Cory Environmental Holdings Limited

CORY DECARBONISATION PROJECT

Environmental Permit Application: Technical Supporting Document

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FOREWORD - NON-TECHNICAL SUMMARY

This document presents the technical supporting information for a Bespoke Environmental Permit Application under the Environmental Permitting (England and Wales) Regulations 2016 (as amended) (‘the EP Regulations’), submitted on behalf of Cory Environmental Holdings Limited (‘Cory’) to secure an Environmental Permit for the Cory Decarbonisation Project (CDP), comprising a two-train Carbon Capture Facility (CCF). The CCF’s location and site boundary are provided at Appendix A of this report.

A new Bespoke Environmental Permit is required to operate and regulate a two-train CCF, to serve and operate in conjunction with Cory’s two energy from waste facilities, known as Riverside Resource Recovery Facility (Riverside 1) and Riverside Energy Park (Riverside 2). These facilities are regulated under two separate existing Bespoke Environmental Permits, EPR/BK0825UI and EPR/GP3535QS respectively.

The CCF will be regulated by a separate Bespoke Environmental Permit as part of a multi-operator installation with Riverside 1 and Riverside 2. This is because Riverside 1 and Riverside 2 will be served by the same directly associated activity (the CCF). This was the advice provided by the Environment Agency (EA) as part of the enhanced pre-application discussions (EPR/JP3020LL/P001).

The CCF will be located at Riverside Campus (comprising Riverside 1 and 2), Norman Road North, Belvedere, DA17 6JY.

The CCF will comprise of post-combustion carbon capture technology that will receive the exhaust gases from both Riverside 1 (operational since 2011) and Riverside 2 (due to be operational by 2026), capturing the carbon dioxide (CO_2) from the exhaust gas for transmission and offshore storage in geological storage fields in the North Sea. This Bespoke Environmental Permit application assesses and considers the capture, treatment, and storage of CO_2 up to the point of leaving the installation boundary, where the CO_2 is then loaded onto transport vessels via the Proposed Jetty for onward transport and geological storage off site.

The CO_2 will be captured in the CCF before being processed through compression, dehydration and liquefaction, prior to being stored onsite ready for export via a Proposed Jetty. The CO_2 will be temporarily stored onsite in a liquid form (LCO_2) and then loaded from the Proposed Jetty onto and transported via a shipping vessel for permanent sequestration underground. The Proposed Jetty is at the northernmost area of the site, predominantly located within the River Thames and is not within the regulated installation boundary. The CCF is currently in the process of Pre-Front End Engineering Design (Pre-FEED), and is set to include the following elements:

- Carbon Capture Plant(s) comprising:
  - Flue Gas Pre-Treatment;
  - Absorber Column(s) and Stack(s);

- Back Pressure Turbine and Generator;
    - Solvent Regeneration System;
    - Rich Solvent/Lean Solvent Heat Exchanger; and
    - Solvent Storage.
- CO_2 Processing Plant, each comprising:
    - Compression;
    - Dehydration;
    - Liquefaction; and
    - CO_2 Vents.
- LCO_2 Buffer Storage Area, comprising:
    - Temporary Storage; and
    - Boil off Gas Processing.
- LCO_2 Pipelines
- Flue Gas Supply Ductwork
- Supporting plant, comprising:
    - Cooling System;
    - Chemical Storage and Distribution Handling Facilities; and
    - Effluent Treatment Plant (ETP).
- Amenities and other buildings, comprising:
    - Gatehouse;
    - Control Room;
    - Welfare Facilities; and
    - Stores and Workshop.

The CCF will use an amine-based solvent to strip CO_2 from the treated Energy from Waste (EfW) flue gas streams within packed Absorber Column(s). The CO_2-depleted flue gas will then pass through washing and mist elimination, as required, in the Absorber Column(s) prior to its release to atmosphere via two dedicated stack(s). These stack(s) will comprise two Emission Points (A1 and A2).

The CO_2 will be removed from the CO_2-rich solvent in a CO_2 stripper (or regeneration column) by heat, using the steam provided by the adjacent Riverside 1 and Riverside 2 EfW sites, which is let down to the required pressure through dedicated back-pressure turbines. This releases the CO_2 for further processing and onsite LCO_2 Buffer Storage and enables the lean amine-solvent to be recycled back into the absorption process for reuse.

The CO_2 gas will undergo compression, dehydration and liquefaction ahead of on-site LCO_2 Buffer Storage before being exported off-site by a third-party for transportation by ship for future underground geological storage.

Over time, the solvent can accumulate impurities and heat stable salts, as a result of contaminants in the flue gas and continued thermal cycling of the solvent. To prevent the build-up of these compounds, a slip stream of the solvent is taken from the solvent recirculation system and treated in the thermal reclaimer using sodium hydroxide and medium pressure steam. The waste produced by the reclamation process is considered hazardous and will be taken off-site for disposal.

The capture of CO_2 using amine-based solvents is a proven technology used for many years in oil refineries and gas processing plants. More recently, it has been employed at a number of power stations worldwide, although its use at scale in the UK for carbon capture on EfW flue gas is still in the early phase of development and deployment.

The design and operation of the CCF against BAT (where applicable) and otherwise the EA Guidance: *Post-combustion carbon dioxide capture: emerging techniques*[1] has been assessed and reviewed in full as part of Section 11 of this document.

The principal emissions from the CCF will consist of residual pollutants originating from the Riverside 1 and Riverside 2 plants. These include nitrogen oxides (NO_x), sulphur dioxide (SO_2), ammonia (NH_3), hydrogen chloride (HCl), total organic carbon (TOC), heavy metals, dioxins and furans, carbon monoxide (CO), particulates, and some residual CO_2. The design of the CCF will optimise CO_2 capture, achieving approximately 95% capture in normal operation. Additionally, other trace pollutants may be present in the flue gas, including trace levels of amine from the solvent and amine degradation products from the carbon capture process. These emissions will be minimised through optimisation of the capture process before the final release of the exhaust gas.

Emissions from the main CCF stack(s) will meet the associated emission levels for incineration plant in accordance with Chapter IV and Annex VI of the Industrial Emissions Direction (IED). The stack height and emission temperature required to minimise impacts on air quality receptors has been determined via a detailed air quality impact assessment which is available in Appendix I, the Stack(s)'s height is within the confines of the minimum and maximum parameters set out in the Development Consent Order (DCO). The assessment includes dispersion modelling of maximum emission parameters and prediction of maximum process contributions to determine the worst-case predicted environmental concentrations that are compared with air quality standards.

The assessment also includes consideration of the potential impacts associated with breakdown products of the amine-based solvent, from both within the process (as 'direct' emissions) and as a result of chemical interactions within the atmosphere (as 'indirect' emissions) which is beyond the normal scope of the EA's risk assessment methodology.

In addition to the two main CCF's emission points at the stack(s), there will be CO_2 vents (Emission Points A4 and A5), which will only operate intermittently in abnormal operation. An assessment of CO_2 venting is available in Appendix J, with further consideration of CO_2 venting discussed in Section 12.2.

The CCF is being designed as a "Zero Liquid Discharge" (ZLD) facility. Effluent generated by the CCF process will be treated at the CCF's ETP and the reclaimed water recycled back into process.

[1] Post-combustion carbon dioxide capture: emerging techniques - GOV.UK

Solid wastes generated by the CCF, such as waste from the thermal reclaimer and waste from the ETP, will be collected and stored onsite prior to disposal off site via a licensed 3rd party waste contractor in line with regulatory requirements and Installation procedures.

Cory operates an Integrated Management System (IMS) that is accredited and certified to multiple ISO standards. The new CCF will be managed under this management system, and operations will be reviewed and systems updated to include operating procedures to manage the various aspects of the operation of the CCF, including but not limited to emissions monitoring, accident management, waste minimisation and management, and infrastructure maintenance. Any required management plans developed as part of this permit application will be incorporated into the future site's Environmental Management System (EMS).

This application is submitted as an application for an Environmental Permit, as the CCF will be regulated as a Schedule 1 Part A(1) activity in its "own right", as per EA Guidance titled *Environmental Permitting Regulations (2016)*[2].

In addition, as the CCF, which is the subject of this application, will be technically connected to both Riverside 1 and Riverside 2, two separate variation applications are being submitted on behalf of Cory to vary the Environmental Permits EPR/BK0825UI and EPR/GP3535QS respectively.

The following aspects have been considered as part of this Bespoke Environmental Permit Application:

Management Arrangements & Summary: Cory operates Riverside 1, and will operate Riverside 2, in accordance with an Integrated Management System (IMS) which meets the requirements of ISO 14001 (Environmental Management System), ISO 9001 (Quality Management System), ISO 45001 (Health and Safety Management) and ISO 27001 (Information Security Management Systems) management system standards. Cory also applies a Competence Management Systems, developed by Energy and Utility Skills, covering the provision of waste management services, including treatment and recovery, in accordance with our environmental permits.

Preliminary Environmental Risk Assessment: A preliminary Environmental Risk Assessment has been prepared for the proposed CCF, appended as Appendix B.

Raw Materials Inventory: The CCF will require materials and reagents which are not currently stored or used at Riverside 1 or Riverside 2. Therefore, the implementation of the CCF will require additional raw materials to be stored and utilised within the CCF's Installation boundary. An indicative raw materials inventory is included in Section 4, and storage locations are shown in the Indicative Site Layout, included in Appendix A.

To establish a net zero process water requirement, the ETP will extract water from the Direct Contact Cooler (DCC) effluent and the cooling blowdown for reuse to meet process requirements and as cooling water makeup.

Potable water will be required for welfare facilities and emergency showers. This is expected to be obtained via Riverside 1 and Riverside 2 water connections and may be

[2] The Environmental Permitting (England and Wales) Regulations 2016

subject to buffer storage in two above ground approximately 80m³ storage tanks on site. These buffer storage tanks will not be used in normal operation.

Process Description & Flow Diagram

A complete process description and high-level process flow diagram is set out in Section 3.2.

Air Quality and Noise

An Air Quality Risk Assessment and Noise Impact Assessment, along with detailed modelling, have been undertaken as part of Stage 3 of the staged application process.

The overall conclusions of the air dispersion modelling are that no significant effects are likely on either human health or local environmental habitats.

The Noise Impact Assessment results showed that without any additional mitigation measures, the operational noise rating levels would exceed the operational noise limits by up to +7 dB. This outcome is largely due to the backup Air Source Heat Pump (ASHP) fans associated with the heat transfer station that forms part of the CCF. The ASHP will have an acoustic barrier surrounding the ASHP fans to provide appropriate acoustic mitigation. Further, the ASHP are a back-up and would only be used on a contingency basis on those occasions when there is no thermal capacity available from R1 and R 2.

The details of the final mitigation measures will be determined, as part of the detailed design. As part of the DCO, a Noise Mitigation Plan demonstrating compliance with the operational noise limits set out in the DCO will be prepared and submitted to and approved by the relevant planning authority in writing prior to the operation of the CCF. Relevant to this application, a preliminary Noise and Vibration Management Plan has been prepared for the submission. This identifies the measures that can be employed to manage and mitigate noise sources. This is included within Appendix H.

Considering the results of the initial impact estimation for the CCF, as well as the CCF in combination with the existing Riverside 1 facility and the Riverside 2 facility combined, and taking account of contextual evaluation and the additional mitigation measures to be implemented, it is concluded that the operation of the CCF will not lead to a significant noise adverse impact or noise ‘pollution’ at receptors.

Climate Change

There are not anticipated to be any significant effects during the operation of the CCF from extreme weather events and long-term climate change, as the CCF will be designed to allow for long term climate change. The design will be in accordance with UK Building Regulations and BS EN codes. These account for increases in wind event frequencies and magnitudes due to climate change. The design has also incorporated flood level data which includes allowances for climate change, and a lower dependence on water.

The outcome of the greenhouse gas assessment for the operational phase is that there will be a substantial decrease in greenhouse gas emissions at the Riverside Campus, having a beneficial effect. The selection of BAT for equipment and technology specifications will optimise carbon capture rates, aiding the carbon capture scheme to capture as much CO_2

as practicable and maintain, as a minimum, the expected 95 % carbon capture rate during normal operation.

Flood Risk

The EA's Flood Map for Planning shows that the area of the CCF is located within Flood Zone 3. The EA has confirmed that the CCF and its surroundings are protected up to the present day 1 in 1,000-year event by the flood defences located along the banks of the River Thames. The flood defences will also be maintained by riparian landowners to keep pace with Climate Change and therefore maintain the standard of protection as flood levels rise in the River Thames. There is, however, residual risk associated with a breach of the River Thames Flood Defences. A breach of the existing flood defences is considered unlikely to happen as they are regularly inspected by the EA. The risk of flooding is further considered in the Environmental Risk Assessment included within Appendix B. In addition, the detailed design of the CCF will consider additional measures to ensure that the risk from flooding to the CCF has been reduced as far as reasonably practicable.

Preliminary Site Layout Plan

A preliminary site layout plan for the Cory Decarbonisation Project is included in Appendix A.

Indicative Drainage Layout

This document demonstrates that foul and surface water drainage have both been considered at the early stage of design and will comply with national and local policies relevant to drainage and flood risk. An indicative drainage layout is included in Appendix C and shows the existing drainage catchments for the CCF, which mainly drain towards the west and east.

The proposed drainage strategy is to split the CCF area into three main drainage catchments, namely North, Central and South, as indicated in Appendix C. Each of these main catchments consists of sub catchments which will drain the surface water via new individual outfalls, mainly into the ditch network to the west. Any internal roads with gradients towards Norman Road will drain east via new separate outfalls, one into Norman Road Stream and others into the existing highway drain, both running along Norman Road. There will be 12 outfalls, labelled N1-N12, as shown in the Indicative Drainage Layout in Appendix C.

An Outline Drainage Strategy is summarised in detail at Section 7.2.2 and is consistent with the Outline Drainage Strategy submitted as part of the DCO, for which consultation with the EA has been undertaken.

Wastewater generated by the welfare facilities will be discharged into the local sewer network.

Relevant Hazardous Substances (RHS) Inventory

A range of chemical substances and hazardous substances required for the CCF, and an indicative RHS Inventory, are discussed and identified within Section 4.5 of this Technical Supporting Document.

Monitoring Arrangements & Proposed Emission Point Location Plan

A commissioning plan will be agreed with the EA under the Environmental Permit, which will specify monitoring and control procedures to be used, and set out a commissioning schedule.

Flue gas being released from the two new stack(s) will be continuously monitored via a Continuous Emissions Monitoring System (CEMS) pursuant to the Environmental Permit. Furthermore, there will be periodic sampling procedures and methodologies adopted for some pollutants.

The risk from potential noise impacts has been considered as part of the ERA and in line with the outcomes from the Noise Impact Assessment, is considered not significant. The acoustics assessment and detailed modelling has been undertaken; the Noise Impact Assessment is available in Appendix G and the outline Noise and Vibration Management Plan is available in Appendix H.

A network of observation boreholes for the purpose of groundwater level monitoring pre- and post-construction will be installed to assess groundwater level response and inform any mitigation measures required as part of the site condition report and management arrangements.

Operational waste tonnages will be monitored on a monthly basis using data provided through established management practices and data supplied by appropriate and appointed Waste Contractor(s). This data will demonstrate compliance with permitted waste codes and tonnages of material. This will be used to create a baseline of waste arisings for year one, and to then support the identification and development of additional efforts that move wastes up the waste hierarchy at subsequent reviews. Waste arisings will be recorded and analysed on a monthly basis or at a frequency agreed with the Waste Contractor(s) against set key performance indicators (KPIs) as part of the IMS. The Operational Environmental Management Plan (OEMP), part of the EMS, will outline a mechanism to collate all waste arisings data across all operations of the CCF and will demonstrate the fate of operational wastes, e.g. reuse and recycling routes, waste treatment routes or disposal routes.

The CCF will additionally monitor the effects of extreme weather-related incidents (for example, road and surface deformations, flooding, storm damage and debris, snow and ice etc.) and identify measures required. Inspections by an appropriately qualified professional will be carried out following an intense rainfall event, heatwave, high wind or storm event to monitor any damage and implement appropriate mitigation as necessary.

1 INTRODUCTION

Cory Environmental Holdings Limited (hereinafter "Cory") is in the process of designing a CCF consisting of a two-train carbon capture plant, to serve and operate in conjunction with their two energy from waste facilities, known as Riverside Resource Recovery Plant (Riverside 1) and Riverside Energy Park (Riverside 2). Both of these facilities are regulated under existing Environmental Permits, Riverside 1 reference EPR/BK0825UI and Riverside 2 reference EPR/GP3535QS ("the environmental permits"). Riverside 1 has been operational since 2011. Riverside 2 is under construction and due to become operational in 2026. These permits are the subject of separate variation applications, for the inclusion and reference to the proposed CCF.

The purpose of this application is to seek the granting and issue of a new bespoke environmental permit (enhanced pre-application reference: EPR/JP3020LL/P002) for the operation of the CCF. Riverside 1 and Riverside 2 will be technically connected and serving the CCF, therefore it is deemed to meet the definition of a multi-operator installation. However, Riverside 1, Riverside 2 and the CCF will continue to be operated under separate Environmental Permits.

This is a staged application, split into three submissions. This is the third and final stage of submission and includes:

- Application Forms Part A, B2, B3 and F1
- Technical Supporting Document including:
    - Non-technical summary
    - Management Arrangements and Summary
    - Preliminary Environmental Risk Assessment
    - Raw Materials Inventory
    - Process Flow Diagram and Description
    - Monitoring Arrangements
    - Preliminary Site Layout Plan
    - Preliminary Site Location Plan
    - Indicative Drainage Layout
    - RHS Inventory
    - Proposed Emission Point Plan
    - Surface Water Management and Drainage
    - Waste Generation and Management
    - Operating Techniques and Abnormal Operations
    - Preliminary Accident Prevention and Management Plan
    - Site Condition Report
    - CO_2 Venting Assessment
    - Air Emissions Risk Assessment

- Noise Impact Assessment
- Noise Management Plan

In summary, Riverside 1 and Riverside 2 will transfer their respective exhaust gases to the CCF, the gases will be subject to treatment and abatement in the EfW before transfer to the CCF and will be monitored to demonstrate compliance with the respective site's Emission Limit Values (ELVs) set within the permits. Upon receipt of the exhaust gases the, CCF will then condition and remove 95% of the CO_2 from the exhaust gases before venting the remaining gases to atmosphere from the proposed stack(s) that will serve the CCF. Flue-gas conditioning is achieved through the DCC. This cools and condenses water out of the saturated flue gas and treats residual components (sulphuric acid and nitric acids) within the flue gas prior to it reaching the Absorber Column(s) and Stack(s).

As stated above, the exhaust gases from Riverside 1 and Riverside 2 will remain subject to the Waste Incineration ELVs prior to connection to the CCF, with additional ELVs to be set for the CCF stack(s) (A1 and A2) which will be influenced by the choice and selection of solvent used in the CCF.

The CCF will comprise the installation of post combustion carbon capture technology to capture CO_2 from both Riverside 1 and Riverside 2. It will be designed to capture a minimum of 95 % of CO_2 emissions from both Riverside 1 and Riverside 2, during normal operating conditions, which is equivalent to approximately 1.3 Mt CO_2 per year. Furthermore, due to the feedstock for Riverside 1 and Riverside 2 comprising approximately 50% biogenic content, the CCF would result in net-negative CO_2 emissions of approximately 0.6 Mt per year.

Cory has received advice from the EA through enhanced pre-application advice, that the Environmental Permit for the CCF will be determined as a standalone bespoke permit, as part of a multi-operation installation following pre-application discussion (EPR/JP3020LL/P001).

A pre-application meeting was held on 20th January 2025 with the EA, and specifically their carbon capture leads, prior to submission of the application with enhanced pre-application advice provided and referenced as EPR/JP3020LL/P001.

1.1 REGULATORY CONTEXT

As stated in Schedule 1 of the Environmental Permitting Regulations 2016[3], the installation and operation of the CCF is covered as a Section 6.10 A(1)(a) activity - Capture of carbon dioxide streams from an installation for the purposes of geological storage pursuant to Chapter 3 of Part 1 of the Energy Act 2008 and other EU-derived domestic legislation which transposed Directive 2009/31/EC of the European Parliament and of the Council on the geological storage of carbon dioxide in relation to England and Wales.

In the absence of specific BAT for carbon capture, the following EA guidance has been considered in the preparation of this application: *Post-combustion carbon dioxide capture: emerging techniques issued July 2021 (updated 27 March 2024)*[4] to consider the Best Available Techniques for preventing or minimising the environmental impacts of post-combustion carbon dioxide capture. Operators are not legally obliged to follow the guidance, but it has been agreed by UK Regulators

[3] The Environmental Permitting (England and Wales) Regulations 2016
[4] Post-combustion carbon dioxide capture: emerging techniques - GOV.UK

and, in the absence of an applicable BAT Reference Document (BREF) Note, this guidance identifies important environmental issues to address and best practice measures. Therefore, this application will demonstrate alignment to the guidance.

Prior to this application, enhanced pre-application discussions were held, and advice was received in writing from the EA in their role as Regulator. This is referenced: *EPR/JP3020LL/P001* dated 23rd January 2025. Advice was provided by the EA regarding the following aspects:

- Acknowledgment and agreement in principle to a staged application.
- Extent of Installation - The CCF will require a separate permit. Riverside 1, Riverside 2 and the CCF will form a single multi-operator installation, but will each be operated under separate permits held by separate entities.
- Approach to ELV's.
- Noise - direction and agreement on approach to assessment and modelling (as required).
- Emissions Modelling – direction and agreement on approach to modelling.
- Carbon dioxide venting – The EA is developing guidance on what should be included in a venting management plan and will include a pre-operational condition in the permit to require the plan to be submitted prior to operation of the CC plant.
- Updates to guidance – The EA Post-combustion carbon dioxide capture: emerging techniques[5]" will be updated as the EA learns from other applications, and engagement with industry and trade bodies. This GET remains guidance until the UK BAT is developed, consulted and published.

