefore present possible navigation risks. This option is also likely to incur additional operation costs for items such as maintenance of the floating offshore storage unit along with maintenance dredging (regular dredging of the river silt built up around the floating storage unit). This option is least preferred and has not been progressed.

3.5.37. There is currently no clear advantage between Option 1 or Option 2. After further design development since the PEIR[5], it has been confirmed that the any difference in footprint between the two options will be minimal. Factors for assessment at the detailed design stage will include cost, constructability, operational efficiency, and health and safety considerations. To allow a fully informed decision to be made, both options are being taken forward for further consideration in the design evolution of the Proposed Scheme.

3.5.38. The matter of vertical or spherical Above Ground Storage Tanks was considered as part of the statutory consultation process (comments and responses included In **Table X-3** of each technical chapter and in the **Consultation Report (Document Reference 5.1)**). As described within the **Consultation Report (Document Reference 5.1)** there was no clear preference expressed on the vertical or spherical Above Ground Storage Tanks.

3.5.39. Final design of the storage vessels to be used for the Above Ground Storage Tanks will be part of the Carbon Capture Technology Vendor selection within the detailed design of the Proposed Scheme. At this stage, further information will be available to optimise the balance between the relevant design factors. The design parameters (as described in **Section 2.3** of **Chapter 2: Site and Proposed Scheme Description (Volume 1)**) provide the flexibility to select vertical or spherical Above Ground Storage Tanks, with the height limited to 48m (vertical Above Ground Storage Tanks).

LCO_2 EXPORT

3.5.40. The Proposed Scheme is not within an area with an existing or proposed LCO_2 network; thus, export of LCO_2 via an existing or proposed network is not a feasible option.

3.5.41. This leaves three alternative options for export, via:

- Option 1 – shipping;
- Option 2 – rail; or
- Option 3 – road.

3.5.42. Option 1 shipping vessels can hold a vast amount of LCO_2 and is a practical way of moving large amounts of liquid gas. The technology is proven and used in other industries safely and cost effectively. Shipping of large quantities of liquified gas is also more economically viable than other options. However, shipping can be affected by adverse weather conditions and may be subject to tidal restrictions. Another downside is the requirement for a new loading jetty to be constructed to allow berthing of the vessel.

3.5.43. Option 2 rail tankers can hold a larger capacity of LCO_2 in comparison to road tankers but would still be unsuitable for the large volumes to be captured by the Proposed Scheme, the number of rail tankers that would be required per day/per week would not be economically viable. The Site Boundary does not contain a rail link and there is not deemed to be ample or suitable land upon which to build a loading depot on or adjacent to the Site. Further, the nearest railway line is located approximately 600m south of the Site Boundary (Belvedere Railway Station), with no feasible route for a rail spur to the Carbon Capture Facility. On this basis, Option 2 was not progressed.

3.5.44. A typical LCO_2 road tanker, Option 3, has capacity of between 20 and 30 tonnes; and would therefore be inappropriate for the large volume of CO_2 to be captured by the Proposed Scheme. In addition, road export would cause extensive additional traffic movements in the local area and would need to be transported across a large distance leading to additional emissions with consequent detrimental effects. Consequently, Option 3 has been disregarded.

3.5.45. The Proposed Scheme has been progressed using Option 1, shipping export, necessitating inclusion of the Proposed Jetty. Information on LCO_2 geological storage is presented in **Section 2.2** of **Chapter 2: Site and Proposed Scheme Description (Volume 1)**.

3.6. ALTERNATIVE WATER SUPPLY AND DISCHARGE

WATER SUPPLY

3.6.1. The Carbon Capture Facility requires water for the following elements:

- The wet-dry cooling tower system (if selected); the quality of the feed water dictates the water demand of the cooling system; and
- The wash water system of the upper section of the CO_2 Absorber Column(s), requiring a demineralised water feed. This demand is minimal compared to the demand from the cooling system.

3.6.2. The local water supply network capacity is unlikely to be able to meet the demand of a wet-dry cooling system if used untreated due to the high mineral content. Dissolved minerals would need to be removed prior to use to prevent fouling and build up within equipment using it. Four approaches have therefore been considered:

- Option 1 – Potable water supply;

- Option 2 – Internal recycling of the process wastewater;
- Option 3 – Effluent supply from the nearby Crossness Sewage Treatment Works;
- Option 4 – A new abstraction from River Thames; and
- Option 5 – New abstractions from boreholes.