The existing flue gas treatment at Riverside 1, and proposed at Riverside 2, will abate the exhaust gases before transfer to the CCF, cleaning and scrubbing the flue gas, abating the emissions from the process to ensure compliance with the current emission limit values defined within the existing environmental permit. Compliance with current ELVs will be demonstrated via two new compliance points at the exit from Riverside 1 and Riverside 2, before transferring to the CCF for further conditioning and treatment to remove and capture the carbon dioxide. The EA has limited guidance around associated emissions for carbon capture as it is a new and emerging technology within the UK. As part of enhanced pre-application discussions, an outline approach to the proposed air quality assessment and detailed dispersion modelling was discussed and the Regulator's requirements associated with these were agreed. This application will follow the recommendations and guidance stipulated by the EA. The CCF will be subject to the Waste Incineration Emission Limit Values in addition to those specific to carbon capture.

1.2 THE CCF AND SITE SETTING

The CCF site is predominantly located on Strategic Industrial Land within Belvedere Industrial Zone, Belvedere, South-east London. Approximately 70% of the land proposed to accommodate the CCF is identified in the Bexley Local Plan for employment use and is either developed for commercial use or being used in relation to the construction of Riverside 2. The remainder of the CCF site (approximately 30%) is undeveloped greenfield land and mainly in use as a grazing paddock. Figure

[5] Post-combustion carbon dioxide capture: emerging techniques - GOV.UK

1-1 below shows the location of the site for the CCF, and a full-scale version of Figure 1-1 as well as additional drawings and plans are included within Appendix A.

The Facility will be located at:

Riverside Campus (Riverside 1 and Riverside 2),

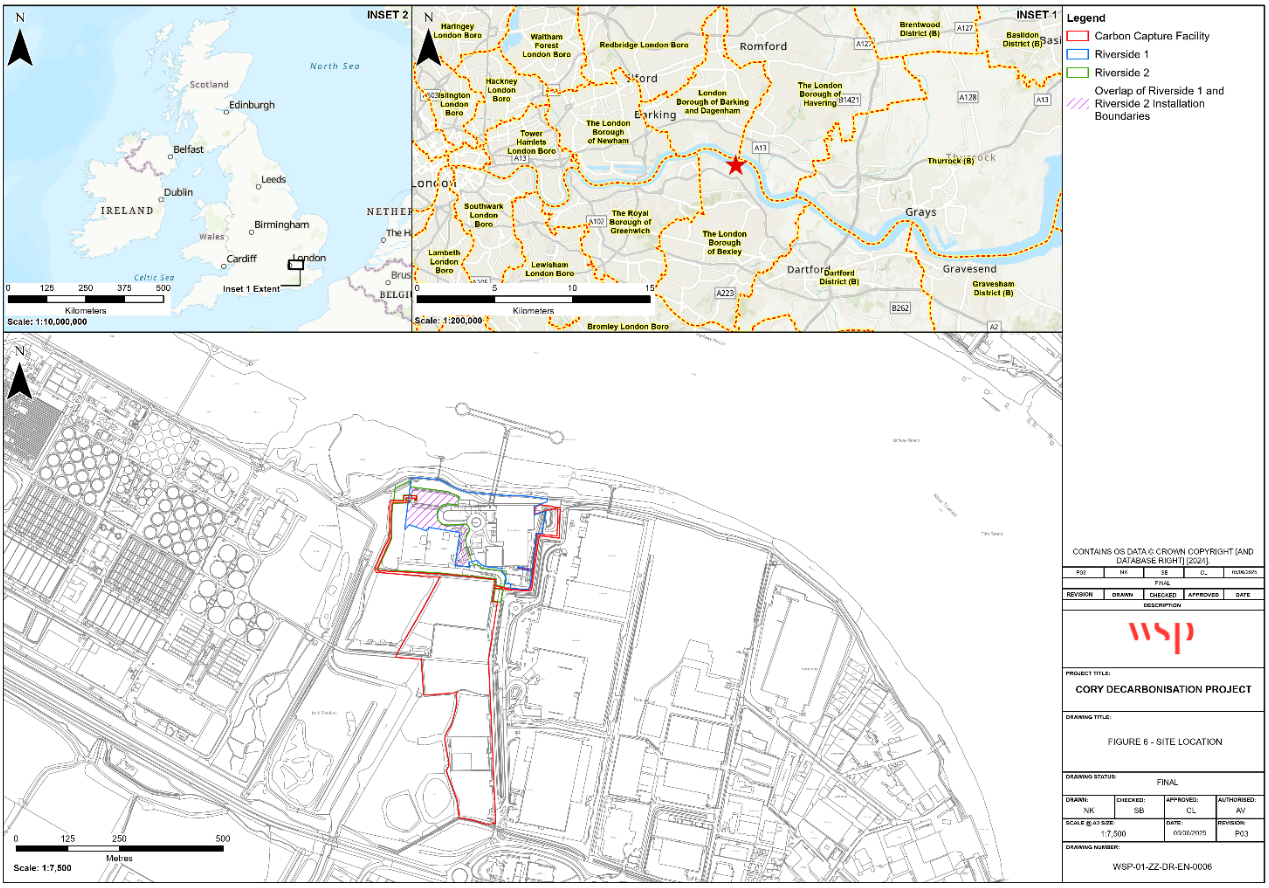
Norman Road North,

Belvedere,

DA17 6JY

The centre of the site is at Grid Reference TQ 49583 80344.

Figure 1-1 - Site Location



1.3 PROPOSED ACTIVITIES AND OPERATIONS

The bespoke environmental permit for the CCF will include an activity which meets the definition under Schedule 1 of the Environmental Permitting Regulations (2016), Section 6.10 for the capture of carbon dioxide from an installation for the purpose of geological storage.

Table 1-1 below sets out the proposed scheduled activities and directly associated activities for the CCF.

Table 1-1 – Proposed Activities

Activity listed in Schedule 1 of the EP Regulations	Description of Specified Activity	Limits of Specified Activity
Section 6.10 Part A(1): Carbon Capture and Storage	Operation of a CCF, with provision for geological storage.	From receipt of abated flue gas from Riverside 1 and Riverside 2 to the treatment conditioning and capture of CO_2, to storage and export of CO_2 from the installation, to release of CO_2 abated gases to atmosphere.
Raw materials storage and handling.	Storage of amine solvent and other reagents, chemicals and raw materials to the point of use in CCF	From receipt of raw materials to dispatch for use.
Reclaimer waste storage	Storage of reclaimer waste, which includes waste solvent, generated from the CCF.	From generation of waste materials to dispatch off-site for disposal / recovery.
Solvent regeneration	From receipt of used solvent in the carbon capture plants to solvent reclamation and regeneration for reuse.	Removal and re-conditioning of the amine-based solvent by use of heat and treatment for re-use in the carbon capture plants.
Effluent treatment plant	Effluent treatment plant	From receipt of DCC effluent and cooling blowdown to dispatch of waste sludge and treated water for reuse. The Effluent Treatment Plant is designed to treat approximately $170m^3/hr$ of process effluent.
Back Pressure Turbine	Providing steam/heat and electricity for use within the CCF with excess electricity exported from the site.	From receipt of imported electricity and steam from Riverside 1 and Riverside 2 to use at CCF.
CO_2 compression, dehydration, liquefaction and storage and transfer	High pressure compression plant to compress CO_2 prior to export from the site. Dehydration and liquefaction plant to condition the CO_2 for transport and storage.	From conditioning and compression of CO_2 to its export from the site via ship.
Surface Water Drainage	Handling and storage of site drainage through to discharge or removal from site.	

1.4 ENVIRONMENTAL SITE SETTING

The topography of the area surrounding the CCF comprises a low-lying estuarine landscape consisting of extensive stretches of intertidal habitats containing mudflats, saltmarsh, coastal dunes and wetland adjacent to the River Thames.

The CCF is located to the east of central London, with Riverside 1 and Riverside 2 to the north of the CCF and Asda Distribution Centre to East, Crossness Local Nature Reserve to the west and a retail park to the South.

The nearest residential receptor is located 120m south of the southern installation boundary on Clydesdale Way, the nearest settlements are part of the Belvedere residential area and the Thamesmead residential area, located approximately 170m to the south and 1.7km to the NW of the CCF respectively.

There is no Special Area of Conservation (SAC), no Special Protection Area (SPA), two Sites of Special Scientific Interest (SSSI), two Local Nature Reserves and there are twenty-three Local Wildlife Sites (LWS) within 2km of the CCF.

A site location plan is included in Appendix A.

1.5 SITE CONDITION

A Site Condition Report is available in Appendix F and includes detail of the environmental sensitivity of the CCF and surrounding area, including the details on soil and groundwater and the requirement for monitoring arrangements that will be established at the CCF. The report has been prepared in line with the EA's latest guidance[6] and includes a RHS Assessment as directed by the guidance and taken from the Industrial Emissions Directive. Except for the Amine Solvent, proxy Material Safety Data Sheets have been provided as part of the full RHS assessment. The RHS Inventory and assessment will be subject to further review and update as the detailed design progresses. A summary of the Site Condition Report is provided below.

The CCF will be constructed south of the Riverside 1 and Riverside 2 on an area of land approximately 8 hectares in size as shown on the Site Boundary Plan (Appendix A).

Approximately 70% of the land proposed to accommodate the CCF is identified for employment use in the London Borough of Bexley Local Plan and is either developed for commercial use or being used as construction laydown for Riverside 2. The remainder of the CCF site (approximately 30%) is undeveloped greenfield land and mainly used as a grazing paddock. Therefore, it is considered that there has been minimal potential for contamination. A brief summary of the sensitivity of the CCF and localised area is provided below:

Groundwater - Medium sensitivity - The underlying superficial stratum consists of Alluvium and Taplow Gravel member, which are classified as Secondary Undifferentiated Aquifer and Secondary Aquifer respectively. However, the bedrock contains White Chalk, which is a Principal Aquifer.

Surface water - Low sensitivity – At its closest point the River Thames is located approximately 50m to the north of the CCF installation boundary, this relates to the exhaust gas ducting pipeline which connects to Riverside 2. The CCF is located within the Thames Middle Transitional WFD

[6] Environmental permitting: H5 Site condition report - GOV.UK

Water Body catchment (GB530603911402). The current (2019) classification has a 'Moderate' ecological status and a chemical status of 'Fail' due to priority hazardous substances mercury and its compounds and polybrominated diphenyl ethers (PBDE). This section of the River Thames is also designated as a heavily modified water body.

Land use – Low sensitivity - Approximately 70% of the land proposed to accommodate the CCF is identified in the Bexley Local Plan for employment use, developed for commercial use and for the construction of Riverside 2. The remainder of the CCF (approximately 30%) is undeveloped greenfield land and mainly in use as a grazing paddock. The CCF is mainly surrounded by industrial land use. The Lidl Warehouse/Belvedere Regional Distribution Centre is located adjacent (southeast), and Iron Mountain Records Storage Facility (adjacent east) and the Asda Belvedere Distribution Centre is located adjacent (east) of the site boundary.

1.6 APPLICATION STRUCTURE

As part of this application, for a new bespoke permit, the following application forms have been downloaded from the EA website and completed. The forms completed include:

- Part A – About you
- Part B2 – General new bespoke permit
- Part B3 – New bespoke installation permit
- Part F – Charges and declarations.

The completed application forms provided are supported by this Technical Supporting Document, which is the main application document. The Technical Supporting Document will be updated at each stage of the staged application process. In addition to the Technical Supporting Document and Application Forms, the following supporting information is provided in the appendices to this report:

- Appendix A – Site Plans and Drawings
- Appendix B – Environmental Risk Assessment
- Appendix C – Indicative Drainage Layout
- Appendix D – Management System Manual and Certifications
- Appendix E – Preliminary Accident Prevention and Management Plan
- Application F – Site Condition Report
- Application G – Noise Impact Assessment
- Application H - Noise and Vibration Management Plan
- Application I – Air Emissions Risk Assessment
- Application J – CO_2 Venting Assessment

1.7 TECHNICAL STANDARDS

The CCF will operate in accordance with the conditions set within the new Bespoke Environmental Permit, and applicable EA Sector guidance, namely:

- Post-combustion carbon dioxide capture: Emerging techniques on how to prevent or minimise the environmental impacts of post-combustion carbon dioxide capture. Published 2 July 2021 (updated 27 March 2024)1 to advise on the Best Available Techniques Activities.
- Best Available Techniques [BAT] Conclusions: Emissions from Storage, July 2006.
- Best Available Techniques [BAT] Conclusions: Energy Efficiency, amended September 2021.
- Best Available Techniques [BAT] Conclusions: Industrial Cooling Systems, December 2001.
- Emergency backup diesel engines on installations: Best Available Techniques (BAT), August 2023.
- Best Available Techniques [BAT] Conclusions: Best Available Techniques (BAT) Reference Document for Common Wastewater and Waste Gas Treatment/Management Systems in the Chemical Sector, 2016.

A review of the CCF against the relevant BAT Standards and the emerging techniques guidance is available in Section 11 of this document.

In the absence of specific BAT for Carbon Capture facilities, it is important to note that the EA guidance does not hold the same legal status as BRefs, and BAT Conclusions published under the IED. The EA's guidance[7] webpage states that,

"Except where regulations apply, this guidance for emerging techniques is not a regulatory requirement but identifies best practice to address important environmental issues

The regulators expect operators to follow this guidance, or to propose an alternative approach to provide the same or greater level of protection for the environment".

Following the review of the CCF against the relevant BAT Standards and the emerging techniques guidance, the CCF is considered to comply with BAT, and an alternative approach has not been proposed.

It is acknowledged by the EA that this is a new and emerging technology. Therefore, there are limited operational plants to provide information to support and inform these types of application.

It is considered that a development of this nature will help shape the progress of BAT for Energy from Waste Carbon Capture facilities looking forwards and in the future.

The site will implement and operate in accordance with Cory's Integrated Management System and Environmental Management System specifically, which will be amended and written to include the proposed operation of the CCF Plant prior to commencement of its operation. Cory's EMS is compliant with the EA's guidance - 'Develop a management system: Environmental Permits'[8].

The EMS and procedures will be made available for inspection by the EA upon request, and will be applicable to all staff, contractors and visitors to the CCF. The EMS will be developed to enable compliance with the Environmental Permit and other legislative requirements for the protection of the environment and human health.

[7] Post-combustion carbon dioxide capture: emerging techniques - GOV.UK
[8] Develop a management system: environmental permits - GOV.UK

2 CARBON CAPTURE AND STORAGE TECHNOLOGIES

2.1 BACKGROUND

The role of energy from waste facilities in treating residual waste (non-hazardous waste materials that cannot be reused or recycled) is to divert it from landfill and recover renewable energy where practicable. This is a key element of the UK's waste management strategy. Installing carbon capture technology is the leading technological way to reduce CO_2 emissions from energy from waste facilities[9]. In general terms, the process captures the post-combustion CO_2 emissions at source, after which it is safely stored underground, rather than being released into the atmosphere.

Carbon Capture and storage is vital to help the UK reach net-zero emissions by 2050. In 2025, the UK government reaffirmed its support for carbon capture and storage technology in both its Industrial Strategy[10] and Clean Energy Industries Sector Plan[11], recognising the key role carbon capture and storage technologies can play in decarbonising the UK.

In order to achieve the UK's net zero target[12,] 100 million tonnes of CO_2 will need to be removed from the atmosphere each year. This will need to balance emissions from industries which do not yet have a clear path for decarbonisation, such as power stations without access to carbon storage, and aviation. By capturing around 1.3 million tonnes of CO_2 a year (of which approximately 50 % will be fossil carbon (from plastics), and 50 % will be biogenic (from wood, paper, cardboard and food) due to the composition of mixed residual waste), Cory's decarbonisation plan can contribute significantly to the UK's net zero goal, as well help achieve Cory's own net zero target.

2.2 CCS TECHNOLOGIES

Carbon Capture and Storage refers to the technologies that capture and store CO_2 and permanently store it safely underground, to reduce the impact on the climate. Carbon capture and storage technologies can capture over 90 % of CO_2 emissions from industries where they are applied, that would have otherwise been released into the atmosphere.

A variety of capture methods have been developed for different technological applications. Three effective CO_2 capture methods for power generation are shown below[13]:

- Pre-combustion: Involves separation of CO_2 from flue gases before fuel combustion in industrial processes or facilities. This method converts fuel into a gaseous mixture of hydrogen and CO_2. The CO_2 is compressed for transport and storage, while the hydrogen is separated and can be burnt for energy without producing CO_2.
- Post-combustion: Involves the separation of CO_2 from flue gases emitted after fuel combustion in industrial facilities. This method separates CO_2 from combustion exhaust gases using a liquid solvent or other separation methods. In an absorption-based approach, once absorbed by the solvent, the CO_2 is released by heating to form a CO_2 stream, which can be compressed for transport and storage.

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[9] Carbon capture, usage and storage: a vision to establish a competitive market - GOV.UK
[10] Invest 2035: the UK's modern industrial strategy - GOV.UK
[11] Clean Energy Industries Sector Plan - GOV.UK
[12] assets.publishing.service.gov.uk/media/6194dfa4d3bf7f0555071b1b/net-zero-strategy-beis.pdf
[13] https://www.globalccsinstitute.com/

- Oxyfuel combustion: Involves separating the CO_2 by combusting fuel in the presence of nearly pure oxygen rather than air. This produces exhaust gas that is mainly water vapour and CO_2 that can be easily separated to produce a CO_2 stream that can be compressed for transport and storage.

It is considered that post-combustion carbon capture is the most proven and commercially viable process for the capture of CO_2 from Riverside 1 and Riverside 2 for the following reasons:

- This technology can be retrofitted to existing facilities and installations.
- It is a well demonstrated technology with various pilot plants and commercial projects proving the credibility and reliability of the technology.

Therefore, post-combustion carbon capture technology will be used for the Cory Decarbonisation Project and will be discussed throughout this permit application.

3 THE CCF

3.1 INTEGRATION OF FACILITIES

The flue gas ducting between the CCF and Riverside 1 and Riverside 2 will be approximately 260 m and 540 m respectively. This route avoids existing buried utilities on the Riverside 1 and Riverside 2 sites, avoids ducting onsite where it will impact existing operations and maintenance activities, does not require the location of infrastructure in a non-encroachment area (the River Thames) and avoids crossing along any public routes. The stack for Riverside 1 is located at the south end of the site, consequently, connection to the CCF is comparatively simple.

The CCF will operate concurrently with Riverside 1 and Riverside 2 (once operational), which are designed, and consented, for continuous operation. Therefore, other than for periods of maintenance and unplanned shutdowns, the CCF will operate continuously. Planned maintenance of the CCF will coincide with planned maintenance of Riverside 1 and/or Riverside 2 requiring high numbers of Contractor(s) onsite to support the outage activities.

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 stack(s). The Riverside 1 flue gas exhaust ducts do not join up prior to the stack, and Riverside 2 has two separate exhaust stack(s). Thus, five separate tie-ins, one to each flue, would be required if treated flue gas was to be returned from the CCF back to the Riverside 1 and Riverside 2 exhaust stacks, increasing engineering complexity and capital costs. Furthermore, there would be a requirement for additional flue gas fans due to the pressure drop across the ducting. Therefore, abated and treated flue gas will undergo carbon capture and then be emitted from two new emission points, A1 and A2, located at the top of two new stack(s) at the CCF rather than returned to the existing stacks.

3.2 PROCESS FLOW DIAGRAM - CCF

The proposed CCF and carbon capture process will follow the below steps and stages. An indicative process schematic is shown in Figure 3-1 below, and a detailed Process Flow Diagram is included in Appendix A.

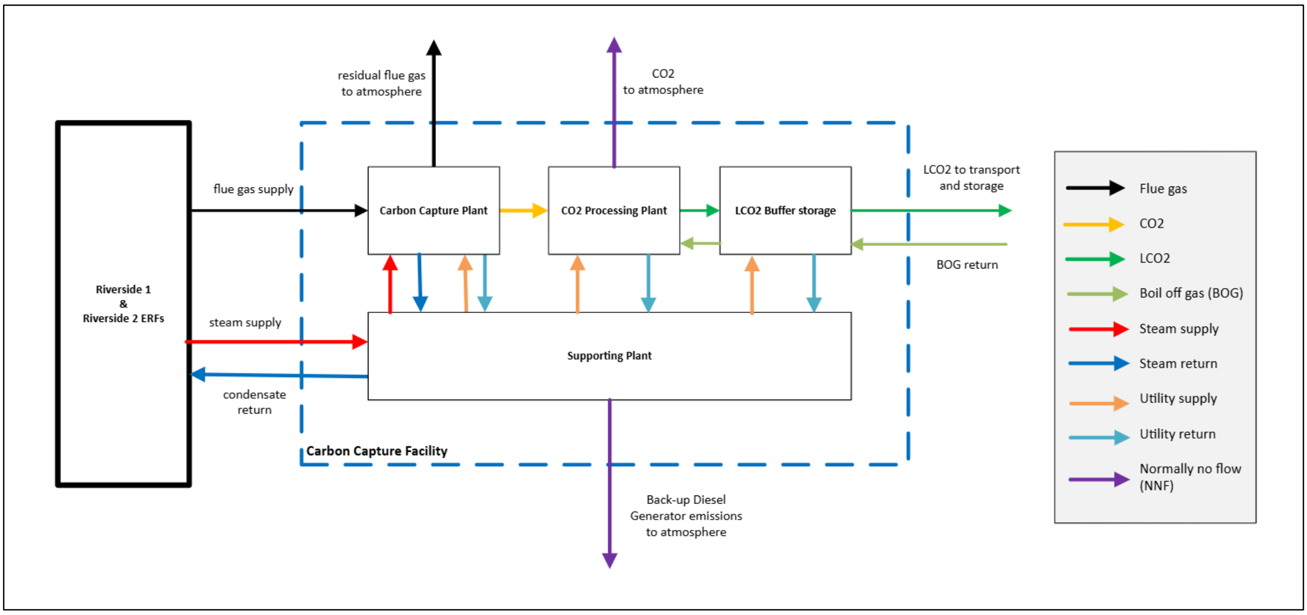

Figure 3-1 - Carbon Capture Process Overview

3.2.1 CCF AND PROCESS DESCRIPTION

The CCF will comprise of a two-train Carbon Capture Plant, serving both Riverside 1 and Riverside 2 to provide greater flexibility.

The CCF will comprise of the following:

- Carbon Capture Plant(s) comprising:
  - Flue Gas Pre-Treatment;
  - Absorber Column(s) and Stack(s);
  - Back Pressure Turbine and Generator;
  - Solvent Regeneration System;
  - Rich Solvent/Lean Solvent Heat Exchanger; and
  - Solvent Storage.
- CO_2 Processing Plant, each comprising:
  - Compression;
  - Dehydration;
  - Liquefaction; and
  - CO_2 Vents.
- LCO_2 Buffer Storage Area, comprising:
  - Temporary Storage; and
  - Boil off Gas Processing.

- LCO_2 Pipelines
- Flue Gas Supply Ductwork
- Supporting plant, comprising:
  - Cooling System;
  - Chemical Storage and Distribution Handling Facilities; and
  - ETP.
- Amenities and other buildings , comprising:
  - Gatehouse;
  - Control Room;
  - Welfare Facilities; and
  - Stores and Workshop.

The scope of this permit application covers the landside activities as the loading activities and Proposed Jetty will be operated by a third party and is covered by marine consents including River Works Licence.

3.2.1.1 Flue Gas Pre-treatment

A new connection into the existing flue gas lines of Riverside 1 and Riverside 2 will be required, prior to the connection point to their existing exhaust stacks, this will allow for the routing and transport of the flue gas through new Flue Gas Supply Ductwork into the CCF.

Flue gas conditioning is achieved through a DCC. This cools and condenses water out of the saturated flue gas and treats residual components (sulphuric and nitric acids) within the flue gas prior to it reaching the Absorber Column(s) and Stack(s). The incoming flue gas is cooled via the DCC to around 40 °C before entering the Absorber(s).

Booster fans will be installed within the Flue Gas Pre-Treatment area to increase the pressure of the cooled flue gas to overcome the pressure drop across the Carbon Capture Plants within the CCF.

3.2.1.2 Absorber Column(s) and Stack(s)

In the Absorber Column(s) the cooled flue gas will move upwards through the Column(s), with the amine-based solvent being supplied from the top. As the flue gas moves upwards, the CO_2 within the flue gas will be absorbed by the amine-based solvent. Post CO_2 absorption, the flue gas will continue upwards to the water wash component of the Absorber Column(s). This will maintain the flue gas water balance, recover chemical vapour and control chemical emissions.

The Absorber(s) operates at circa 40°C and is exothermic. The temperature is maintained using intercoolers, removing the excess heat via the cooling system. The treated flue gas will be re-heated prior to being emitted to the atmosphere via two new stack(s).

The heat source for this re-heat will be supplied through a gas-gas heat exchanger, which cools incoming flue-gas and reheats outgoing flue gas. This will be confirmed as part of the final detailed design.

The treated flue gas will then be emitted into the atmosphere, via two new Stack(s). The treated flue gas emitted from the Stack(s) will be reheated prior to discharge in order to mitigate against visible plumes across most weather conditions. There will be two new stack(s) and point source emissions associated with the CCF. The flue gas emissions will be continuously monitored via a Continuous Emissions Monitoring System (CEMS) to ensure compliance with the Emission Limit Values set within the bespoke environmental permit.

The CO_2 rich amine-solvent will accumulate at the bottom of the Absorber Column(s), separate from the now treated flue gas. The CO_2 rich amine-solvent will be pumped through a Rich Solvent/Lean Solvent Heat Exchanger to the Regenerator Column (described below). Each Absorber Column will include navigational lighting.

Further information regarding emissions to air is provided in Section 6.1 of this document and in the detailed dispersion modelling and associated air quality assessment available in Appendix I.

3.2.1.3 Solvent Regeneration System

The Solvent Regeneration System consists of the Regenerator Column (or stripper), reboiler and Solvent Processing System.

In the Regenerator Column, low-pressure steam indirectly heats the CO_2-rich amine-based solvent stripping the CO_2 from the solvent. The Regenerator Column operates at a temperature of approximately 100-120°C in order to initiate the desorption process. This heat is provided by the steam in the reboiler. Solvent degradation will be minimised through the control of solvent temperature within the Absorber Column(s)and regenerator column, in line with licensor's guidance and recommendations

At the top of the column, a condenser cools the solvent vapour, returning the condensed solvent stream back to the Regenerator Column. The remaining CO_2-rich gas stream, at around 40°C is then directed to downstream CO_2 Processing.

The steam will be supplied from the Riverside 1 and Riverside 2 boilers. The Back Pressure Turbine is utilised to provide steam at the temperature and pressure conditions required by the regenerator reboiler while also generating electricity.

The Solvent Processing System consists of a filtration and reclamation system, to remove any Heat Stable Salts (HSS) and degradation products in the amine-based solvent. Lost solvent will be replaced by fresh solvent from the Solvent Storage Tanks (SSTs) located within the CCF.

SSTs will supply fresh amine-solvent as required. Small volumes of amine-loaded sludge will be produced as a by-product of the carbon capture process. This will be temporarily stored onsite prior to being transported offsite to an appropriate waste treatment facility as hazardous waste.

3.2.1.4 Rich Solvent / Lean Solvent Heat Exchanging

The CO_2-lean solvent is required to be cooled prior to be being sent back to the Absorber Column(s) to absorb CO_2 once again from the incoming flue gas.

The CO_2-rich solvent is required to be pre-heated prior to the regeneration process as part of the Solvent Regeneration System.

A Rich Solvent/Lean Solvent Heat Exchanger will be utilised that will act to:

- Cool the CO_2-lean solvent at the Regenerator Column outlet before it is further cooled via the Cooling Water System, prior to the Absorber Column(s); and
- Heat the CO_2-rich solvent at the Regenerator Column inlet.

This heat integration within both the Carbon Capture Plant(s), at the CCF, both reduces external cooling demands (and hence energy consumption of the wet / hybrid and dry cooling systems) and reduces the amount of steam required. The CO_2-lean solvent is further cooled via the Cooling System.

3.2.1.5 Back Pressure Turbine Generator Plant

The CCF requires low pressure steam. However, sufficient steam to meet the reboiler demand is only available from Riverside 1 and Riverside 2 at high pressure. To maximise process efficiency, the CCF will be supported by one Back Pressure Turbine and one Pressure Reducing De-Superheating Station. The Back Pressure Turbine will maximise the extraction of energy within the steam during pressure reduction. The Pressure Reducing De-Superheating Station will refine the temperature and pressure of the steam exiting the Back Pressure Turbine, to make it suitable for use in the Solvent Regeneration System.

In addition to conditioning the steam required for the carbon capture process, the Back Pressure Turbine will also supply an amount of the electricity required for the CCF. The thermal energy within the steam entering the Back Pressure Turbine will be used to rotate the turbine shaft and subsequently drive the generator, thus generating electricity.

The remaining electrical demand for the CCF will be supplied from the electricity generated by Riverside 1 and Riverside 2. The CCF will be supplied with electricity via a 132kV connection. Onsite electrical infrastructure will be used to step this supply down to the voltages required onsite.

3.2.2 CO_2 PROCESSING PLANT

In order for the captured CO_2 to be transported and permanently sequestered at a CO_2 storage site, Cory will engage in a contract with a CO_2 transport and storage operator(s).

Cory will be responsible for temporary CO_2 storage at the LCO_2 Buffer Storage Area ahead of transport to the jetty terminal for off-taking and loading onto ship and / vessels for transport of CO_2.

The LCO_2 Buffer Storage Area will be operated according to strict specifications (as detailed in Section 3.2.3) that must be adhered to.

This requires the captured CO_2 to undergo the following processes to meet the stipulated conditions:

- Compression;
- Dehydration; and
- Liquefaction.

3.2.2.1 Compression

The captured wet CO_2 will be transferred from the Regenerator Column to the Compression Plant, using Above Ground Pipelines. There will up to four Compressors, two for each Carbon Capture Plant(s).

Compression of the low pressure, wet CO_2 will be undertaken in stages, with the CO_2 cooled using cooling water or through direct air cooling between compression stages.

The compressed CO_2, at approximately 16 bar pressure and a temperature of approximately 40°C, will be routed via above ground pipelines for dehydration (described below).

3.2.2.2 Dehydration

After compression, the CO_2 stream will need to be dehydrated prior to liquefaction, as it will still be water saturated, to avoid the water freezing in the liquefaction plant.

Solid desiccant dehydration will be used; this is a process utilising adsorption to retain water on the surface of the desiccant particles (such as molecular sieve or silica gel), typically within adsorber vessels.

The dry CO_2 will be routed for liquefaction and refrigeration via Above Ground Pipelines.

3.2.2.3 Liquefaction

Liquefaction requires the dry CO_2 stream to be cooled; this can be undertaken via expansion of the gas to a liquid-vapour state via a control valve or turbine (open-cycle), or through a heat exchange system, in which it is condensed against an evaporating refrigerant (typically ammonia or propane) (closed-cycle). Both liquefaction technologies are considered, and selection will be undertaken as part of the detailed design for the CCF.

Further conditioning equipment will be required, such as a distillation column, to remove non-condensable components present in the CO_2 stream as a result of co-absorption into the amine solvent from the flue gas, such as oxygen and nitrogen, so that the CO_2 export specification can be met. The non-condensable components are vented to atmosphere via emission points A4 or A5.

3.2.2.4 CO_2 Vents

There will be times and scenarios where there is a need for operational and emergency venting of CO_2. Operational venting occurs during start-up and shutdown (SU/SD) or maintenance outages of the CCF, and emergency venting in the event of any unscheduled shutdown or emergency shutdown scenarios.

There will be separate supported CO_2 Vents for small volumes of CO_2 venting, with larger volumes of CO_2 (in the form of unabated / partially abated flue gas), such as during SU/SD, to be routed back into the new Stack(s) located at the CCF.

The specific venting requirements and final location of the CO_2 Vents will be confirmed and determined as part of the detailed design of the CCF but have been included as part of the indicative Emission Point Plan contained within Appendix A.

Any operational and emergency venting of CO_2 will be required to meet any environmental limits set out in the future Environmental Permit as issued by the EA.

Further information regarding CO_2 venting and associated management arrangements for this activity are provided in Section 12.10 of this document and in the CO_2 Venting Assessment available in Appendix J.

3.2.3 LIQUIFIED CO_2 [LCO_2] BUFFER STORAGE AREA

LCO_2 Buffer storage is required to store the liquified carbon dioxide (LCO_2) prior to onward vessel export via the Proposed Jetty. This will be provided as insulated, pressurised, Above Ground Storage Tanks made of low-temperature carbon steel. It is expected that the LCO_2 will be stored in 6 vessels. This gives a total LCO_2 capacity of approximately 24,000m^3 of LCO_2. The LCO_2 is to be stored at 13 to 15 barg, -33 to -26 °C. The storage capacity and conditions should be considered indicative prior to completion of detailed design of the facility.

3.2.3.1 Boil off gas processing

As the LCO_2 is stored at saturated conditions, a small amount of boil-off gas (BOG) will be generated due to the ingress of heat into the Above Ground Storage Tanks.

The CO_2 vapour returned from the vessels during loading operations will be combined with the BOG from the Above Ground Storage Tanks and sent to be re-liquefied in the Carbon Capture Plant. If there is any BOG that is unable to be re-liquefied, it would be vented via a CO_2 Vent (Emission Points A4 or A5).

3.2.4 SUPPORTING PLANT

The CCF will have the following supporting systems:

- Cooling System;
- Chemical Storage and Distribution Handling Facilities; and
- ETP.

Amenities and other, comprising:

- Gatehouse;
- Control Room;
- Welfare Facilities; and
- Stores and Workshop.

3.2.4.1 Cooling System

A new, standalone Cooling System will be provided for the CCF.

The cooling system is expected to be a combination of wet / hybrid and dry cooling. The wet / hybrid cooling will be sized to utilise the water stream produced by the ETP.

The recirculated cooling water will be initially cooled by dry coolers. The water is then further cooled by evaporative cooling, which is used as a “trim cooler” to remove remaining heat and allow water to be cooled to temperatures lower than that of the ambient air. The split of wet vs dry cooling can be adjusted depending on the ambient weather conditions and the volume of water recovered from the process.

The cooling water will be cooled to a supply temperature of approximately 30°C. This is subject to change as part of the detailed design.

This approach of combining cooling technologies reduces the consumption of water and is considered BAT[14], it allows the treated water, available from the process, to be used for cooling without the need for disposal, whilst also avoiding the need for additional demand from the mains water supply during normal operation.

The design will allow for the storage of treated water on site to account for short-term fluctuations in water availability and to allow water to be stored during shutdowns.

[14] Industrial Cooling Systems | EU-BRITE

The cooling system design will be finalised during the detailed design phase.

3.2.4.2 Chemical Storage and Distribution Handling Facilities

Chemical Storage and Distribution Handling Facilities are necessary for both the carbon capture process (such as processing amine-based solvent required) and the ETP. This will comprise of new chemical Above Ground Storage Tanks and warehousing for chemicals. The chemicals anticipated to be used during operation include:

- amine-based solvent;
- caustic soda;
- anti-foam;
- effluent treatment chemicals (sodium hypochlorite, sulphuric acid, sodium bisulphite, antiscalent);
- cleaning chemicals;
- lubricating oils; and
- nitrogen (for purging of plant equipment).

In addition to the above, there is potential for ammonia or propane to be used for the first fill of the refrigeration plant as part of the liquefaction section of the CO_2 Processing Plant. This is a closed-loop system with no requirement for top up; thus, there will be no requirement to deliver or store ammonia or propane onsite, except for scheduled maintenance intervals. The selection of liquefaction technology will be undertaken as part of the detailed design for the CCF.

All liquid chemicals stored onsite will be kept in bunded controlled areas (LCO_2 Buffer Storage Area), designed according to BAT and appropriate standards, for example COSHH guidelines and Ciria 736[15], and to minimise the risk of breach of containment and potential future contamination issues.

As the CCF project is not yet in the final detailed design stage, specific details of materials of construction for tanks and bunds are not finalised. However, all materials of construction for primary and secondary containment will be assessed and selected to ensure suitability and compatibility with the stored liquids and substances in each primary containment tank. Furthermore, bunds will be designed to ensure that pipework does not penetrate the bund walls or weaken joints, and storage will be designed to ensure that the facility and measures to detect and catch leaks from tanks and/or fittings is implemented.

3.2.4.3 Effluent Treatment Plant[16]

The design of the ETP is subject to detailed design. However, it is anticipated that it will include treatment of the blowdown from the wet / hybrid cooling and effluent from the DCC.

Blowdown from the hybrid cooling will contain concentrated impurities and will be treated by reverse osmosis, and with bisulphite to remove chlorine.

[15] CIRIA (2014). Containment Systems for the Prevention of Pollution, Secondary, tertiary and other measures for industrial and commercial premises – CIRIA C736.
[16] The ETP serves the serves the intended function of the Water Treatment Plant and the Waste Water Treatment Plant described in the Environmental Statement 6.1 Chapter 2: Site and Proposed Scheme Description. The terminology has been updated to reflect the Evolving Design.

The reject streams from the ETP will be treated in a ZLD evaporator to recover as much water as possible. This will result in the formation of a waste sludge which will be sent for offsite disposal via a closed skip as detailed in Section 9.4.

Recovered water will be re-used as make-up water within the wet / hybrid part of the cooling system. The cooling water will be dosed with sulphuric acid (H_2SO_4) to reduce its mineral content and therefore scaling potential. It will also be dosed with sodium hypochlorite (NaOCl) to kill bacteria such as legionella.

As the ETP is recycling the water from the effluent generated by the CCF for re-use within the system, it will therefore be included as a Directly Associated Activity on the environmental permit.

3.2.5 TIE-INS TO THE EXISTING FACILITIES [RIVERSIDE 1 AND RIVERSIDE 2]

The modification and interconnections with Riverside 1 and Riverside 2 will include the following:

- Steam and Condensate;
- Flue Gas Supply Ductwork; and
- Electrical and control Connections.

3.2.5.1 Steam and Condensate

Steam is required for several processes within the CCF. Predominantly, steam is supplied for indirect use in the Solvent Regeneration System, in which heat is transferred to the solvent to release the CO_2 from the CO_2-rich amine-based solvent.

For the CCF, steam will be extracted from Riverside 1 and Riverside 2 respectively and supplied to the required process.

Once the steam has been used within the CCF, the resulting condensate will be returned to Riverside 1 and Riverside 2 respectively. It is likely to follow a similar route to the process steam piping.

3.2.5.2 Flue Gas Supply Ductwork

A new connection into the Riverside 1 and Riverside 2 flue gas lines, known as flues, will be required, prior to their respective exhaust stacks, to route the flue gas via new ducting to the CCF. The new ductwork tie-ins to the flues will include a damper (shut-off valve) to enable flue gas to be directed to either the CCF, or to the respective Riverside 1 or Riverside 2 exhaust stacks if the CCF is not able to operate or is operating at reduced capacity.

The flue gas ducting between the CCF and Riverside 1 and Riverside 2 is approximately 260 m and 540 m in length, respectively. The chosen route is southwest around Riverside 2. This route avoids existing buried utilities on the Riverside 1 and Riverside 2 sites, avoids locating ducting where it will impact existing operations and maintenance activities, does not require the location of infrastructure in a non-encroachment area (the River Thames) and avoids crossing or routeing along any public routes.

The stack for Riverside 1 is located at the south end of Riverside 1, consequently, connection to the CCF is comparatively simple due to the proximity to the CCF.

The Flue Gas Supply Ductwork tie in points are shown on the Flue Gas Tie-in Plan within Appendix A.

3.2.5.3 Electrical Connections

The electrical demand for the CCF will be supplied primarily via the Back Pressure Turbine and Generator, supplemented by the 132kV supply.

4 RAW MATERIAL INVENTORY

Wherever feasible, the detailed design will eliminate the use of hazardous materials. In instances where elimination is impractical, their use will be minimised.

Operational and chemical handling areas will be appropriately paved, kerbed, and bunded to ensure that any spillages or leaks are contained, enabling manual clean-up and removal for appropriate off-site disposal in line with the future environmental management system and site procedures.

All liquid chemicals stored at the CCF will be appropriately bunded and segregated areas with full and proper signage. Furthermore, controls such as emergency isolation valves will be put in place to reduce and minimise the risk of discharges off-site from any breach, spillage or incident/accident entering the site's surface water drainage system.

The CCF will introduce materials and reagents which are not currently stored, handled or used at Riverside 1 or Riverside 2. Therefore, the construction and operation of the CCF will require new and additional raw materials to be handled, stored and utilised within the CCF's operational boundary.

Most, if not all, chemicals, reagents and raw materials will be delivered to the CCF by road via HGVs in drums and intermediate bulk containers (IBCs) which, as stated, will be stored in appropriate storage infrastructure fully implementing the use of suitable primary, secondary (incorporating acid and alkali resistant coatings where appropriate) and tertiary containment measures.

Facilities for the handling and storage of chemicals will be designed in accordance with EA Pollution Prevention Guidance titled 'Pollution prevention for businesses'[17].

All chemicals will be delivered, unloaded, and transferred to appropriate storage facilities. Areas and facilities designated for the storage of chemicals and liquid hazardous materials will feature secondary containment. Secondary containment facilities must have a capacity to hold either 110% of the tank capacity or 25% of the total volume of materials being stored on site, whichever is greater, to address possible storage system failures.

The principal raw material to be used at the CCF will be the amine-based solvent. There will be an initial quantity (first fill) of amine-based solvent and after which the CCF will include equipment for recovering and reclaiming the used solvent for reuse within the process, as described above in the process description of Section 3, thereby minimising the need, consumption and use of fresh solvent. The fresh solvent will be stored in an approximately 130m^3, fresh solvent storage tank.

Caustic will be used and diluted to 20wt% (weight percent) at the CCF, with a storage capacity of approximately 40m^3 calculated.

Other raw materials in the CCF plants will be stored in small quantities in appropriate containers, with adequate spill protection measures such as bunds, bunded pallets, drip trays, specifically designed cabinets, cupboards, or other suitable storage units and areas. Additional hazardous materials will be supplied, stored, and used in containers of approximately 1 m^3 or less. There will be separate storage provision for incompatible materials.

[17] Pollution prevention for businesses - GOV.UK

The main raw materials anticipated to be stored and utilised at the CCF are provided in Table 4-1. The quantities and storage capacities should be considered indicative prior to completion of detailed design of the facility.