3.6.3. In considering each of the options, the Applicant has focussed on seeking to minimise water usage from the cooling tower system by treating it at the Water Treatment Plan, by increasing the number of concentration cycles to reduce blowdown water volume and consequently the make up water volume required.

3.6.4. Option 1 relies on the availability of a potable water supply from Thames Water as the existing water supply for Riverside 1 and Riverside 2 is deemed not sufficient. Thames Water was approached to carry out a capacity check of the local water supply and has confirmed that there is not enough capacity to supply the full peak water flow rates estimated to be required for the Carbon Capture Facility. Option 1 is therefore being progressed as only one part of the water supply solution, within the capacity available from Thames Water, supplemented with further supplies discussed below. In addition, in order to reduce the impact on Thames Water's water network and provide some resilience a water storage tank is to be located on the Gannon land parcel.

3.6.5. The internal recycling of process wastewater (Option 2) is therefore being progressed as part of the water supply solution. This includes maximising recycling of the flue gas condensate and blowdown water from the cooling tower.

3.6.6. The use of effluent from neighbouring Crossness Sewage Treatment Works (Option 3) has the advantage of providing a resilient and reliable water supply but would require a more complex and higher level of treatment in comparison to Option 1, in order to mitigate risks to public health and the process. The volume of wastewater generated would be similar to that expected in the hybrid approach described above, albeit with a poorer water quality. The use of this source would also require the installation of a pipeline between Crossness Sewage Treatment Works and the Carbon Capture Facility. This pipeline would need to either be installed via open trench excavation beneath the Thames Water Access with potential impact on Crossness LNR during construction and operation. Option 3 is therefore not being progressed as part of the water supply solution.

3.6.7. The option of a new abstraction on the River Thames (Option 4) was discarded due to water quality challenges (high total suspended solids and conductivity variation associated with tidal brackish river water), leading to abstraction of high volumes of water from the River Thames. The use of this source would require either the construction of a large buffer storage tank, to reduce the impact of the daily water quality variation observed, or treatment to accommodate the observed water quality variability, which makes the operability of the treatment complex. This would also lead to a high volume of wastewater needing to be discharged (as covered within the next section).

3.6.8. New abstractions from existing boreholes (Option 5) were discarded due to water quality challenges (brackish groundwater). The use of this source would require extensive treatment to accommodate the observed water quality. This would also lead to a high volume of wastewater needing to be discharged (as covered within the next section).

3.6.9. The water supply for the Proposed Scheme is therefore anticipated to be delivered by a hybrid approach consisting of potable water supply reducing demand by treating potable water (Option 1), supplemented by maximising internal recycling of process wastewater (Option 2). This solution provides the best economical approach (CAPEX and OPEX) and smallest plant footprint. It also minimises wastewater generation from the Carbon Capture Facility.

WASTEWATER DISCHARGE

3.6.10. The wastewater streams produced as part of the Carbon Capture Facility cannot be returned to Riverside 1 or the future Riverside 2 for disposal. The wastewater streams are the flue gas condensate from the Direct Contact Cooler; the effluent from the Absorber Column(s); the blowdown water from the Cooling Water System; and wastewater from the Water Treatment Plant. These options were considered:

- Route 1 – Discharge to the local sewer (with or without treatment, depending on trade effluent consents). This assumes that the local sewer has sufficient capacity, and a new connection can be obtained from Thames Water.
- Route 2 – Discharge into the River Thames (likely to require pre-treatment to meet discharge permit requirements) via:
  - Route 2A – a new outfall off the Proposed Jetty;
  - Route 2B – a decommissioned Belvedere Power Station outfall[b]; and
  - Route 2C – an outfall within the Crossness Sewage Treatment Works.
- Route 3 – Discharge to Great Breach Dike North Culvert (MR12)). Water from this ditch would be pumped into the River Thames via the Great Breach Pumping Station.
- Route 4 – wastewater would be treated as part of a Zero Liquid Discharge solution (This option consists of concentrating contaminants to a solid waste, allowing releasing a source of water supply) within the Carbon Capture Facility.