Table 4-1 – Types and Quantity of Raw Materials

Material	Purpose	Estimated Maximum Storage Capacity	Storage Location	Estimated Annual Consumption	Description
Amine Solvent	CO_2 Scrubbing, 100% solvent within CCF	130m^3	Chemical Storage Area	200 tonnes/annum	CO_2 Scrubbing agent
Sodium hydroxide (20%wt)	CCF neutralisation of flue gas.	40m^3	Chemical Storage Area	1,700 tonnes/annum	Various applications across the carbon capture process such as flue gas injection for pre-treatment.
Anti-foam	Prevent foaming in the CO_2 Absorber Column(s) during recirculation of amine.	N/A	Chemical Storage Area	Extent of potential foaming not known until operation commences	To be added to the re-circulating amine, preventing foaming in the CO_2 Absorber Column(s) if required. An injection point for antifoam is provided for future use if required, but it is not expected to be used (or stored)
Ammonia / Propane	Refrigerant	This will only present in the liquefaction plant. No provision for further storage is needed as no top up should be required.	Not stored on site.	Extent of usage not known until operation commences, no expected top up expected during routine operation.	Liquefaction – cooling of the dry CO_2 stream through condensing of CO_2 against evaporated refrigerant.
Solid desiccant for dehydration	Molecular sieve or silica gel, to be confirmed as part of detailed design.	Not stored on site, it will be brought in for change overs when required (~ every 5yr)	Chemical Storage Area	Extent of usage not known until operation commences	CO_2 Dehydration Technology - Solid desiccant dehydration
Diesel	Fuel for the backup power generator.	5m^3	Generator area	2500 litres/annum	Consumption is based on maximum testing under BAT for emergency backup for 50 hours/year.
Activated carbon	Solvent Filtration	Not held on site, brought in for change	Chemical Storage Area	Extent of usage not known until operation commences	Not held on site, brought in for when changeover is required.

Material	Purpose	Estimated Maximum Storage Capacity	Storage Location	Estimated Annual Consumption	Description
		over when required			
Sodium hypochlorite	Treatment of effluent	4m^3	ETP	200 tonnes/annum	Effluent treatment
Sulphuric acid (96/wt%)	Treatment of effluent	2m^3	ETP	60tonnes/annum	Effluent treatment
Sodium bisulphite	Treatment of effluent	2m^3	ETP	40 tonnes/annum	Effluent treatment
Antiscalent	Treatment of effluent	1m^3	ETP	5 tonnes/annum	Effluent treatment
Citric acid	Treatment of effluent	1m^3	ETP	1 tonnes/annum	Effluent treatment

A Provisional Mass Balance and a supporting Process Flow Diagram have been included in Appendix A. A detailed description that accompanies the Process Flow Diagram is available in Section 3 of this document.

The Mass Balance shows the distribution and flow of heat and materials relating to the CCF, that aligns with the information presented in this Technical Supporting Document.

During the initial design stage of the project, Hazard Identification (HAZID) studies were conducted. These studies identified and assessed potential risks associated with the chemicals intended for handling, storage, and use at the CCF Plant. This will be reviewed and expanded upon during Front End Engineering Design (FEED), with the completion of additional environmental and safety studies, including a Hazard and Operability Study (HAZOP).

As shown and considered above, there is potential for ammonia or propane to be used for the first fill of the refrigeration system as part of the liquefaction section of CO_2 Processing Plant. This is a closed-loop system with no top up required; thus, there is no requirement to deliver or store ammonia or propane onsite. The selection of liquefaction technology will be undertaken as part of the detailed design for the CCF.

As water is condensed from the incoming flue gas, this water, once treated, will be used to satisfy the water requirements in the CCF, to avoid additional water requirements during normal operation. Wastewater from the process is treated and re-used as process water and cooling water make-up, to avoid any wastewater disposal requirements. The use of a combination of wet / hybrid and dry cooling maximises the re-use of treated water without requiring an additional water supply, as would be required for a fully hybrid solution.

All chemical tanker and material off-loading areas will occur in areas with containment drainage systems designed to handle the appropriate capacity for any potential spills during delivery. Sufficient quantities of spill absorbent materials will be made readily available at accessible locations where chemicals are stored. An Indicative Drainage Layout is included in Appendix C; this plan remains subject to further review until the detailed design is finalised.

All accidents, incidents and spillages, which have the potential to impact the environment and cause harm or migrate beyond the installation boundary will be reported in accordance with environmental permit, site management system and inspection, audit and reporting procedures. The relevant regulatory authorities (EA / Health and Safety Executive) would be informed as specified and required to remain legally compliant and ensure full investigation and resolution is implemented.

4.1 RAW MATERIALS STORAGE AND HANDLING

Raw material and chemical storage will be required at the CCF as discussed above in Section 4. It is necessary to both store and handle new raw materials that are required for the function and standard operation of the carbon capture plants and associated infrastructure within the CCF. Ultimately this will comprise of a new above ground chemical storage warehouse and above ground storage tanks.

As part of the detailed design of the CCF Cory will aim to eliminate hazardous materials where feasible. When elimination is not feasible, usage will be minimised. As previously stated, areas designated for chemical handling will be paved and equipped with kerbing and/or bunding to contain potential spillages and leaks.

As stated in Section 4 above, the principle raw materials and chemicals for storage will include sodium hydroxide for neutralisation of the incoming flue gas and amine solvent for the CO_2 absorption process. This is in additional to smaller volume chemicals used within the CCF as shown in Table 4.1.

All spills will be manually cleaned and disposed of following the CCF's established spillage management protocols, as outlined in Cory's Environmental Management System (EMS). Any spillages with potential environmental harm or incidents resulting in such releases will be reported to site management and documented according to relevant procedures. The appropriate regulatory authorities, such as the EA or the Health and Safety Executive, will be notified of the incidents where applicable.

The effectiveness of emergency response procedures will undergo Management Review and will be revised and updated as necessary following any major spillages, incidents, or accidents. All liquid chemical storage will be confined within appropriately bunded and segregated areas.

Appropriate design features to minimise the likelihood and severity of any loss of containment will be incorporated within the CCF. These will include:

- Physical barriers to prevent damage to the pipelines;
- Pressure monitoring and pressure relief systems to prevent over-pressurisation situations;
- Leak detection systems;
- Containment infrastructure and measures such as bunding; and
- Features to isolate or shut down systems in the event of an abnormal operation, accident or incident.

All above-ground storage tanks (ASTs) will be enclosed within appropriately designed bunds that comply with CIRIA 736 guidelines. The bunded containment areas for bulk liquid chemicals will be sized to accommodate at least 110% of an individual storage vessel's capacity or 25% of the total volume for systems containing multiple vessels. In instances where spatial constraints affect bund sizing, certain bunds may exceed these minimum containment criteria. Bulk chemicals will be stored in segregated zones as detailed in Section 4.3.

The primary raw material for CCF operations will be the amine-based solvent. To minimise transportation requirements, the solvent will be supplied in a concentrated form and diluted on site as necessary. It will be stored in a dedicated Fresh Solvent Storage Tank with a capacity of approximately 130 m^3 and will be integrated into the lean solvent stream as needed. The Fresh Solvent Storage Tank will include a heating system to maintain suitable viscosity in colder conditions. The storage of amines requires consideration of their high reactivity, which can induce metal corrosion and generate degradation products. The construction materials for amine storage and dilution tanks, as well as associated pipeline systems, will be determined during detailed design. However, initial specifications suggest either stainless steel or carbon steel tanks with stainless steel lining and atmospheric fixed roofs. Additional containment information is detailed in Section 4.3.

The amine solvent designated for carbon capture operations exhibits low volatility, possessing a boiling point higher than that of water. Although characterized by a mild 'ammoniacal' odour, its low volatility significantly mitigates potential odour concerns during storage and handling. As a result, emission abatement systems are not expected to be required on storage tank breather vents, nor are back-venting measures expected to be necessary for tanker deliveries, but further assessment will be undertaken as part of the BAT review.

The site will feature one or two additional Amine Solvent Storage Tanks. These tanks will be designed to accommodate the full solvent inventory of the CCF, with additional capacity for flushing operations. Under normal conditions, these additional tanks will stand empty. However, they will be required when the CCF undergoes complete solvent drainage, such as during scheduled maintenance periods, anticipated at three-year intervals. Following maintenance, the stored solvent will be reintroduced to the CCF solvent system.

Additionally, minor quantities of other raw materials, such as maintenance chemicals, may be required. These substances will be stored in appropriately designed containment units including bunds, bunded pallets, drip trays, and specialised cabinets or cupboards. It is anticipated that any additional hazardous materials will be supplied, stored, and utilised in containers of approximately 1m^3 or smaller.

Surface water drains and attenuation system will contain isolation valves, to be closed in the event of accidental spillages and/or environmental incidents and accidents to ensure containment and prevent migration into the uncontaminated surface water drainage system.

An Indicative Site Layout is included in Appendix A and details the Chemical Storage Area and ETP. Upon completion of the detailed design, an updated site layout drawing detailing the location of material and waste storage areas will be produced.

4.2 ADDITIONAL MATERIALS

The CCF will also require the provision and utilisation of both heat (in the form of steam) and electricity, but these are assessed separately in Section 5 of this document.

4.3 CONTAINMENT INCLUDING BULK STORAGE

The CCF and associated Riverside 1 and Riverside 2 Energy from Waste Facilities are not classified as upper or lower tier sites under the thresholds outlined in the Control of Major Accident Hazards (COMAH) Regulations.

The CCF, similar to Riverside 1 and Riverside 2, will operate a hierarchy of containment measures from primary through to secondary and tertiary containment.

The CCF will receive regular inspections from the EA as their Competent Authority and Regulator, including reviews of emergency response plans.

All primary / secondary / tertiary containment systems at the CCF will be regularly inspected and maintained as detailed and required by Cory's Environmental Management System (EMS). Management arrangements and maintenance measures will include prescribed regular visual inspections, programmed engineering inspections and cleaning routines including emptying of rainwater to maintain the containment capacity.

Cory will implement good engineering practice to ensure application of Best Available Techniques (BAT) and minimum standard for all aspects of design, construction and operation are met.

All new tanks, bunding and containment within the CCF site will be designed and installed in line with good engineering practice and the requirements of CIRIA 736[18] and any other relevant guidance or standards, as is required.

CIRIA 736 provides guidance to operators on the identification and management of potential risks associated with the storage of hazardous substances and their potential impact on the environment. To effectively address these risks, the guidance recommends the use of a source pathway receptor model to assess whether there is a source, a receptor and a pathway by which the source material could reach the receptor. Using the guidance, the outcome of the model can be used to provide a site hazard rating (low, moderate or high) depending on the potential risk. This risk assessment then considers the likelihood of a loss of containment which is then combined with the site hazard rating to provide an overall site risk rating.

CIRIA 736 outlines a three-tiered classification framework (Class 1, 2 and 3) each representing a different level of integrity of secondary and tertiary containment to match the different requirements of high, moderate and low overall site risks. The classification system recommends different standards of construction, or levels of performance in accordance with each of the three levels of risk.

A low-risk site is Class 1, moderate is Class 2 and a high-risk site is Class 3. The site risk rating informs which of the three-tier risk-based classifications the site falls within. The primary goal of the containment system, as outlined in the guidance, is to effectively mitigate the potential pathway between a source and receptor.

Based on the risk assessment framework, the site is considered to be Class 1, although this will be reviewed during detailed design.

During the project's initial design, Hazard Identification (HAZID) studies identified potential risks related to chemical storage and usage for the CCF Plant. These will be reviewed and expanded upon during FEED with additional environmental and safety studies, including a Hazard and Operability Study (HAZOP).

Some materials of construction for tanks and bunds are not finalised and will be developed during detailed design. However, all materials of construction for primary and secondary containment will

[18] Design of containment systems for the prevention of water pollution from industrial incidents

be selected to ensure compatibility with the stored liquids in each primary containment tank. In addition, bunds will be designed to be resistant to the materials held in the storage tanks they contain, to ensure that wherever possible pipework does not penetrate the bund walls and to catch leaks from tanks or fittings.

A full risk assessment for the containment infrastructure will be undertaken as part of the detailed design of the decarbonisation project. A suitably qualified and competent Engineering, Procurement and Construction (EPC) contractor will be selected to complete the detailed design phase, including the design and specification of the necessary tank systems and their overfill protection measures, such as high-level alarms, trips and specification of leak detections systems.

Secondary containment bunds will be designed to have low point sumps. The sumps will be sized for one week's worth of average rainfall falling on the entire bund area up to a maximum of $1m^3$.

Automated systems, including high-level alarms and pressure feedback systems, will be subjected to routine testing and maintenance checks to ensure continued and optimum operating conditions.

Operators will also visually inspect and confirm / identify any high-level contents within bund sumps, in addition to use of automated systems as a failsafe, as part of daily routine walkarounds. Where high levels are identified, the site will arrange to test contents ahead of identifying a solution to remove the contents and review any failure of automated systems i.e. high-level alarm.

Drainage from bunds will be via a closed valve pit with appropriate sampling of bund contents prior to opening of the valve for collection / disposal.

A schematic showing the preliminary site surface water drainage arrangements for the CCF is provided in Appendix C and details of the storage and containment arrangements, based on the current design, are provided below in Table 4-2.

Table 4-2 – Bunding and Containment Arrangements for Bulk Storage

Tank ID	Primary Containment				Secondary Containment		Tertiary Containment
	Size	Holding Capacity	Material of Construction	Other	Bund Size	Bund Construction	
LCO_2	6 Vessels	24,000m^3	Low-temperature Carbon Steel		N/A	N/A	
Diesel	3.1m (L) x 1.2m (W) x 2.6m (H)	5m^3	Carbon steel	Appropriate instrumentation and procedure will be in place to prevent overfilling.	110% bund integral to tank.	Carbon steel, integral to tank.	Tertiary containment in the form of hardstanding with raised kerbs and sealed drainage systems will be present across the process site, final arrangements are to be confirmed at detailed design. Tertiary containment will reduce the impact of losing both primary and secondary containment simultaneously. Tertiary containment measures shall prioritise preventing offsite impacts. As such, spillages from Secondary containment will be routed into a kerbed area(s) whenever possible.

Tank ID	Primary Containment				Secondary Containment		Tertiary Containment
	Size	**Holding Capacity**	**Material of Construction**	**Other**	**Bund Size**	**Bund Construction**	
							Action shall also be taken to mitigate the potential for impact to the site drainage system.
Sodium hydroxide	To be confirmed as part of the detailed design	40m^3	Stainless Steel	Level gauge. Tank level checked to confirm sufficient capacity for road tanker contents. Operator in attendance during road tanker offloading. High level alarm. High-high level trip.	Bunds will be sized appropriately, following the CIRIA Risk Assessment process, but will be at least either 110% of the volume of the largest tank in the bund or 25% of the total volume of all the tanks in the bund.	Bunds will be designed and constructed according to the latest standard. For example, Eurocode 2, Design of concrete structures - Part 3 Liquid retaining and containment structures. Where it is identified, during detailed design, that the presence of reinforced concrete alone will not be adequate for long term containment then additives will be considered and as appropriate added to the concrete mix. Alternatively, bund liners will be specified in suitable materials, to provide additional	Tertiary containment in the form of hardstanding with raised kerbs and sealed drainage systems will be present across the process site, final arrangements are to be confirmed at detailed design Tertiary containment will reduce the impact of losing both primary and secondary containment simultaneously. Tertiary containment measures shall prioritise preventing offsite impacts.
Fresh Solvent Storage	To be confirmed as part of the detailed design	130m^3					

Tank ID	Primary Containment				Secondary Containment		Tertiary Containment
	Size	Holding Capacity	Material of Construction	Other	Bund Size	Bund Construction	
						resistance for product storage. Such materials have not yet been confirmed, however, this information can be provided to the EA when detailed design is complete, as part of a pre-operation condition in the Environmental Permit, if required.	
Effluent Treatment Chemicals	IBCs	10m³	IBCs in appropriate material for contents as delivered		As per supplier recommendation	Standard IBC spill trays	

4.4 WATER MANAGEMENT AND CONSUMPTION

4.4.1 PROCESS WATER RECYCLING

Raw water treatment will not be required for the CCF as Cory will utilise a net zero process water approach where the treated process effluent from the DCC is re-used to meet the process water demand. The ETP (Section 3.2.4.3) will treat the DCC effluent and the cooling blowdown for reuse to meet process and cooling requirements.

In line with the Industrial Cooling Systems BREF[19], in sites where water availability is limited, a technology should be chosen that enables recirculation of water. The cooling system utilises a net zero water approach which is consistent with BAT.

In order to prevent the contamination of amine-free DCC process effluent and cooling blowdown streams with amine, process water that has been contaminated with amines will be segregated to reduce the volume of effluent streams that require disposal. This demonstrates compliance with BAT for waste water collection and segregation from the BREF for Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector[20].

Most of the steam produced will be recycled as condensate when appropriate. Some condensate will be lost in the process, e.g. through blowdown to prevent build-up in the steam system. Steam losses will be determined at detailed design.

4.4.2 WATER CONSUMPTION

An 8,400m^3 tank will be installed at the southernmost part of the site to store treated water. This will serve as buffer storage for the process water requirements for CCF such as cooling water make-up. Final tank specification will be confirmed as part of the detailed design.

Potable water will be required for welfare facilities and emergency showers. This is expected to be obtained via Riverside 1 and Riverside 2 water connections.

Table 4-3 summarises the predicted water requirements of the CCF.

Table 4-3 – Water Requirement

Nature of Use	Volume/Annum m^3
Process water	no net water requirement
Estimated potable water consumption	550

A Mass Water Balance is provided in Appendix A, which provides preliminary details on how water will be used across the CCF. The process streams are detailed below in Table 4-4 and the processes are described and explained in detail at Section 3 of this Technical Supporting Document.

The Preliminary first fill of the cooling system and water supply will be part of the considerations made at detailed design.

[19] Industrial Cooling Systems | EU-BRITE
[20] Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector | EU-BRITE

Table 4-4 – Water Balance Streams

Stream Number	1	2	3	4	5	6	7
Description	DCC Process Effluent	Treated Water	Cooling Water Make-up	Blowdown	Evaporation Losses	CCF Process Water	Waste Sludge
Flowrate (m^3/hr)	167	172	172	5	167	TBD*	93kg/hr
*The CCF Process Water is to be determined as part of the detailed design.							

4.5 RHS INVENTORY

As stated above in Section 4.1, the use of hazardous materials will be eliminated by design where possible, and minimised where this is not possible.

Table 4.4 below identifies the current indicative list of RHS associated with the CCF.

Following the European Commission Guidance on baseline reports under Article 22(2) of the IED[21], a Stage 1 – 3 assessment will be conducted, to identify hazardous substances used at the CCF. Each of the assessment stages are described as follows:

- Identify which hazardous substances are used, produced or released at the CCF.
- Determine which of these substances are classified as 'relevant hazardous substances' according to Article 3 of EC Regulation 1272/2008. Provide justification for any hazardous substances excluded due to their inability to contaminate soil or groundwater.
- For each relevant hazardous substance, assess the potential for soil or groundwater contamination at the Site (including probability of release), considering quantities, storage, transport, and risk of release.

A full and detailed RHS assessment has been undertaken in line with H5 guidance (inclusive of Stages 1-3 as appropriate) and is appended to the SCR in Appendix F.

With the exception of the Amine Solvent, proxy Material Safety Data Sheets have been provided as part of the full RHS assessment. The RHS Inventory and assessment will be subject to review and update as the detailed design progresses.

Table 4-4 – Relevant Hazardous Substances

Substance	Hazardous? Y/N
Amine Solvent[22]	Y
Sodium hydroxide (20wt%)	Y

[21] EUR-Lex - 52014XC0506(01) - EN - EUR-Lex
[22] Specific solvent to be determined as part of the detailed design

Substance	Hazardous? Y/N
Anti-foam	N
Ammonia	Y
Propane	Y
Sodium hydroxide	Y
Diesel	Y
Citric acid	Y
Nitrogen	Y
Sodium bisulphite	Y
Sulphuric Acid	Y
Sodium hypochlorite	Y
Antiscalent	Y
Molecular Sieve	Y
Silica Gel	Y
Activated Carbon	N
Carbon Dioxide (liquified)	Y
Reclaimer Waste	Y

5 ENERGY CONSUMPTION

The CCF, along with the supporting and auxiliary plant, represent a parasitic load on Riverside 1 and Riverside 2 as is consistent with the EA Guidance[23], and therefore optimised integration of utilities for energy efficiency is paramount to maximising the overall CO_2 reductions of the project as a whole. As the CCF represents a parasitic load, this will lead to an overall decrease in the energy produced by Riverside 1 and Riverside 2. Consequently, the supply of steam and electricity to the CCF from Riverside 1 and Riverside 2 will reduce the amount of electricity exported from Riverside 1 and Riverside 2 by around 40%. The CCF has incorporated energy efficiency from the initial design and is a prime consideration in the selection of key equipment including compression and liquefaction. A review of Best Available Techniques [BAT] Conclusions: Energy Efficiency, amended September 2021[24] has been completed and is included in Section 11.3 of this report. Whilst Cory's IMS is not currently certified to ISO 50001, key aspects of the standard's intent have been integrated within ISO 14001 and the site intends to transpose these into their own management systems. The CCF aims to minimise the overall electricity output penalty of the EfWs, whilst meeting the 95% CO_2 capture requirements.

The CCF will be subject to regular planned and preventative maintenance in order to optimise efficiency of the installation as laid out in Section 10.5.

The key interfaces for energy efficiency within the CCF are:

- Amine Capture Technology
- Heat Recovery and Transfer System
- CO_2 Liquefaction technology
- High efficiency electric motors and variable speed drives for pumps
- Backpressure turbine and generators
- Wet / Hybrid and Dry Cooling System Flue gas reheating
- Steam condensate recovery
- Recovery of water streams

The energy performance of the system will be further refined as part of the detailed design. This will include insulation to reduce energy losses as appropriate.

The CCF will not be operating under the EU Emissions Trading Scheme[25], or a Climate Change Agreement[26], however the CCF will operate in accordance with and meet:

- Energy Efficiency standards for industrial plants to get environmental permits[27]
- BAT listed in the Reference Document on Best Available Techniques for Energy Efficiency Section 4: Best Available Techniques[28]; and

[23] Post-combustion carbon dioxide capture: emerging techniques - GOV.UK
[24] BAT reference documents | EU-BRITE
[25] UK Emissions Trading Scheme (UK ETS): technical guidance and tools - GOV.UK
[26] Climate change agreements - GOV.UK
[27] Energy efficiency standards for industrial plants to get environmental permits - GOV.UK
[28] ENE_Adopted_02-2009corrected20210914.pdf

- Emerging Techniques on how to prevent or minimise the environmental impacts of post-combustion carbon dioxide[29].

A review of the CCF against the relevant BAT standards is included in Section 11.

5.1.1 AMINE CAPTURE TECHNOLOGY

Shell's Cansolv technology utilises their proprietary advanced amine-based solvent and has reduced energy use and increased absorption rate which minimises overall energy consumption when compared to a generic monoethanolamine (MEA) solvent.

5.1.2 HEAT RECOVERY AND TRANSFER SYSTEM

The CCF will be capable of incorporating a Heat Recovery and Heat Transfer System so that this energy can be captured and redirected to heat networks. .

The CCF has the potential to provide a nominal supply 100MWth of additional heat, but there could be up to 300MWth of heat available from the Riverside Campus, which would benefit an even greater number of homes and businesses.

A Heat Transfer Station will be installed as part of the CCF It will accommodate the main operating plant and water treatment equipment necessary to support the heat transfer system, including thermal storage, and provide a connection into the receiving heat network and potentially backup heat generating plant in the event of outages.

The Heat Recovery and Heat Transfer system will include the following:

- Heat recovery equipment for the reuse of heat within the CCF
- Heat offtake equipment to either transfer the waste heat from the CCF to the circulating heat transfer medium, or route hot process streams directly to the heat transfer system via separate insulated pipes;
- Insulated pipework that will run from the heat offtake equipment or heat sources to the Heat Transfer Station; and
- A Heat Transfer Station, as above.

5.1.3 CO_2 LIQUEFACTION TECHNOLOGY

Dry CO_2 will be routed for liquefaction (by compression and refrigeration) via above ground pipelines.

The CCF will use a closed-cycle liquefaction system, where CO_2 gas is compressed then cooled via an external refrigerant loop. Closed-cycle liquefaction is more energy efficient than open-cycle liquefaction. Further, as the refrigeration loop is sealed, there is a reduced risk of releases to the environment.

5.1.4 HIGH EFFICIENCY ELECTRIC MOTORS AND VARIABLE SPEED DRIVES FOR PUMPS

To help reduce the energy consumption, the CCF will include selection of high efficiency electric motors, and variable speed drives for motors when appropriate, to power compressors, pumps, fans and any other power consuming equipment. Motors shall generally be three phase, squirrel cage induction motors, except where the application specifically requires a different motor type. Motors

[29] Post-combustion carbon dioxide capture: emerging techniques - GOV.UK

shall be suitably rated for the duty which they will undertake. Motors for variable speed applications shall be designed and rated specifically for use with variable speed drives. Motors for variable speed application shall be type tested with the specified drive and supplied as a matched pair.

5.1.5 BACK PRESSURE TURBINES AND GENERATORS

Steam is only available from Riverside 1 and Riverside 2 at high pressures; however, the CCF requires low and medium pressure steam. In order to maximise process efficiency, the CCF will utilise a back pressure turbine with de-superheating, as well as pressure reducing and de-superheating station (PRDS) to allow LP steam to be provided when the back pressure turbine is not operational.

The Back Pressure Turbine will maximise the extraction of energy within the steam during pressure reduction. This is followed by de-superheating to refine the temperature of the steam exiting the Back Pressure Turbine to the conditions required by the Solvent Regeneration System. As well as conditioning the steam from Riverside 1 and Riverside 2 for use at the CCF, the Back Pressure Turbine will supply a small amount of electricity to the CCF. The thermal energy within the steam entering the Back Pressure Turbine will be used to rotate the turbine shaft and subsequently drive the generator, thus generating power, and reducing the parasitic load on Riverside 1 and Riverside 2.

The CCF will have a 132 kV electrical supply to meet any additional electrical requirement on top of using electricity created by the back-pressure turbine, and to supply all of the electrical power requirements of the CCF at times when the back-pressure turbine is not operating. MP steam will be provided by a separate PRDS as the low volumes required are not expected to justify the installation of a backpressure turbine capable of producing both MP and LP steam, in place of the backpressure turbine described above. However, this will be confirmed at detailed design.

5.1.6 HYBRID COOLING TECHNOLOGY

There is no spare capacity within either of the cooling systems for Riverside 1 or Riverside 2. A new, standalone Cooling System comprising hybrid (i.e. plume-abated wet) cooling towers and air cooling is currently the preferred cooling configuration for the CCF as described above in Section 3.2.4.1. This is considered to represent BAT in cases for optimum overall energy efficiency[30] with additional benefits including water saving and visible plume reduction when compared to alternative options. The split of wet and dry cooling can be adjusted depending on the ambient weather conditions and the volume of water recovered from the Effluent Treatment Plant.

5.1.7 HEAT INTEGRATION

Heat is recovered from the hot solvent through the lean/rich solvent heat exchanger, where the heat from the hot lean solvent from the stripper is transferred to cold CO_2-rich solvent leaving the Absorber Column(s).

5.1.8 FLUE GAS REHEATING

The incoming and outgoing (abated) flue gas will pass through a gas-gas heat exchanger to simultaneously cool the incoming flue gas and reheat the outgoing treated flue gas to the extent

[30] Industrial Cooling Systems | EU-BRITE

necessary for adequate dispersion to ensure acceptable air quality impacts, as confirmed by the dispersion modelling.

5.1.9 STEAM CONDENSATE RECOVERY

Steam is required for several processes within the CCF as described in Section 3.2.5.1. Steam will be extracted from both Riverside 1 and Riverside 2 and supplied to the required processes. Once the steam has been used within the CCF, the resulting condensate will be returned to Riverside 1 and Riverside 2 respectively. It is likely to follow a similar route to the process steam piping.

5.1.10 ENERGY EFFICIENCY PLAN

An Energy Efficiency Plan will be built into the operation and maintenance procedures in the OEMP ensuring maximum practicable, sustainable, safe and controllable carbon capture. This plan will be regularly reviewed as part of the EMS and will be aligned to some of the key elements of ISO 50001.

6 EMISSION POINTS

6.1 EMISSIONS TO AIR

Point source emissions to air from the CCF will include:

- Stack(s) A1 and A2.
- The backup power generator A3.
- Two CO_2 vents A4 and A5.

The point source emissions to air relating to the CCF are summarised in Table 6-1 – Emission Monitoring Points and their location is shown on the Emission Point Plan located in **Error! Reference source not found.** of this document. All emission points will be within the confines of the minimum and maximum parameters set by the DCO for the stack height and will adhere to the assumptions of the Air Quality Risk Assessment (detailed below in Section 6.1).

Table 6-1 – Emission Monitoring Points

Reference	Emission Point	Height
A1	Train 1 - Stack	Maximum height of Absorber Column(s) and Stack(s) - 110m (113m Above Ordnance Datum (AOD)). Minimum height of the top of Stack(s) -100m Minimum distance between top of Absorber Column(s) and top of Stack(s) - 30m. Maximum internal diameter of Stack -3.1m.
A2	Train 2 – Stack	Maximum height of Absorber Column(s) and Stack(s) – 110m (113m AOD). Minimum height of the top of Stack(s) -100m Minimum distance between top of Absorber Column(s) and top of Stack(s) - 30m. Maximum internal diameter of Stack - 2.5m
A3	Backup Power Generator	Maximum height of 6m
A4	CO_2 Vent	Maximum height of 45m (48m AOD)
A5	CO_2 Vent	Maximum height of 45m (48m AOD)

6.1.1 BACKUP POWER GENERATOR

The final design of the backup power generator will be selected as part of the final detailed design, however based on professional judgement and similar project experience, together with the requirement to meet BAT, the following inputs have been used and represent a worst-case basis.

Table 6-2 – Proposed Backup Power Generator Stack Inputs

Parameter	Generators
Stack height (m)	6
Stack diameter (m)	0.5
Release temperature (°C)	450
Volume flux (m^3/s)	0.668

6.1.2 AEROSOL FORMATION

The potential for the formation of fugitive emissions will be managed to reduce the formation of aerosols and solvent carryover.

As part of the carbon capture process, exhaust gas will flow up through the Absorber Column(S) against a counter-current of solvent. In doing so, droplets of solvent, or solvent degradation products can become entrained in the gas. A water wash component in the Absorber(s) is used to capture aerosols and to reduce the levels of amines, and soluble amine degradation products such as nitrosamines and nitramines, in the treated flue gas.

Both the amine solvent and its main degradation products have low volatility, meaning that a single stage water wash is anticipated to be sufficient to limit emissions of these components well below ppm levels and thus are expected to ensure compliance with ELVs. However, this is dependent on the characteristics of the incoming flue gas, which will be fully evaluated as part of the detailed design. If determined to be required in detailed design, a "mist elimination" system will be added to the top of the Absorber(s), to provide further mitigation against aerosol emissions.

6.2 ASSESSMENT OF EMISSIONS TO AIR

6.2.1 H1 ASSESSMENT

The following section provides detail of the Environment Agency's H1 assessment, following the Regulator's Guidance[31] for using the assessment tool.

The H1 assessment provides screening and assessment of the potential effects to air quality for the predicted emissions associated with the CCF.

The back-up generator (emission point A3) has a net rated thermal capacity of less than 1 MWth and therefore falls outside of the scope of the Medium Combustion Plant Directive[32] and does not

[31] Risk assessments for specific activities: environmental permits - GOV.UK
[32] Directive - 2015/2193 - EN - EUR-Lex

require regulating under EPR. Details of the back-up generator have been included for reference and completeness only.

Venting will not occur during normal operating conditions and occur as result of the scenarios described in Section 12.10.1. The H1 tool does not list CO_2 as an option in the substance drop-down menu, and therefore it has not been included in this H1 assessment. However, the consideration and assessment of CO_2 venting will be assessed separately using advanced detailed modelling, using Phast Software, within the CO_2 venting assessment (included in Appendix J and summarised in Section 12).

Appendix B of this document contains the qualitative Environmental Risk Assessment.

6.2.2 H1 ASSESSMENT: EMISSIONS TO AIR

The H1 software tool has been used to complete a screening and risk assessment of the point source emissions to air at the CCF and to determine whether detailed air dispersion modelling is required as part of the permit application.

As is shown below, new emission release points A1 and A2, have been included in the H1 assessment, these have been added to the emissions inventory.

The H1 assessment determined that further detailed modelling would be required. A detailed air dispersion model and Air Emissions Risk Assessment (AERA) have been prepared in support of this new bespoke permit application, in order to predict the likely concentrations of key substances emitted to air at the location of nearby sensitive receptors and within a modelled grid over the surrounding area. The modelling was also used to calculate the potential for impact of nitrogen and acid deposition rates at local sensitive receptors and to inform the setting of potential Emission Limit Values (ELVs) within any potential future environmental permit. The findings of this study have been summarised in Section 6.2.3 and full report can be referenced at Appendix I.

The air release points and emissions inventory are shown in Figure 6- and

Figure 6- below, respectively.

Figure 6-3 - Air Release Points

Release point code	Location or grid reference	Activity/Activities	Effective height (metres)	Dispersion factor (Long term)	Dispersion factor (short term)	Dispersion factor (monthly)	Efflux velocity (m/s)	Total flow (m3/h)
A1	TQ 49610 80471	Train 1	100	0.11	8.6	0.13	32.4	572600
A2	TQ 49610 80471	Train 2	100	0.11	8.6	0.13	26.5	468700

Figure 6-4 - Air Emissions Inventory

Release Point	Substance	Measurement method	Operating mode(%)	Long term conc (mg/m3)	(long term)	(Long term)	Short term conc (mg/m3)	term)	(short term)	(t/yr)	(ug/m3)	(ug/m3)	(m3/h)
A1	Nitrogen oxides (as NO2) (ecological)	Estimated	100%	173	27.52	daily emission	385	61.24	half hourly emission	867.76	3.03	310.71	572600.00
A2	Nitrogen oxides (as NO2) (ecological)	Estimated	100%	78	10.16	daily emission	418	54.42	half hourly emission	320.25	1.12	276.13	468700.00
A1	Nitrogen dioxide	Estimated	100%	173	27.52	daily emission	385	61.24	half hourly emission	867.76	3.03	263.32	572600.00
A2	Nitrogen dioxide	Estimated	100%	78	10.16	daily emission	418	54.42	half hourly emission	320.25	1.12	234.01	468700.00
A1	Sulphur dioxide (24 hr mean)	Estimated	100%	38	6.04	daily emission	192	30.54	half hourly emission	190.61	0.66	154.95	572600.00
A2	Sulphur dioxide (24 hr mean)	Estimated	100%	31	4.04	daily emission	209	27.21	half hourly emission	127.28	0.44	138.07	468700.00
A1	Sulphur dioxide (15 min mean)	Estimated	100%		0.00		192	30.54	half hourly emission	0.00	0.00	351.93	572600.00
A2	Sulphur dioxide (15 min mean)	Estimated	100%		0.00		209	27.21	half hourly emission	0.00	0.00	313.58	468700.00
A1	Particulates (PM10)	Estimated	100%	4.8	0.76	daily emission	4.8	0.76	daily emission	24.08	0.08	3.87	572600.00
A2	Particulates (PM10)	Estimated	100%	5.2	0.68	daily emission	5.2	0.68	daily emission	21.35	0.07	3.44	468700.00
A1	Hydrogen chloride	Estimated	100%	7.733333333	1.23	daily emission	58	9.23	half hourly emission	38.79	0.14	79.34	572600.00
A2	Hydrogen chloride	Estimated	100%	6.3	0.82	daily emission	63	8.20	half hourly emission	25.87	0.09	70.54	468700.00
A1	Hydrogen fluoride	Estimated	100%	1	0.16	30min emissions	1	0.16	30min emissions	5.02	0.02	1.37	572600.00
A2	Hydrogen fluoride	Estimated	100%	1	0.13	30min emissions	1	0.13	30min emissions	4.11	0.02	1.12	468700.00
A1	Hydrogen fluoride (ecological)	Estimated	100%	1	0.16	30min emissions	1	0.16	30min emissions	5.02	0.42	0.81	572600.00
A2	Hydrogen fluoride (ecological)	Estimated	100%	1	0.13	30min emissions	1	0.13	30min emissions	4.11	0.35	0.66	468700.00
A1	Carbon monoxide	Estimated	100%	48	7.63	daily emission	144	22.90	10min emissions	240.77	0.84	137.88	572600.00
A2	Carbon monoxide	Estimated	100%	52	6.77	daily emission	157	20.44	10min emissions	213.50	0.74	123.05	468700.00
A1	Ammonia	Estimated	100%	7.5	1.19	30min emissions	7.5	1.19	30min emissions	37.62	0.13	10.26	572600.00
A2	Ammonia	Estimated	100%	9.3	1.21	30min emissions	9.3	1.21	30min emissions	38.18	0.13	10.41	468700.00
A1	Cadmium and compounds (as Cd)	Estimated	100%	0.019	0.00	daily emission	0.019	0.00	daily emission	0.10	0.00	0.02	572600.00
A2	Cadmium and compounds (as Cd)	Estimated	100%	0.021	0.00	daily emission	0.021	0.00	daily emission	0.09	0.00	0.01	468700.00
A1	Mercury and its inorganic compounds (as Hg)	Estimated	100%	0.019	0.00	daily emission	0.019	0.00	daily emission	0.10	0.00	0.03	572600.00
A2	Mercury and its inorganic compounds (as Hg)	Estimated	100%	0.021	0.00	daily emission	0.021	0.00	daily emission	0.09	0.00	0.02	468700.00
A1	Acetone	Estimated	100%	0.06	0.01	daily emission	0.06	0.01	daily emission	0.30	0.00	0.08	572600.00
A2	Acetone	Estimated	100%	0.075	0.01	daily emission	0.075	0.01	daily emission	0.31	0.00	0.08	468700.00
A1	Acetonitrile	Estimated	100%	0.216	0.03	daily emission	0.216	0.03	daily emission	1.08	0.00	0.30	572600.00
A2	Acetonitrile	Estimated	100%	0.27	0.04	daily emission	0.27	0.04	daily emission	1.11	0.00	0.30	468700.00
A1	Benzene	Estimated	100%	11.2	1.78	daily emission	22.4	3.56	half hourly emission	56.18	0.20	18.08	572600.00
A2	Benzene	Estimated	100%	12.2	1.59	daily emission	24.4	3.18	half hourly emission	50.09	0.17	16.12	468700.00
A1	Formaldehyde	Estimated	100%	0.746	0.12	daily emission	1.492	0.24	half hourly emission	3.74	0.01	2.65	572600.00
A2	Formaldehyde	Estimated	100%	0.932	0.12	daily emission	1.864	0.24	half hourly emission	3.83	0.01	2.71	468700.00
A1	Nickel and compounds (as Ni) except nickel carbc	Estimated	100%	0.289	0.05	daily emission	0.289	0.05	daily emission	1.45	0.01	0.40	572600.00
A2	Nickel and compounds (as Ni) except nickel carbc	Estimated	100%	0.314	0.04	daily emission	0.314	0.04	daily emission	1.29	0.00	0.35	468700.00

Please note that the reference conditions reflect the actual conditions and have not been normalised.

The Process Contributions (PC) of emissions to air are shown in Figure 6-.

Figure 6-5 - Process Contributions of Emissions to Air

Number	Substance	Long term EAL (ug/m3)	Long term PC (ug/m3)	Short term EAL (ug/m3)	Short term PC (ug/m3)
1	Nitrogen oxides (as NO2) (ecological)	30	4.143895556	75	586.8470007
2	Nitrogen dioxide	40	4.143895556	200	497.3279667
3	Sulphur dioxide (24 hr mean)	0	1.11	125	293.02
4	Sulphur dioxide (15 min mean)	0	0.00	266	665.50
5	Particulates (PM10)	40	0.16	50	7.31
6	Hydrogen chloride	0	0.23	750	149.88
7	Hydrogen fluoride	16	0.04	160	2.49
8	Hydrogen fluoride (ecological)	0.5	0.77	5	1.47
9	Carbon monoxide	0	1.58	10000	260.93
10	Ammonia	180	0.26	2500	20.67
11	Cadmium and compounds (as Cd)	0.005	0.00	0.03	0.03
12	Mercury and its inorganic compounds (as Hg)	0.06	0.00	0.6	0.05
13	Acetone	18100	0.00	362000	0.17
14	Acetonitrile	680	0.01	10200	0.60
15	Benzene	5	0.37	30	34.20
16	Formaldehyde	5	0.03	100	5.37
17	Nickel and compounds (as Ni) except nickel ca	0.02	0.01	0.7	0.75

The results of the first screening stage are summarised in Figure 6-.

Figure 6-6 - Results of H1 First Screening Stage

Number	Substance	Long term EAL (ug/m3)	Long term PC (ug/m3)	%PC of EAL (long term)	>1% of EAL? (long term)	Short term EAL (ug/m3)	Short term PC (ug/m3)	%PC of EAL (short term)	>10% of EAL? (short term)
1	Nitrogen oxides (as NO2) (ecological	30	4.143895556	13.81%	fail	75	586.8470007	782.46%	fail
2	Nitrogen dioxide	40	4.143895556	10.36%	fail	200	497.3279667	248.66%	fail
3	Sulphur dioxide (24 hr mean)	0	1.108815278			125	293.0199764	234.42%	fail
4	Sulphur dioxide (15 min mean)	0	0			266	665.5029972	250.19%	fail
5	Particulates (PM10)	40	0.158452556	0.40%	pass	50	7.308984244	14.62%	fail
6	Hydrogen chloride	0	0.225528009			750	149.8762611	19.98%	fail
7	Hydrogen fluoride	16	0.0376025	0.24%	pass	160	2.48755	1.55%	pass
8	Hydrogen fluoride (ecological)	0.5	0.7711405	154.23%	fail	5	1.4676545	29.35%	fail
9	Carbon monoxide	0	1.584525556			10000	260.9340572	2.61%	pass
10	Ammonia	180	0.26440975	0.15%	pass	2500	20.672035	0.83%	pass
11	Cadmium and compounds (as Cd)	0.005	0.000633175	12.66%	fail	0.03	0.029206649	97.36%	fail
12	Mercury and its inorganic compound	0.06	0.000633175	1.06%	fail	0.6	0.049502794	8.25%	pass
13	Acetone	18100	0.002123871	0.00%	pass	362000	0.166048083	0.00%	pass
14	Acetonitrile	680	0.007645935	0.00%	pass	10200	0.5977731	0.01%	pass
15	Benzene	5	0.370677389	7.41%	fail	30	34.19667402	113.99%	fail
16	Formaldehyde	5	0.026399633	0.53%	pass	100	5.366325467	5.37%	pass
17	Nickel and compounds (as Ni) excep	0.02	0.009553292	47.77%	fail	0.7	0.746893756	106.70%	fail

The figure above indicates that, for multiple substances, their respective level of emissions are above 1% and 10% of the long-term (nitrogen oxides (as NO_2) (ecological), nitrogen dioxide, hydrogen fluoride (ecological), cadmium and compounds (as Cd), mercury and its inorganic compounds (as Hg), benzene and nickel and compounds (as Ni) except nickel carbonyl) and short-term (nitrogen oxides (as NO_2) (ecological), nitrogen dioxide, sulphur dioxide (24 hr mean), sulphur dioxide (15 min mean), particulates (PM_{10}), hydrogen chloride, hydrogen fluoride (ecological), cadmium and compounds (as Cd), benzene and nickel and compounds (as Ni) except nickel carbonyl) Environmental Assessment Levels (EALs), respectively.