3.6.11. Route 2A was discarded in order to avoid discharging into the River Thames, via the Proposed Jetty.

3.6.12. Route 2B was not considered further as it is understood that the Belvedere Power Station outfall has been decommissioned. Conveyance of the wastewater to this

[b] The decommissioned power station outfall is located adjacent (north) of the Lidl Warehouse / Belvedere Regional Distribution Centre on the southern bank of the River Thames.

outfall location would involve high CAPEX to restore the outfall, when compared to the other routes.

3.6.13. Route 2C was also discarded due to high CAPEX associated with length of the pipeline and to avoid routing a pipeline through the Crossness LNR.

3.6.14. Route 3 was discarded because it is highly likely to impact the operation of the Great Breach Pumping Station and the ditch was considered unlikely to have sufficient capacity to accommodate the wastewater effluent. Consultation with the Environment Agency highlighted that the Great Breach Pumping Station does not drain under gravity due to silt affecting its operation, confirming the justification for discarding Route 3.

3.6.15. Route 1 (discharge to the local sewer) is the preferred option as it involves the least engineering complexity and has the lowest CAPEX. This assumes that the local sewer has sufficient capacity, and a new connection can be obtained from Thames Water. Engagement with Thames Water has been undertaken and is ongoing as part of the design development.

3.6.16. Route 4, the Zero Liquid Discharge solution would both utilise process wastewater as make up water in the Riverside Campus and concentrate waste within the wastewater into a solid for disposal offsite. This has a high OPEX in comparison to the routes detailed above. Route 4 will not be progressed unless further study of Route 1 shows that Route 4 is required or could economically compete.

3.6.17. Technical assessments have been undertaken based on Route 1, discharge to the local Thames Water sewer as this is considered representative of the worst case scenario.

SURFACE WATER DRAINAGE

3.6.18. The Proposed Scheme will require a new surface water drainage system within the Site. The drainage system will use the existing ditches within the Site as a point of connection, with attenuation tanks, filter drains and ponds used to control the discharge quality and rate to the ditches. The proposed drainage would include a system of containment to mitigate the potential risk of pollution to the surrounding site area and/or environment. This would include bunded areas around chemicals for the Direct Contact Cooler and the Absorber Column(s), solvent storage/make up system, LCO_2 Storage, diesel generator and storage, compressor lube oil and refrigerant area. Additionally, a downstream defender will be installed at all outfall locations. These, in combination with the filter drains and any open Sustainable Drainage Systems (SuDS) such as attenuation ponds will provide an adequate level of pollution control from the Proposed Scheme.

3.6.19. The surface water drainage strategy for the Proposed Scheme comprises of the following:

- discharge of the surface water flows from the Site will be restricted to the Q_{bar} greenfield runoff rate and discharge into local surface water network via a number of new outfalls;
- flows will be attenuated for the 1 in 100 year + 40% climate change allowance rainfall event; and
- the surface water flows will be attenuated in the attenuation ponds; and underground storage placed across the Carbon Capture Facility surface water will be discharged into the local ditch network within the Crossness LNR and Norman Road Field.

3.6.20. This approach to surface water drainage will support the improvement in soil moisture in Norman Road Field, to support the improvement in the quality of the existing Flood Plain Grazing Marsh to deliver the required habitat mitigation resulting from the physical loss of Flood Plain Grazing Marsh as a result of the facility location.

3.6.21. The proposed surface water drainage strategy and subsequent drainage design will ensure that there is no increase in flood risk and pollution elsewhere.

3.6.22. An **Outline Drainage Strategy (Document Reference 7.2)** has been developed and included within this application. Consultation with the Environment Agency and LLFA in respect to this **Outline Drainage Strategy (Document Reference 7.2)** is ongoing and will aid in choosing the most sustainable option for the Proposed Scheme as part of developing the full Drainage Strategy for approval post-consent.

3.7. ALTERNATIVE TRANSPORT ROUTES

3.7.1. The Proposed Scheme will require a small number of vehicle and vessels movements, as detailed in **Chapter 2: Site and Proposed Scheme Description (Volume 1)**. Vehicle movements are those associated with the operation and maintenance of the Proposed Scheme, and the transport of the LCO_2 described in **Section 3.5.**

CONSTRUCTION PHASE

3.7.2. Due to the expected location of staff, diesel, chemicals and emergency services landside transport is the only viable method of transport. As such, transport of construction plant and materials will only be road-based. Further information on the transport routes to the Site is presented in **Chapter 18: Landside Transport (Volume 1)**.