Therefore, these substances have been taken forward to the second stage of the assessment which considers the background concentration of substances being screened. It should be noted that revised background concentrations, were obtained from DEFRA's background concentration maps, APIS, AURN monitoring Network and the Heavy Metal Monitoring Network, and were then input into the second stage of the H1 risk assessment.

The results of the second stage screening is provided in Figure 6- below which details whether further modelling of emissions to air is required.

Figure 6-7 - Results of H1 Second Screening Stage

Number	Substance	Long term EAL (ug/m3)	Long term PC (ug/m3)	Air Background conc (ug/m3)	%PC of headroom (long term)	PEC Long term (µg/m3)	%PEC of EAL% (Long term)	%PEC of EAL>70%? (long	Short term EAL (ug/m3)	Short term PC (ug/m3)	%PC of the EAL-2*background	%PC of headroom >=20%? (short
1	Nitrogen oxides (as NO2) (ecological)	30	4.143895556	21.1	47%	25.24	84.15%	fail	75	586.8470007	1789.17%	fail
2	Nitrogen dioxide	40	4.143895556	21.1	22%	25.24	63.11%	pass	200	497.3279667	315.16%	fail
3	Sulphur dioxide (24 hr mean)	0	1.108815278	4.3	100%	5.41			125	293.0199764	251.74%	fail
4	Sulphur dioxide (15 min mean)	0	0	4.3	100%	4.30			266	665.5029972	258.55%	fail
5	Particulates (PM10)	40	0.158452556	15.9	1%	16.06	40.15%	pass	50	7.308984244	40.16%	fail
6	Hydrogen chloride	0	0.225528009		100%	0.23			750	149.8762611	19.98%	pass
8	Hydrogen fluoride (ecological)	0.5	0.7711405		100%	0.77	154.23%	fail	5	1.4676545	29.35%	fail
11	Cadmium and compounds (as Cd)	0.005	0.000633175	0.0001	13%	0.00	14.66%	pass	0.03	0.029206649	98.01%	fail
12	Mercury and its inorganic compounds (a	0.06	0.000633175		1%	0.00	1.06%	pass	0.6	0.049502794	8.25%	pass
15	Benzene	5	0.370677389	0.5	8%	0.87	17.41%	pass	30	34.19667402	117.92%	fail
17	Nickel and compounds (as Ni) except ni	0.02	0.009553292	0.0016	52%	0.01	55.77%	pass	0.7	0.746893756	107.19%	fail

The second screening stage results indicate that for multiple substances both the long (nitrogen oxides (as NO_2) (ecological) and hydrogen fluoride (ecological)) and short-term tests (nitrogen oxides (as NO_2) (ecological), nitrogen dioxide, sulphur dioxide (24 hr mean), sulphur dioxide (15 min mean), particulates (PM_{10}), hydrogen fluoride (ecological), cadmium and compounds (as Cd), benzene and nickel and compounds (as Ni) except nickel carbonyl)) were failed. Therefore, detailed air dispersion modelling has been carried out and is summarised below.

Some background air quality data was unavailable for some of the pollutants screened when completing the H1 tool. However, their impact has also been fully assessed in the detailed air dispersion modelling.

6.2.3 DETAILED DISPERSION MODELLING AND AIR EMISSIONS RISK ASSESSMENT (AERA)

This section sets out the approach and results from the detailed dispersion modelling assessment produced in support of the permit application for the CCF.

Specifically, dispersion modelling was undertaken to assess the impact of the carbon capture facility and its operation of the two-trains. Modelling has been undertaken using ADMS 6 (v6.0.0.1).

The full modelling report and associated supplementary information has been provided within Appendix I.

The format of the AERA report follows the requirements for dispersion modelling reporting set out in the EA risk assessment for air emissions guidance[33].

The overall conclusions of the air dispersion modelling are that **no significant effects are likely** with respect to both human health and local environmental habitats.

[33] Risk assessments for specific activities: environmental permits - GOV.UK

A concise and succinct summary of the assessment undertaken and its findings, for emissions from the whole Site, is included below.

For full detail and methodology, including further discussion and expansion of the findings please refer to Appendix I.

6.2.4 HUMAN HEALTH

6.2.4.1 Combustion-related Pollutants

The “With Carbon Capture” Process Contribution (PC) for existing combustion-related pollutants including nitrogen dioxide, sulphur dioxide, particulate matter, hydrogen chloride, hydrogen fluoride, ammonia and metals is **insignificant** or classed as **negligible** due to the predicted environmental concentration (PEC) being well within the Air Quality Assessment Levels (AQAL).

This conclusion is robust since the assessment has tended to overestimate impacts and the conclusions hold even if overall model uncertainty is taken into account (from general model uncertainty up to +/-50% for short term metrics and +/-10% for long term metrics).

6.2.4.2 Carbon-Capture Related Pollutants

The “With Carbon Capture” PC for direct emissions of amines, aldehydes, amides and other degradants except nitrosamines is **insignificant**. This conclusion is robust since taking account of overall model uncertainty (+/-50%, driven by overall model uncertainty), the process contribution will remain insignificant for all metrics.

The process contributions to concentrations of nitrosamines and nitramines in the Core Scenario (being the difference between operations at Riverside Campus with Carbon Capture) do not screen as insignificant, and the maximum modelled contribution with amines at their emission limit value is approximately 18% of the EAL for nitrosamines and 9% of the EAL for nitramines in residential receptor areas. However, the concentrations will not exceed the EAL even if uncertainty of +/-70% (driven by kinetic reaction parameter uncertainty) is taken into account and/or if the impact is assessed as nitrosamines and nitramines separately or combined.

Moreover, the EAL has been set conservatively at the EAL for one of the most toxic nitrosamines (NDMA) and the proposed ELV takes account of potential short-term fluctuations in emissions and hence is likely to overestimate typical (average) emissions. Therefore, taking into account the likely underestimation of nitrosamine and nitramine degradation/removal processes in the ADMS chemistry module, this is an **acceptable** maximum impact within the study area and health effects are likely to be insignificant.

6.2.5 ECOLOGY

6.2.5.1 Critical Levels

The “With Carbon Capture” PC for concentrations of NOx and SO_2 over sites designated for nature conservation is **insignificant** where any adverse impacts occur, and also beneficial in places. The conclusion is robust since taking a conservative view of overall model uncertainty of +/-10% (with the upper limit driven by long term concentration model uncertainty) together with the many conservative assumptions in the modelling, and the committed mitigation measures, the PC would remain **insignificant**.

The PC to concentrations of ammonia is beneficial over all sites, but any effects are unlikely to be measurable since total concentrations are dominated by emissions from agriculture and long-range transport.

6.2.5.2 Critical Loads

The PC to nitrogen and acid deposition is **insignificant** over all designated sites where any adverse impacts occur, and also beneficial in places. This is driven by the beneficial impacts on ammonia concentrations. Taking into account uncertainty (+/-10% driven by model uncertainty), committed mitigation measures and overall conservative assumptions in the modelling, this conclusion is robust.

6.3 EMISSIONS TO SEWER

A ZLD solution will likely be implemented at the detailed design phase. This option consists of concentrating contaminants to a solid waste, whilst allowing for the release of a source of water supply for the CCF (and thereby eliminating the need for make-up water). Therefore, no trade effluent connection will be required.

No surface water discharge into any public sewer, either a surface water or a combined sewer is being considered as part of this strategy.

Wastewater generated by the welfare facilities will be discharged into the local sewer network.

6.4 EMISSIONS TO WATER

It is proposed that pollution to the environment will be contained by means of bunding (where the surface water within these areas is only released to the environment once testing has proved it is suitable for discharge).

An isolation system (with monitoring) would be applied to all attenuation tanks preventing any inappropriate discharge into the surface water drainage network. These additional measures will help to mitigate the risk of potential pollution to the site and adjacent areas, including the Crossness LNR. The following aspects of the CCF are identified as requiring pollution prevention measures to collect and control potentially contaminated surface water runoff:

- Chemical storage and injection;
- Main electrical infrastructure, including transformers, and backup power generator;
- Solvent storage;
- Liquefaction and refrigeration part of the CO_2 compression, conditioning and liquefaction plants;
- Liquefied CO_2 Buffer Storage; and
- ETP.

The proposed drainage strategy is to split the CCF area into three main drainage catchments, namely North, Central and South as indicated in Appendix C. Each of these main catchments consist of sub catchments which will drain the surface water via new individual outfalls, mainly into the ditch network to the west. Any internal roads, with gradients towards Norman Road, will drain east via new separate outfalls, one into Norman Road Stream and others into the existing highway drain, both running along Norman Road. There will be 12 outfalls labelled N1-N12 as shown in the Indicative Drainage Layout in Appendix C.

An Outline Drainage Strategy is summarised in Section 7.2.2 and is consistent with the Outline Drainage Strategy submitted as part of the DCO, for which consultation with the EA has been undertaken.

6.5 NOISE AND VIBRATION

A Noise Impact Assessment has been undertaken by WSP on behalf of Cory in accordance with BS 4142:2014+A1:2019 to determine the likely noise impact arising from the operation of the CCF. This is included in Appendix G

A computerised noise model of the Site and the surrounding area was created using the CadnaA noise prediction software, which implements calculations to predict the effects on noise propagation of geometric spreading, topography, screening, meteorological conditions, based on information provided by the user regarding the sources of noise. Calculations were carried out in accordance with ISO 9613-2:2024 which assumes a moderate downwind condition in all calculations, as recommended in Section 5 of the same standard. Table 6-8 identifies the assumptions made for sound power levels and heights of each noise source that has been identified for the operation of the CCF, based on the evolving design.

Table 6-8 – Operation Noise Source assumptions

Noise Source	Sound Power Level L_{WA} dB	Height (m)	Information Source
Stack(s)	103	60[34]	Sound power level equivalent to the stack for Riverside 2, excludes the Absorber Column(s). Height of the Absorber Column(s) and Stack(s) is 113m.
Flue Gas Fan	85	9.8	Based on similar development (professional judgement).
Pumps	104	1	WKC Group Pump Noise Calculator, 450kW rich solution pump, assumed worst-case speed range.
Pumps associated with solvent/waste tanks	96	1	WKC Group Pump Noise Calculator, 100kW pump, assumed 1500rpm speed range.
Back Pressure turbines	85	6	Based on similar development (professional judgement).
33/11kV Transformers	78	6	Based on NEMA TR1[35] and the Institute of Electrical and Electronics Engineers (IEEE) standards for specifying sound pressure and converting to sound power.

[34] A precautionary height of 60m was used for the Stack(s) to represent a worst-case assessment in terms of noise propagation from this component to the nearest noise sensitive receptors.
[35] National Electrical Manufacturers Association (NEMA). (2019). NEMA Standards Publication TR 1-2013 (R2019) Transformers, Step Voltage Regulators and Reactors. United States of America.

Noise Source	Sound Power Level L_{WA} dB	Height (m)	Information Source
132/33kV Transformers	86	6	Based on NEMA TR1 and the IEEE standards for specifying sound pressure and converting to sound power.
CO_2 Vents	110	11.6	Based on similar development (professional judgement).
CO_2 Compressors	90	11	The CO_2 compressors are a part of the Compression Plant.
Refrigeration Package	98	1	Based on similar development (professional judgement).
Cooling Solution	93	15	Assumed as part of design based on similar developments.
Backup ASHP Fans	98	7.75	Assumed as part of design based on similar developments, height assumed to be 2.5m above the roof of building as a worst case.

It has been assumed that all plant would be running constantly for the entire assessment period during both the daytime and night-time as a worst-case with the exception of the CO_2 vents.

For the CO_2 vents, the sound power level presented above is derived from a 3-minute duration. Due to the nature of its operation, the sound power level has been assumed to only occur for 3 minutes within the time period of 1 hour during the daytime and 15 minutes during the night-time.

There are emergency pressure relief valves associated with the onsite LCO_2 temporary storage. These valves will release LCO_2 should pressure within the temporary storage become too great, to avoid damage. As the valves will only be used in emergency situations and are not considered part of typical activities, they have not been included within this assessment.

In accordance with BS 4142 a difference of around +5 dB is likely to be an indication of an adverse impact, depending on context, and a difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on context. The results above show that a significant adverse impact from the CCF is unlikely to occur at the receptors as the rating levels are predicted to exceed the background levels by no more than +7 dB without any additional mitigation measures in place.

The results showed that without any additional mitigation measures, the operational noise rating levels would exceed the operational noise limits by up to +7 dB. This exceedance is largely due to the backup Air Source Heat Pump (ASHP) fans of the CCF. As such, options for mitigation measures have been considered which would provide the attenuation required to result in a reduction in noise levels such that the operational noise rating levels do not exceed the operational noise limits set out in the DCO. For example, the ASHP could have an acoustic barrier surrounding the ASHP fans to provide appropriate acoustic mitigation. Further, the ASHP are a back-up and would only be used on a contingency basis on those occasions when there is no thermal capacity available from R1 and R 2.

Although the details of the final mitigation measures are not yet available, through the DCO, a Noise Mitigation Plan to detail the final mitigation measures and demonstrate compliance with the operational noise limits will be prepared and submitted to and approved by the relevant planning authority in writing prior to the operation of the CCF.

The combined noise levels from the CCF, Riverside 1 facility and the Riverside 2 facility (currently under construction) were also predicted based on the specific sound levels presented in the noise assessment for their respective planning applications. The initial estimate indicates a low cumulative impact (barely audible or detectable noise) during the daytime and at night.

Considering the results of the initial impact estimation for the CCF as well as the CCF in combination with the existing Riverside 1 facility and the Riverside 2 facility cumulatively and taking account of contextual evaluation and the additional mitigation measures to be implemented, it is concluded that the operation of the CCF will not lead to a significant noise adverse impact or noise ‘pollution’ at receptors.

6.6 ODOUR

Odour has been considered and assessed within the ERA for the CFF. The risk posed to the Site and surrounding environment is considered to be not significant with management practices adhered to. Please refer to Appendix B for full detail.

6.6.1 POTENTIAL ODOUR SOURCES

6.6.1.1 Amine Solvent

The amine solvent designated for carbon capture exhibits a boiling point of 246°C, i.e. higher than water, and it has a very low vapour pressure. Although characterized by a mild ‘ammoniacal’ odour, its low volatility significantly mitigates potential odour concerns, especially with regard to the storage and handling of the solvent. As a result, emission abatement systems are not expected to be required on storage tank breather vents, nor are back-venting measures expected to be necessary for tanker deliveries, but further assessment has been undertaken as part of the BAT review in Section 11 of this document.

The temperature in the stripper will be process controlled, to limit the amount of amine degradation products (e.g. nitrosamines and nitroamines) from being formed. Solvent dosing and reaction rates will be controlled in accordance with the parameters set out by the licensor, and these will be monitored through an automated control system as well as the monitoring arrangements set out in Section 7.4 of this report.

The Absorber(s) gas treatment system includes a water wash component, which will reduce levels of amines and soluble amine degradation products, and a mist eliminator will be implemented on top of the Absorber(s) if required to remove aerosols and solvent carryover.

The transfer of reclaimer waste will be conducted within designated chemical handling areas, using sealed systems as appropriate and established management practices using competent staff and contractors.

6.6.1.2 Ammonia (use as refrigerant)

Given that ammonia is already used at Riverside 1 and will be used at Riverside 2, Cory are adept and experienced with handling procedures and how to minimise the potential odour. Should ammonia be selected for use as part of the final design, this would be within a closed loop refrigeration system, which only requires a one-time fill and occasional maintenance carried out by licensed contractors. There will be no need or arrangement for bulk storage of ammonia, if selected as the choice of refrigerant. Detailed design will further assess options to ensure minimisation of the potential for odour generation associated with the commissioning of the refrigeration plant.

6.6.1.3 Effluent Treatment Plant (ETP)

The ETP will be designed to ensure fugitive emissions will be minimised as far as is reasonably practicable through the detailed design.

All chemicals used for effluent treatment will be appropriately stored in sealed containers when not in use. Sludge from the ETP will be collected promptly in order to minimise residence time and, in alignment to manufacturers specification, will be stored appropriately in enclosed covered skips prior to removal.

6.6.2 MANAGEMENT AND CONTROL MEASURES

Cory will implement good management practices and operating techniques in accordance with their certified IMS. The CCF will be operated in accordance with manufacturers recommendations and guidance.

The CCF will use and store all raw materials, chemicals and wastes in accordance with appropriate management practices, and the loading and unloading during delivery will be supervised. Tanker deliveries of substances with a risk of odour, odorous air will be vented into the delivery tankers. All chemicals will be stored in appropriately sealed containers when not in use. Where necessary, bulk storage tanks will have abated breather vents.

The CCF will be subject to a daily inspection, and any unusual odours will be assessed in accordance with appropriate EMS procedures. Any odours detected will be logged with any corrective actions undertaken.

The effectiveness of odour control measures will be reviewed at least once a year; however, this interval will be shorter should substantiated odour complaints or relevant changes to the CCF occur.

6.6.3 COMPLAINT PROCEDURE

The installation's EMS will ensure that any odour issues are managed in accordance with Cory's procedure: Communication (IMS-MP-07) which states:

- All complaints received from external parties are managed in accordance with the site-specific Work Instruction on how to deal with complaints. Details of the complaint are recorded on the relevant site record. The Site Manager/HSEQ Assurance Team on notification of an external complaint will respond accordingly.
- Complaints received from internal parties are managed in accordance with the site-specific Work Instruction on how to deal with complaints. Details of the complaint are recorded on the relevant site record. The Site Manager/HSEQ Assurance Team on notification of an internal complaint will respond accordingly if the incident relates to the IMS.
- Complaints will be fully investigated, within a specified timeframe, to confirm whether it is justified or inconclusive. Investigations will include review of operational activities at the time of the complaint and where justified, a review of the operational actions taken, mitigation

measures and event response would be undertaken, recorded and reported to the Regulator through a Schedule 5 submission.

6.6.4 ADDITIONAL MEASURES

ELV's and monitoring requirements, specific to odour, within the permit are not considered to be appropriate for the CCF given that there are limited sources of odour, and CCF design will minimise the risk of odour. This will be considered further as part of the detailed design and may include measures, where applicable, such as:

- Carbon filters;
- Containment of odorous streams (e.g. enclosed process, sealed containers and interlocking transfer valves); and
- The stack height and emission temperature of exhaust gases, required to minimise impacts on air quality and odour receptors will be determined as detailed in Section 6.1.

As suitable controls are in place, an Odour Management Plan is not considered to be required for the proposed installation. This is consistent with the Regulator's previous permit determinations for carbon capture within this sector and aligns with the post-combustion carbon dioxide capture: Emerging techniques on how to prevent or minimise the environmental impacts of post-combustion carbon dioxide capture. *Published 2 July 2021 (updated 27 March 2024)*.

6.7 EMISSIONS TO GROUNDWATER

There are no intended emissions to groundwater.

Equipment that is considered to be sensitive to flood water inundation will be protected by either locating equipment on a platform raised to a height above the maximum breach flood level (including welfare facilities required for safe refuge), or protecting equipment by an impervious bund raised to a height above the maximum breach flood level. Further information is provided in Section 10.9 Climate Change and Flood Risk.

The material for site raising will require compaction and consolidation and will consequently be unlikely to provide suitable infiltration potential. The CCF has been considered unsuitable for the implementation of infiltration-based SuDS based on the following:

- Because of the underlying geology;
- The low infiltration potential resulting from the cohesive soil associated with the underlying alluvium superficial deposits;
- The presence of shallow groundwater levels; and
- Potential presence of contamination.

On the basis of the above information, the use of infiltration methods for surface water drainage have been discounted.

7 MONITORING ARRANGEMENTS

Cory's IMS procedure Monitoring, Measurement, Analysis and Evaluation (IMS-MP-06) outlines the necessary processes, as deemed necessary to meet compliance obligations, are managed and therefore subject to adequate monitoring and measurement. This is undertaken both internally and externally and includes both proactive and reactive methods.

7.1 INFRASTRUCTURE MONITORING

The monitoring and assessment of the CCF infrastructure will be systematically integrated into site-wide operational procedures and management frameworks. Monitoring of all the CCF infrastructure will be undertaken as part of the site's operating procedures and management systems, ensuring adherence to established protocols and engineering best practices. A proactive and defined methodology will be employed to uphold infrastructure integrity, operational efficiency, and system reliability.

Plant maintenance is undertaken in accordance with relevant UK legislation ensuring that all plant is certified and fit for proper use, subject to appropriate internal/external testing and maintained in accordance with the manufacturers' guidance. All mobile plant is subject to daily pre-use checks, ensuring that all defects are reported and repaired within an appropriate time scale. Only maintenance staff are able to advise on when plant should and should not be used and their decision is final.

7.2 EMISSIONS TO WATER

The CCF will not have any process discharges to water or sewer. Indicative surface water drainage arrangements are shown in Appendix C, and a detailed description is provided in Section 6.3 and further detail below.

7.2.1 SITE DRAINAGE

The EA have produced guidance, detailed below, on surface water which states that you do not need a permit:

- To discharge uncontaminated water, such as clean rainwater from roofs or from small areas of hardstanding to surface water.
- To discharge uncontaminated water collected from public roads and small parking areas (that's been through a properly maintained oil separator) to surface water.

Outline surface water drainage plans are provided in Appendix C. The proposed drainage plans comply with the established criteria outlined in the following guidance and standards:

- *Discharges to surface water and groundwater: environmental permits. When you need an environmental permit to discharge liquid effluent or wastewater to surface water or the ground, and how to apply*, published 1 February 2016 and updated 30 September 2024[36];
- Sewerage Sector Guidance document; SSG Appendix C – Design and Construction Guidance v2.1[37];

[36] Discharges to surface water and groundwater: environmental permits - GOV.UK
[37] SSG Appendix C - Design and Construction Guidance v2-3_0.pdf

- DEFRA's non-statutory technical standards for Sustainable Development Systems Section 4[38]: *"Runoff volume from the development in the 1 in 100-year, 6 hours rainfall event should not exceed the greenfield/brownfield runoff volume for the same event;*
- LBB Council's Sustainable Drainage Systems (SuDS) Design & Evaluation Guidance[39]; and
- CIRIA C753: The SuDS Manual[40].

A detailed drainage strategy will be developed as part of the detailed design, to ensure that the proposed surface water drainage system meets the requirements of BAT within the EA's "post-combustion carbon dioxide capture: Emerging techniques on how to prevent or minimise the environmental impacts of post-combustion carbon dioxide capture.41" Published 2 July 2021 (updated 27 March 2024).

The location of the CCF comprises relatively flat land to the immediate south of Riverside 1 and Riverside 2. Most of this land is currently being used as construction compounds for Riverside 2 or for other industrial/commercial development, with undeveloped grassland occupying the northern and southern area.

These areas either positively or naturally drain surface water runoff via overland flows/pipes towards a number of interconnecting watercourses, including ditches, leading to the water bodies within, and adjacent to the Site. These features ultimately flow towards the existing Environment Agency operated surface water pumping stations (Great Breach Pumping Station located 40m west of the Site Boundary and the Green Level Pumping Station located approximately 1km to the southeast of the Site Boundary).

7.2.2 OUTLINE SITE DRAINAGE STRATEGY

The proposed site drainage strategy is to split the CCF into three main drainage catchments, namely North, Central and South as indicated in the Indicative Drainage Layout in Appendix C. Each of the main catchments consist of sub catchments which will drain clean surface water via new individual outfalls, mainly into the ditch network to the west. Any internal roads, with gradients towards Norman Road, will drain east via new separate outfalls, one into Norman Road Stream and others into the existing highway drain, both running along Norman Road.

The surface water outfall locations designated for the CCF will ensure that the appropriate gradients and velocities are achieved within the proposed surface water drainage network. The Outline Drainage Strategy drawings (showing this working in practice with an example layout based on the Indicative Equipment Layout Drawing) are included in Appendix C.

Discharge rates at the gravity outfalls within the installation boundary are likely to be dictated by the pipe size and gradient, as no formal attenuation (in addition to the gravel sub-base to the compound and the internal ditches) has been observed at the CCF site.

Areas with a risk of contamination to the environment, such as operational process areas and storage areas, will be contained by means of primary and secondary containment i.e. double

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[38] National standards for sustainable drainage systems - GOV.UK
[39] London Borough of Bexley (LBB) Sustainable Drainage Systems (SuDS) Design & Evaluation Guide, by McCloy Consulting & Robert Bray Associates, dated 2018
[40] CIRIA C753: The SuDS Manual, dated December 2015, updated in February 2021, Item Detail (ciria.org)
[41] Post-combustion carbon dioxide capture: emerging techniques - GOV.UK

skinned tanks and use of bunding. An isolation system, with monitoring, will be applied to all attenuation tanks preventing any inappropriate discharge to either ground or the surface water drainage network. The location of these monitoring chambers is shown in the proposed Drainage Layout Plans as included in Appendix C.

Process effluent will be treated as part of a ZLD solution, which will utilise treated process effluent as makeup water and concentrate waste, through removal of water, into a solid for disposal offsite. The surface water drainage system is only intended for clean surface water runoff and rainwater.

7.2.3 SURFACE WATER MANAGEMENT

To ensure that there are no adverse impacts on the water environment, this section outlines the measures that will be implemented as part of the operational phase to ensure that surface water discharged to the environment is of a managed and uncontaminated state, suitable to prevent any harm or impact on the water environment and associated habitats and where possible provide enhancements.

There are three aspects to this, which are addressed in turn:

- Quality of the routine runoff;
- Quality associated with the spillages/leakages of chemicals used/stored on site; and
- Firewater.

The SuDS Manual[42] sets out a common approach to managing the quality of surface water runoff. It describes risks posed by surface water runoff to the receiving environment as a function of:

- The pollution hazard at a particular site (i.e. the pollution source);
- The effectiveness of SuDS treatment components in reducing levels of pollutants to environmentally acceptable levels (i.e. the pollutant pathway); and
- The sensitivity of the receiving environment (the environmental receptor).

It is proposed that areas with the highest risk of pollution to the environment will be contained by means of primary, secondary and tertiary containment as appropriate including the use of bunding (where the surface water within these areas is only released to the environment once testing has proven its uncontaminated and suitable for discharge). An isolation system (with monitoring) would be applied to all attenuation tanks preventing any inappropriate discharge into the surface water drainage network. These additional measures will help to mitigate the risk of pollution from the CCF to the surrounding areas.

The following aspects of the CCF are identified as requiring pollution prevention measures to collect and control potentially contaminated surface water runoff:

- Chemical storage and injection (a part of the Carbon Capture Plant (s));
- Main electrical infrastructure, including transformers, and backup diesel generator;
- Liquefaction and Refrigeration part of the CO_2 Compression, Conditioning and Liquefaction Plants;
- LCO_2 Storage; and
- ETP.

[42] CIRIA C753: The SuDS Manual, dated December 2015, updated in February 2021, Item Detail (ciria.org)

The indicative location of the proposed bunded areas is also outlined in the Indicative Drainage Layout in Appendix C.

The design of the CCF will consider the relevant regulations, approved codes of practices, design codes and guidance applicable to the systems proposed.

The CCF is to be designed in accordance with Dangerous Substances and Explosive Atmospheres (DSEA) Regulations[43], Control of Substances Hazardous to Health (COSHH) Regulations[44], HSG140 Safe use and handling of flammable liquids guidance[45], L5 Control of substances hazardous to health ACOP and guidance[46] and CIRIA's Design of containment systems for the prevention of water pollution from industrial incidents[47].

Appropriate design features will be incorporated within the CCF, such as containment measures and barriers to prevent damage to pipelines, pressure monitoring and pressure relief systems to prevent over pressurisation situations and leak detection systems will be installed, features to minimise, isolate or shut down systems in the event of an abnormal plant performance. The surface water drains, and attenuation system will contain isolation valves, to be closed in the event of accidental spillage that has to potential to reach the uncontaminated surface water drainage system and the inclusion of pollution prevention/control measures, including primary, secondary and tertiary containment measures, such as the use of double skinned storage vessels and bunding.

Operational activities/management regimes will be controlled through adherence to the Environmental Permit, preparation of operational emergency plans (covering chemical leak scenarios), transportation of hazardous/dangerous loads in appropriate vehicles in accordance with relevant legislation and guidance, including The Dangerous Substances (Conveyance by Road in Road Tankers and Tank Containers) Regulations[48] and International Carriage of Dangerous Goods by Road (ADR)[49], and adherence to all relevant approved codes of practice (ACOP) and guidance including, but not limited to, the following: HSG140 Safe use and handling of flammable liquids guidance[50]; L5 Control of substances hazardous to health ACOP and guidance[51] and L138 Dangerous substances and explosive atmospheres ACOP and guidance[52] Furthermore, when the surface water runoff is collected and enters the onsite drainage system, discharge valves at the outfall points will be kept closed initially to allow for testing as required.

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[43] Dangerous Substances and Explosive Atmospheres Regulations 2022 No. 2776
[44] Control of substances hazardous to health (COSHH) - HSE
[45] HSE (2015) HSG140 Safe use and handling of flammable liquids guidance
[46] HSE (2013) The Control of Substances Hazardous to Health Regulations 2002. Approved Code of Practice and guidance (L5)
[47] CIRIA (2014) Design of containment systems for the prevention of water pollution from industrial incidents (C736)
[48] The Dangerous Substances (Conveyance by Road in Road Tankers and Tank Containers) Regulations 1981 No. 1059
[49] Economic Commission for Europe Inland Transport Committee (2023) Agreement Concerning the International Carriage of Dangerous Goods by Road
[50] HSE (2015) HSG140 Safe use and handling of flammable liquids guidance
[51] HSE (2013) The Control of Substances Hazardous to Health Regulations 2002. Approved Code of Practice and guidance (L5)
[52] HSE (2013) Dangerous Substances and Explosive Atmospheres Regulations 2002. Approved Code of Practice and guidance (L138)

If surface water runoff was found to be contaminated, then the water would be diverted to a storage tank prior to removal and treatment offsite under a waste transfer licence to a suitable licensed wastewater treatment facility.

Hydrocarbon / Oil Water Interceptors (OWIs) will be installed in high-risk areas, such as parking, unloading, and refuelling zones, to filter out and capture any potential hydrocarbons from surface water runoff before it can leave the site. A stringent schedule of regular inspections and maintenance for the OWIs and all storage vessels will be implemented, to further mitigate the risk of accidental leaks. The focus will be on diesel generator, and storage areas to ensure integrity and leak prevention

The controls to manage this process would be included in the CCF's Emergency Preparedness and Response Plan, to be certified in compliance with ISO 14001, and also in accordance with the Preliminary Accident Prevention and Management Plan and Outline EPRP prepared pursuant to the DCO.

In addition to the above:

- Oil storage for the flue gas blower, CO_2 compressor and air compressor unit would be designed in accordance with the Control of Pollution (Oil Storage) (England) Regulations 2001[53]; and
- All amine systems will be contained within either a bunded or kerbed area, to be confirmed as part of the detailed design. The bunds and/or kerb will be designed in accordance with the COSHH/HSE guidance/ GPPs requirements at the detailed design stage.

As part of the detailed design, an assessment of the risk for all the tanker/chemical unloading bays will be undertaken. This will determine whether they are designed as fully bunded areas or require suitable protection measures to prevent the entry of any spillages to the onsite surface water drainage systems. The bunds, if required, will be designed in accordance with the COSHH/HSE guidance/GPP requirements at the detailed design stage.

There would be additional control measures in accordance with the ISO 14001 certified EMS within the APMP for the CCF in order to control surface water runoff that could become contaminated by chemicals and oil. These would include, but not be limited to, the following:

- A minimum of twice daily checks undertaken to inspect for chemical and oil leakage. Furthermore, there is a constant presence of key operative staff at the CCF with responsibility to undertake informal checks as part of their other duties and could undertake immediate rectification/pollution prevention measures as required.
- Drip trays, or similar, would be installed under pumps to capture any potential leaks.
- Leakage detection systems will be considered for high-risk areas during detailed design.

Fire water pollution prevention measures will be incorporated within the drainage network for the CCF including profiling roads towards attenuation features that will offer containment. This will enable flows from the outfalls to be isolated (e.g. via a penstock or similar), with fire waters retained within the CCF area. These would consequently be treated on site or transported offsite for treatment/disposal as appropriate.

[53] Guidance note for the Control of Pollution (Oil Storage) (England) Regulations 2001

Further to the above, the site's clean surface water drainage system will include a downstream defender that will be installed at all outfall locations and oil water separators (OWIs) as identified and required during detailed design in accordance with the standard practice. 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 to the CCF as detailed in the Surface Water Management and Drainage Plan included in Appendix E.

Any potential for contaminated drainage would be intercepted by adherence to the site's operating procedures and management of the drainage system, which will manage connection points with attenuation tanks, filter drains, and attenuation ponds utilised to control the discharge quality and rate to the existing drainage ditches.

Ground investigations will determine mitigation requirements at detailed design including considerations of changes in groundwater abstractions adjacent to the CCF. IF shallow groundwater levels are identified or expected within the superficial deposits, mitigation to prevent groundwater flooding may include measures for additional groundwater drainage and/or formation of granular pathways to introduced flow barriers (i.e., perimeter sheet pile wall). This will ensure groundwater flow conditions are only altered locally.

7.3 EMISSIONS TO AIR

Continuous Emissions Monitoring Systems (CEMS) will be installed downstream of the CCF Plant and process. Additionally, CEMS are fitted and utilised at both of the Energy from Waste facilities, Riverside 1 and 2, monitoring the following substances during normal operating conditions on a continual basis:

- Oxides of nitrogen (NO_x)
- Sulphur dioxide (SO_2)
- Carbon monoxide (CO)
- Ammonia (NH_3)
- Oxygen (O_2)
- Particulate matter
- Total organic Carbon (TOC)
- Hydrogen chloride (HCl)
- Mercury and its compounds
- Nitrous Oxide (N_2O)
- Carbon Dioxide (CO_2)

Some extractive periodic monitoring and sampling is also set within the environmental permits, including:

- Hydrogen fluoride
- Cadmium, Thallium and their compounds (total)
- Heavy Metals/Metalloids (Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V and their compounds (total))
- Dioxins / furans (I-TEQ / WHO-TEQ)
- Dioxin-like PCBs
- Polybrominated dibenzo-dioxins and furans
- Specific individual poly-cyclic aromatic hydrocarbons (PAHs)

In addition, the following parameters are also measured using CEMS during normal operating conditions on a continual basis:

- Exhaust gas temperature

- Exhaust gas pressure
- Exhaust gas flow
- Exhaust gas oxygen content
- Exhaust gas water vapour content

The new CCF Plant will accept the pre-treated exhaust gases for Riverside 1 and Riverside 2. This will be post-abatement and treatment, with the exhaust gases being monitored as per the permit requirements at a point before the gases are taken forward to the CCF for CO_2 absorption. The design is such that the exhaust gases will then be subject to the carbon capture process, further monitoring and emitted during normal operating conditions from the stack(s), Emission Points A1 and A2, which will become the principle point source emissions to air and compliance monitoring points for the CCF. Cory propose to assess compliance with ELV's prior to Carbon Capture.

When the CCF / CO_2 Absorber Column(s) and stack(s) are offline, for example during a planned maintenance outage, the compliance point and emission location will revert back to the existing stacks and current permitted discharge points for Riverside 1 (A1, A2 and A3) and Riverside 2 (A1 and A2).

The existing CEMS in the exhaust stacks from Riverside 1, and the CEMS that will be installed in the exhaust stacks from Riverside 2, are at locations that will become the "bypass stacks" once the CCF has been installed. These locations would consequently not see any flow when the CCF is in operation under standard operating conditions. The detailed design will include tie-in points and transfer ducting for exhaust gases, as well as locations for additional CEMS and monitoring points to meet permit requirements for monitoring flue gas before it leaves the site.

In addition to DESNZ requirements, there will be a requirement to install pre-capture metering systems to quantify the CO_2 in the streams from Riverside 1 and Riverside 2 that are routed to the capture plant; these will take the form of CEMS but specifically provided to measure the total flowrate and CO_2 content, in order to derive the CO_2 mass flow. Depending on where the pre-capture meters are located, either two (one on each of the main ducts from Riverside 1 and Riverside 2) or five (one on the flue gas stream from each individual line) CEMS will be required for pre-capture metering. A minimum accuracy of 7.5 % in the pre-capture CO_2 mass flowrate is required by DESNZ, and this will be considered in the final design when selecting CEMS equipment.

The new ductwork tie-ins from Riverside 1 and Riverside 2 will include a damper (shut-off valve) to enable flue gas to be directed to either the CCF, or to the pre-existing Riverside 1 and Riverside 2 exhaust stacks if the CCF is not able to operate or is operating at a reduced capacity. At such time, the pre-existing CEMS will have to be utilised to monitor CO_2 mass flow rate. This may require modification to the existing CEMS.

Following the construction and operation of the CCF, additional CEMS will be required to demonstrate compliance with the annual ELVs proposed at Emission Point A1 and A2 of the CCF Plant. These CEMS will demonstrate that the exhaust gas post carbon capture is below the ELVs set. CEMS will be certified at the appropriate range according to the EA's monitoring certification scheme (MCERTS). They will also meet the quality assurance requirements of EN 14181 as appropriate.

The two new stack(s) (Emission Point A1 and A2) will also require additional monitoring for amines and their degradation products. Where possible this will be with additional CEMS, provided that available technologies are compatible with the amines within the solvent. Where this is not possible, periodic extractive monitoring will be carried out or alternative methodology for monitoring as set and agreed with the EA.

Given that the CCS is still an emerging technology, there are currently no recommended monitoring methodologies that are widely utilised. The EA has commissioned the National Physical Laboratory (NPL) to create periodic monitoring methods for amines and breakdown species. Recently, the NPL published a review of potential monitoring techniques. The review explores the potential of Fourier Transform Infra-red (FTIR) and Proton Transfer Reaction-Time of Flight-Mass Spectrometry (PTR-TOF-MS) for monitoring amine and nitrosamine emissions. These technologies can measure concentrations down to parts per trillion levels. However, they are not widely established nor commercially available. The NPL review explains extractive monitoring using solution-filled absorbers or sorbent tubes. With a saturated flue gas the preceding method is more favourable, as sorbent tubes require a dry sample. Detection limits are a concern because degradation products are expected to be at very low levels in the CCF flue gas. The review outlined the limitations of various potential monitoring methods. Continuous monitors, for instance, face challenges due to the necessity of heated sample lines, which are required because of the potential presence of moisture or water. This condition could lead to the degradation of nitrosamines. Alternative condenser systems would likely remove nitrosamines due to their solubility. Furthermore, PTR-TOF-MS was largely dismissed as it is not commercially available.

Extractive sampling techniques were preferred in the NPL review, and a laboratory trial has been conducted to gather more information on knowledge gaps, such as the effect of temperature on degradation, and handling and storage conditions, and whether these affect the sample. This has led to a proposed methodology using impingers, which was found to be suitable for a wide range of nitrosamines, but not for low volatile compounds. At the time of writing this application the NPL have stated that further research is still required into different sampling configurations (e.g., inclusion of a condenser before the impingers) which may improve absorption efficiency.

New guidance has been published by the EA on the 28 March 2025, Monitoring stack emissions: carbon capture plants with solvent-based abatement[54]. This guidance is applicable to the CCF and provides guidance on monitoring approach, sample strategy and sample locations. It also specifies manual and automated monitoring methods that must be used to measure stack gas emissions. The determinants listed relate specifically to the use of amine-based solvent technology.

As stated above CEMS at the CCF will be certified at the appropriate range according to the EA's monitoring certification scheme (MCERTS) and will meet the quality assurance requirements of EN 14181 and sample location will comply with EN 15259.

Compliance points for monitoring compliance with the ELVs is to be sighted within the stack(s) above the Absorber Column(S) where the flue gas will be emitted (Emission Points A1 and A2).

The CEMS for the new incineration monitoring points will be located for each line before the exhaust gas transfer to the carbon capture plant(s) ensuring continued monitoring to demonstrate compliance with the permit ELVs for Riverside 1 and Riverside 2. This is dependent on the final flue gas ducting configuration employed, which will be confirmed at detailed design.

[54] Monitoring stack emissions: carbon capture plants with solvent-based abatement - GOV.UK

Options for the compliance monitoring points and the option finally employed will be dependent on the availability of suitable locations to install the CEM equipment, ensuring that the EA's Monitoring Stack Emissions: Measurement Locations Guidance[55]is complied with as far as possible, within any potential design constraints of the new plant, in addition to the EA's guidance, Monitoring stack emissions: carbon capture plants with solvent-based abatement, published 28 March 2025.

All point source and fugitive emission points will be added to the site emissions monitoring plan and sample locations will be compliant with the requirements of the EA's M1 Stack Monitoring Guidance, as far as reasonably practicable.

The monitoring proposed for the new emission points is shown in Table 7.1 below.

Article 15(5) of the Industrial Emissions Directive (IED) allows for the Regulator and Competent Authority to grant temporary derogations from BAT-AELs for the testing and use of emerging techniques for a period not exceeding 9 months. The CCF is a new and emerging technology, it is therefore considered that some provision for flexibility with new ELV compliance should be made during the commissioning period.

Table 7-1 – Proposed Monitoring for the New Point Source Emissions to Air

Emission Point	Parameter	Monitoring Frequency	Monitoring Standard or Method
A1 and A2	Oxides of nitrogen (NO_x); Sulphur dioxide (SO_2); Carbon monoxide (CO); Ammonia (NH_3); Oxygen (O_2); Particulate matter; Total organic Carbon (TOC); Hydrogen chloride (HCl); Mercury and its compounds; Nitrous Oxide (N_2O); Carbon Dioxide (CO_2)	Continuous	As per existing permits.
A1 and A2	Hydrogen fluoride Cadmium, Thallium and their compounds (total) Heavy Metals (Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V and their compounds (total))	Periodic	As per existing permits

55 Monitoring stack emissions: measurement locations - GOV.UK

Emission Point	Parameter	Monitoring Frequency	Monitoring Standard or Method
	Dioxins / furans (I-TEQ) Dioxin-like PCBs Dioxin / Furans (WHO-TEQ) Polybrominated dibenzo-dioxins and furans Specific individual poly-cyclic aromatic hydrocarbons (PAHs)		
A1 and A2	Exhaust gas temperature Exhaust gas pressure Exhaust gas flow Exhaust gas oxygen content Exhaust gas water vapour content	Continuous	As per existing permits
A1 and A2	Amines	Isokinetic sampling and impingement	EN ISO 21877
A1 and A2	Nitrosamines	Manual / Automated Isokinetic sampling and impingement	EN ISO 21877 or as per EA guidance.[56]
A1 and A2	Formaldehyde	Continuous	EN 14181
A1 and A2	Acetaldehyde	Continuous	EN 14181
A1 and A2	Oxygen	Continuous	EN 14181
A1 and A2	Carbon dioxide	Continuous	EN 14181

The site will also have a backup power generator (A3), which will be included in the permit as a directly associated activity. Due to its proposed size, subject to final detailed design, it could be subject to the Medium Combustion Plant Directive (MCPD)[57], as set out in Article 2, but as it is only to be used for emergency use it will be excluded from requiring emission limits under the MCPD. As it will only be tested for less than 50 hours per year it is classed as an excluded generator and is also exempt from the requirements of Schedule 25B "Specified Generator regulations" of the EPR.