3.7.3. It is assumed that all Abnormal Indivisible Loads (AIL) would also be delivered by road; however, the number of these movements are likely to be minimal and will be agreed on a case-by-case basis with the relevant local highway authorities so have not been considered further.

OPERATION PHASE

3.7.4. It is not feasible to make use of the Middleton Jetty for operational transport as this would interfere with existing operations at the Site. It is also not possible to bring the construction of the Proposed Jetty forward nor practicable because waiting for the Proposed Jetty to be available would delay the programme of construction by 18 months and result in CO_2 emissions continuing for an additional period of time before the Carbon Capture Facility becomes available. The Proposed Jetty would not have the required capacity to accommodate the construction of the Proposed Scheme. In addition, its lightweight structure is less suited for bringing in construction materials. Utilising landside transport for the construction of the Proposed Scheme will not result in significant effects on the local road network, as set out in **Chapter 18: Landside Transport (Volume 1)**.

3.7.5. LCO_2 temporarily stored onsite will need to be transferred to an offshore geological storage location for permanent storage. It is considered safer for the LCO_2 to be transported via marine vessels as the proximity to the general public is reduced compared to road transport. See **Section 3.5** for further detail on LCO_2 export.

3.8. ALTERNATIVE CONSTRUCTION COMPOUND AREAS

3.8.1. No viable alternatives to the Temporary Construction Compounds have been identified either within the Site, or at an offsite location. There is a lack of appropriate available land in the vicinity of the Site. In addition, the Temporary Construction Compounds identified are appropriate for this use and their location within the Site will avoid additional and unnecessary traffic movements.

3.8.2. As detailed in **Chapter 2: Site and Proposed Scheme Description (Volume 1)**, once construction is complete, the core Temporary Construction Compound will be utilised as part of the Carbon Capture Facility, and so the Applicant is proposing an efficient use of land. The majority of the western Temporary Construction Compound will be reinstated to its prior use, except a small strip along the western boundary of Riverside 2 which will be utilised for the Flue Gas Supply Ductwork. The Proposed Jetty Temporary Construction Compound will be reinstated to its prior use, but will be available for maintenance access during the operation phase.

APPROACHES TO MITIGATION AND ENHANCEMENT PROPOSALS

3.8.3. The development of the mitigation and enhancement proposals is informed by an understanding of the direct and indirect impacts of the Proposed Scheme including effects on terrestrial and marine habitats and species, visual receptors and townscape character. The mitigation measures proposed within the design of the Proposed Scheme have been structured to follow the mitigation hierarchy (avoid, reduce, remedy, compensate) as follows:

- avoidance of impacts has been considered as part of the Carbon Capture Facility development zone alternatives (described in the **Terrestrial Sites Alternatives**

Report (Document Reference 7.5)) and embedded design proposals described in the **Outline LaBARDS (Document Reference 7.9)**;

- reduction of impacts has been considered through PRoW diversions, for example, ensuring that there will always be a ‘hard’ route to facilitate a diversion for the England Coast Path (FP3/NCN1) thus reducing the effects on users of these footpaths;
- remedying is achieved via the planting buffer proposed along the western Site Boundary aimed at visual amenity, in particular to users of FP2 and a number of habitat creation proposals in the Mitigation and Enhancement Area and the protection measures set out in the **Outline CoCP (Document Reference 7.4)**; and
- compensation is accounted for through enhancement proposals in the Mitigation and Enhancement Area. The Applicant will separately, also seek to achieve a 10% net gain for biodiversity in accordance with the BNG metric. Further information on this is provided in **Appendix 7-1: Biodiversity Net Gain Report (Volume 3)**.

3.8.4. The mitigation and enhancement proposals aim to provide betterment beyond mitigation and BNG delivery and have been developed in response to opportunities identified during the design evolution and consultation. Detailed design will finalise these measures and be approved as part of the full LaBARDS(s).

3.9. REFERENCES

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