[56] Monitoring stack emissions: carbon capture plants with solvent-based abatement – 28 March 2025
[57] Directive - 2015/2193 - EN - EUR-Lex

CO_2 Venting

The CO_2 vents (A4 and A5) will only be used in an emergency and during SU/SD of the CO_2 Compressor, when CO_2 may not meet the onward transport and storage specification. In addition, venting may also occur during process upset scenarios. However, through careful process control and management CO_2 venting will be minimised as far as is possible.

No monitoring of the CO_2 vents are proposed, other than recording mass of CO_2 released, times and duration of when venting occurs.

CO_2 Export Monitoring

The CCF is being designed to achieve a capture rate of 95% during normal operation. The CO_2 for export will be required to meet the design specification of the onward transport and storage system, and therefore monitoring will be in place to ensure that this is the case. This would typically include:

- CO_2 mass balance;
- CO_2 in fuel combusted;
- total capture level (as a percentage);
- CO_2 released to the environment; and
- CO_2 quality.

As well as ensuring compliance with the pipeline specifications, it is also a requirement of the EA's Post-Combustion Carbon Capture Guidance[58] that these parameters are monitored.

7.4 PROCESS MONITORING & OPTIMISATION

Process monitoring at the CCF will be conducted during operational activity and at critical stages to maintain optimal performance and regulatory compliance. Process monitoring will use high-precision instruments to track key performance indicators and ensure process optimisation. A set of key operational parameters will be continuously measured, and the design of the CCF will incorporate several aspects of process monitoring. These aspects will include, but are not limited to, the following:

- Solvent quality. Key to the optimisation and functionality of the absorption of CO_2 within the Absorber Column(s) and will be measured by several methods that may include gas chromatography to determine the composition of the solvent; visual inspection to inspect for signs of colour change and degradation; periodic sampling of rich and lean solvent; measurements of solvent density.
- Amine loading to monitor stability and reduce degradation.
- Solvent temperature, for consistency and optimisation in the process and efficiency in operation.
- Flow rate – ensuring steady and efficient movement of gases and liquids through the system.
- Temperature and pressure – maintaining optimal operating conditions to enhance process efficiency.

[58] Post-combustion carbon dioxide capture: emerging techniques - GOV.UK

- Gas concentration levels – monitoring the presence and proportion of essential compounds, including CO_2, H_2O, O_2, SO_2, NO_x.

Data collected from these monitoring activities will be utilised to; optimise the CCF operations, improve efficiency, minimise environmental impact, and ensure compliance with relevant safety standards.

Automated data logging and real-time analysis will support operations, proactive decision-making and enable early detection of potential performance deviations.

7.4.1 FLUE GAS MONITORING

The flue gas from Riverside 1 and Riverside 2 will pass through the abatement and treatment systems for Riverside 1 and Riverside 2, as is the current approach, before being diverted to the CCF.

Incoming flue gas will be monitored (for example temperature, pressure, composition), where these conditions do not meet the design conditions of the CCF and could negatively impact the CCF, the gas will be diverted back to the Riverside 1 and Riverside 2 stack(s) as appropriate.

The DCC cools and scrubs the incoming flue gas with NaOH to reduce levels of acid gases.

7.4.2 SOLVENT AND RECLAIMER WASTE

The solvent usage will be monitored through a variety of techniques including:

- Gas chromatography, used to determine the solvent composition;
- Visual inspection of the solvent's colour will be used to assess the level of degradation products;
- Periodic sampling, Coriolis flowmeters and chromatography will be used to determine the solvent density, indicating amine loading and levels of degradation products, heavy metals and soluble iron;
- Daily pH and conductivity tests of the solvent; and
- Periodic laboratory testing for contaminants such as heat stable salts and amine degradation products.
- The maximum amine temperature in the stripper will be controlled to limit degradation product formation.
- A slip stream of the solvent will be sent to the reclaimer to remove impurities, preventing them from building up in the solvent cycle. Any solvent losses resulting from the reclaiming process will be compensated for with fresh solvent.

Further monitoring arrangements will be identified and implemented as appropriate as part of detailed design.

7.5 REGULAR INSPECTIONS AND OPERATIONAL CHECKS

The operational procedures, including maintenance, will be set out in an OEMP, part of the EMS, as required by the DCO, which will be prepared prior to the CCF commencing operation.

Competent, dedicated operators will conduct systematic inspections of the CCF and associated infrastructure, with particular attention to operational plant and bulk chemical storage areas.

Routine operational checks, infrastructure inspections and audits will focus on identifying and addressing key issues, including but not limited to:

- Identification of any breaches of containment i.e. staining, spillages, odour;
- Identification of any minor leaks in pipelines, storage tanks, and critical connections;
- Seal integrity of bunding and joints;
- Accumulation of standing water in bunded areas, which may indicate drainage inefficiencies or structural concerns;
- Integrity and functionality of bulk storage tank bunds to prevent containment failures;
- Signage integrity and condition; and
- Material data sheets held on site against itinerary of held substances.

Where non-conformities / incidents / issues are identified during inspection or audit, or simple routine checks, these will be promptly documented, with corrective actions assigned to relevant personnel and recorded within the management systems on site. Resolutions will be tracked, ensuring that all actions and concerns are effectively closed out and rectified. The site will have a fully integrated EMS that will cover the operation of the CCF and all its associated equipment.

The monitoring of all the CCF infrastructure will be a fundamental aspect of the site's operational procedures and management systems, ensuring compliance with site protocols and industry best practices. A structured and proactive approach will be adopted to maintain the integrity, efficiency, and safety of critical infrastructure components.

8 ENERGY EFFICIENCY & HEAT DEMAND

Information regarding the CCF's energy consumption is available in Section 5 of this report.

As part of meeting BAT, the facility is required to incorporate energy efficiency measures; these are detailed in Section 11.3 of this report.

8.1.1 HEAT RECOVERY AND TRANSFER SYSTEM

One way energy efficiency will be improved is by using a Heat Recovery and Heat Transfer System This so that energy can be captured and redirected into a heat networks The CCF has the potential to provide a nominal supply 100MWth of additional heat, but there could be up to 300MWth of heat available from the CCF.

To facilitate this, a Heat Transfer Station will be installed as part of the It will house the main operating plant and water treatment equipment necessary to support the heat transfer system, including thermal storage, and provide a connection into the receiving heat network and potentially backup heat generating plant in the event of outages.

9 WASTE GENERATION AND MANAGEMENT

The main waste streams generated as a result of the CCF process are laid out below and further detailed in Table 9-1:

- Reclaimer waste
- Spent Desiccants for dehydration – silica gel or molecular sieve
- Lubricant oils
- Spent filter elements and spent activated carbon
- Recyclable materials
- General waste
- Waste Electronic and Electrical Equipment
- Sludge arising from the ETP
- Amine Contaminated Wastewater

9.1 WASTE MANAGEMENT

Cory will operate the CCF in accordance with their onsite Integrated Management System and minimise action in the highest tiers of the Waste Hierarchy and adherence to the proximity principle[59].

As part of the detailed design, circular economy practices will be identified and considered to design out wastes, reduce wastes and to divert materials from landfill, and into other productive uses.

In order to reduce waste generation, in accordance with Cory's existing EMS procedures, indicative opportunities to move the treatment of hazardous waste up the hierarchy, from landfill to recovery or recycling, once compositions and tonnages are known, will be explored as part of the detailed design and operation of the CCF.

In adherence with relevant BAT requirements, Cory will ensure that all waste produced at the CCF, will be handled and disposed of by permitted waste operators. Following completion of the detailed design of the CCF, a waste and residues management plan will be written and incorporated into the site's EMS in accordance with requirements of the EA Guidance "Develop a management system: environmental permits[60]".

Cory's existing EMS, which is accredited to ISO 14001, will be updated to appropriately manage various aspects associated with waste management at the CCF. This will include waste minimisation and management, accident management, fugitive emissions management, infrastructure monitoring and maintenance.

Cory will engage with suppliers to identify opportunities to procure materials that afford higher sustainability performances than typical industry standards, and ensure that, when feasible, procurement agreements include takeback schemes wherein suppliers are obliged to take back any packaging as well as surplus or spent materials.

Suitably qualified and experienced personnel, well defined responsibilities, and clear signage will be used throughout the CCF. This will ensure that waste handling, storage and management is

[59] Directive - 2008/98 - EN - Waste framework directive - EUR-Lex
[60] Develop a management system: environmental permits - GOV.UK

effective and maximised, reducing the likelihood of non-compliance and waste contamination and increasing the likelihood of waste being accepted offsite for reprocessing, reducing the volume of waste being sent to landfill.

The Proximity Principle highlights the need to manage, treat and/or dispose of wastes in reasonable proximity to their point of generation. The principle works to minimise the environmental effects and cost of waste transport as set out in Article 16 of the Waste Framework Directive[61]. Riverside 1 and/or Riverside 2 will be used for the treatment of residual wastes; subject to waste compliance with EP waste codes and acceptance criteria and operational availability. If capacity is not available, alternative recovery will be considered.

Operational waste tonnages will be monitored on a monthly basis using data provided by Waste Contractor(s). This data will demonstrate the compliance with EP waste codes and tonnages of material produced and sent for recovery or disposal. This will be used to create a baseline of waste arisings for year one, and to then support the identification and development of additional efforts that move wastes up the waste hierarchy. Waste arisings will be recorded and analysed on a monthly basis or at a frequency agreed with the waste contractor(s).

Where waste containers are reused for storing process wastes, they will be individually inspected for damage before refilling and marked as such with arrangements in place for them to be inspected as suitable before reuse. This mitigates problems which can commonly arise from damaged linings or corrosion of seams to containers such as drums and IBCs.

9.2 WASTE STORAGE AND TRANSFER

Recycling bins and waste bins are to be kept clean and clearly labelled in order to avoid contamination of materials. Where it is possible to segregate further, by waste type, this will be undertaken. Enclosed covered skips with signage, for the segregation of waste will include, but not necessarily be limited to the following.

- Mixed inert;
- Mixed non-hazardous;
- Hazardous;
- Metals
- Wood;
- Food;
- Paper, cardboard and glass; and
- Waste electronic and electrical equipment (WEEE).

During the preliminary design stage, Hazard Identification (HAZID) studies were conducted for risks associated with the CCF including for the storage and transfer of wastes. Through this process, environmental risks associated with raw materials and wastes, in the event of a spill, leak or incident will be located within a designated bunded waste storage area. This will be further considered as part of the detailed design.

[61] Directive - 2008/98 - EN - Waste framework directive - EUR-Lex

Storage of incompatible substances and materials will be separated and/or segregated and kept in separate areas to any potential ignition sources in order to comply with BAT for Emissions from Storage[62]

All bulk waste storage containment bunding will have a storage capacity of either 110% of the tank/vessel capacity or 25% of the total volume of waste materials being stored on site in line with the requirements of the CIRIA C736 guidance, whichever is greater, to address the potential for storage system failures.

Transfer of the site's reclaimer waste will be conducted by trained and competent operators, following Cory's reclaimer waste procedures, which will be written and produced following detailed design. Tanker loading will utilise interlocking loading valves and be conducted in bunded areas, sized for 110% of the tank's capacity, and the reclaimer waste loading line will use a "fail close" system.

9.3 WASTE STORAGE, TRANSFER, GENERATION AND MINIMISATION

As part of the pre-FEED study, a number of carbon capture plant technologies and suppliers were considered and approached for consideration of the project. Shell has been taken forward as the preferred technology partner. This was in part due to the decreased solvent degradation rate, minimising the amount of reclaimer waste generated from the process.

While the majority of the amine solvent used for carbon capture will be recovered and reused as described in Section 3.2.1.3, there will be a small amount of reclaimer waste which is not suitable for recovery or re-use.

This reclaimer waste, which includes degraded solvent and heat stable salts, cannot be disposed of to landfill as defined in Environmental Permitting Guidance: The Landfill Directive[63]. This reclaimer waste will be transferred to and stored in a dedicated storage tank, with suitable secondary containment. This will be monitored on a daily basis, periodically emptied and transferred to suitably licensed EfW Facilities. Options to further reduce wastes, associated with the solvent, requiring off-site disposal will be explored as part of the detailed design.

As part of the detailed design, opportunities for the reclaimer waste to be treated in facilities with the potential to valorise and recycle amine-based solvents will be assessed. As this stage, the exact composition and details of the reclaimer waste is not known and will not be fully known until the CCF is operational, as this is highly dependent on the composition and properties of the incoming flue gas from Riverside 1 and Riverside 2. The reclaimer waste is a concentrated sludge containing water, salts, heavy degradation products, and some unseparated solvent amines. It is stored in a temperature-controlled vessel prior to periodic disposal. The reclaimer waste is likely to be diluted to approximately 50%wt water to facilitate transfer and disposal. The specification of the reclaimer waste vessel is to be determined as part of the detailed design. The sludge will be disposed off-site, likely in an incinerator via a contractor licensed to transport and handle hazardous waste.

During SU/SD (and outside of normal operating conditions (OTNOC)), nominal amounts of amine contaminated wastewater will be generated by the Absorber(s). It is not proposed to recycle this water via the ETP. The volume of amine contaminated wastewater is expected to be comparatively

[62] Emissions from Storage | EU-BRITE
[63] Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste

small; therefore, the waste will be disposed of by specialised contractors, taking the waste offsite for disposal. Where possible, amine contaminated wastewater will be reused on site e.g. diluting reclaimer waste.

There will be waste cartridges arising from the mechanical filters which will require disposal. The frequency of replacement is expected to be approximately every six months but will depend on the quantity of solids within the process, and therefore it is likely that more frequent changes will be required following abnormal operations such as start-up and maintenance activities. During normal operation of the CCF, less frequent replacement of the cartridges is to be expected. Activated carbon from the carbon filters will also require disposal. Spent filter elements and spent activated carbon will be disposed of off-site as part of change-over processes by a licensed contractor. As part of detailed design, the reuse of activated carbon and filter elements will be considered when applicable.

Dehydration uses either a Molecular Sieve or Silica gel as a desiccant, which will require replacement once spent. The frequency of this will depend on operating experience and the specific desiccant selected for the final design. This is anticipated to be approximately every few years. Spent desiccant will not be stored on site, as this will be removed as part of the changeover process by a licensed contractor during scheduled periods of maintenance.

Lubricating oils will be replaced as per design and manufacturer requirements, with used and degraded lubricating oils stored and either recycled, at appropriately licensed recycling facilities, where feasible or disposed of.

The sludge generated from the ETP described in Section 3.2.4.3 will be disposed of off-site via a suitably licensed waste carrier vehicle. This will be a concentrated sludge containing impurities from the DCC waste stream, where reaction products and impurities are concentrated from the incoming flue gas. Prior to removal, this will be stored adjacent to the ETP in an enclosed covered skip. The transfer of sludge will be an automated process, to be determined by the ETP supplier as part of the detailed design. It is anticipated to be either a sludge pump or an enclosed conveyor system.

This sludge will be consigned as hazardous waste with EWC code 19 01 07*[64], solid waste from flue gas treatment. This will be collected by a licensed hazardous waste contractor, who will send it to a hazardous waste facility for further processing, treatment or disposal.

Recyclable materials and general waste will be similar in composition to household waste and the quantities generated will be negligible on the local infrastructure.

All other wastes generated at the CCF such as packaging, general waste will be managed through waste management procedures implemented as part of Cory's site wide EMS and in accordance with all BAT.

Table 9-1 shows the anticipated operational wastes arising from the CCF; however, this list will be refined as part of the detailed design. The OEMP will outline a mechanism to collate all waste arisings data across all operations of the CCF and will demonstrate the fate of operational wastes, e.g. reuse and recycling routes, waste treatment routes or disposal routes. This will include the characterisation of amine contaminated wastewater and sludge arising from the ETP.

[64] https://leap.epa.ie/docs/3a45dc54-e210-452f-a50e-ad855414616d.pdf

Upon completion of the detailed design, a site layout drawing detailing the location of material and waste storage areas will be produced.

Table 9-1 – Estimated Operational Waste Arisings from the CCF

Operational Waste	Quantity	Unit	Storage Details e.g. covered skip, IBC, wheelie bin etc.
Amine Contaminated wastewater	Nominal amount generated during SU/SD		To be disposed of off-site by a suitably licensed contractor for disposal off site.
Reclaimer Waste	500	Tonnes per annum	Stored in a temperature-controlled vessel until disposal via a contractor licensed to handle hazardous waste.
Desiccants for dehydration – silica gel or Molecular Sieve	30	m^3 per change-over per train	Not stored on site and removed by a licensed contractor for hazardous waste disposal.
Lubricant oils	1	Tonnes per annum	Stored in an oil waste container to be disposed of off-site by a licensed contractor at an appropriately licensed recycling facility.
Spent Activated Carbon for filtration	130	m^3 per annum	Not stored on site and will be disposed of as part of a changeover process via a licensed contractor.
Filter Cartridges	TBC as part of the detailed design		Not stored on site and will be disposed of as part of a changeover process via a licensed contractor.
Sludge arising from the ETP	800	Tonnes per annum	To be disposed of by a licensed contractor.
Recyclable materials	55	Tonnes per annum	Disposed of by a licensed contractor at an appropriately licensed recycling facility.
General Waste	45	Tonnes per annum	To be stored on site in covered and segregated skips as described in Section 9.1. Will be disposed of via EfW facilities (e.g. Riverside 1 and Riverside 2) or non-hazardous landfill.
Waste Electronic and Electrical Equipment (WEEE)	1	Tonnes per annum	To be stored on site and reused or recycled when applicable in line with the WEEE Regulations 2013[65].
Process effluent arising from the	170	m^3/hour	To be treated in the ETP as described in Section 3.2.4.3 and 9.4

[65] The Waste Electrical and Electronic Equipment Regulations 2013

DCC and blowdown from the cooling tower			

[a] Changeover period not known at this stage of design but expected to be approximately five years.

All figures have been rounded and could be subject to change as part of the detailed design.

9.4 PROCESS EFFLUENT

The process effluent streams from the CCF for treatment in the ETP will comprise of DCC effluent, including condensate from the flue gas, and blowdown water from the cooling system. The process effluent will be treated as part of a ZLD solution, which will see the facility utilise as much of the treated water from the process effluent as practicable in the process and cooling systems, leaving a concentrated waste, in sludge form, for disposal offsite.

The ETP is designed to treat 170m^3/hr effluent, accounting for both the DCC effluent and cooling system blowdown.

The ETP's proposed drainage will include a system of containment, to mitigate the potential risk of pollution to the site and the surrounding area. For example, this will include appropriate use and installation of bunded areas, catch pits and drip trays around core CCF processes. This will include chemical storage areas for the DCC, the Absorber Column(s), the stripper, the lean/rich heat exchanger, solvent storage and makeup system, CO_2 buffer storage, backup power generator, diesel storage, compressor lube oil and refrigerant areas. Further containment will be considered as part of the detailed design and implemented when necessary.

10 MANAGEMENT ARRANGEMENTS

10.1 SCOPE AND STRUCTURE

Cory has developed and operates, inclusive of Riverside 1 and Riverside 2, an Integrated Management System (IMS) which meets the requirements of the following management system standards:

- ISO 14001 (Environmental)
- ISO 9001 (Quality)
- ISO 45001 (Occupational Health and Safety)
- ISO 27001 (Information Security)

Measures are undertaken to ensure that this would be communicated effectively to meet the requirements of the BS EN ISO 14001:1015 Environmental Management System Standard, which has been certified to comply with the requirements of ISO:14001. Copies of these management certifications are included in Appendix G, along with a copy of Cory's current IMS Manual.

Cory will extend the existing management system to incorporate the CCF. This EMS will form part of the CCF's EMS that will establish an organisational structure, responsibilities, practices, procedures and resources for achieving reviewing and maintaining the company's commitment to environmental protection.

Cory also applies a Competence Management System, developed by Energy and Utility Skills, covering the provision of waste management services, including treatment and recovery, required for Riverside 1 and Riverside 2 under Environmental Permits EPR/BK0825UI and EPR/GP3535QS respectively.

10.2 GENERAL REQUIREMENTS

Cory will maintain the site EMS in accordance with ISO:14001 standard and ensure that the EMS objectives and scope meet these requirements by:

- Identifying potential environmental impacts;
- Documenting and implementing standard procedures to mitigate and control these impacts;
- Determining a procedural hierarchy that considers the interaction of the relevant processes;
- Ensuring adequate responsibility, authority and resources to management necessary to support the EMS;
- Establishing performance indicators to measure the effectiveness of the procedures;
- Monitoring, measuring and analysing the procedures for effectiveness; and
- Implementing actions as required based on the results of auditing to ensure continual improvements of the processes.

10.3 SITE PLAN(S)

Upon completion of the detailed design of the CCF, the EMS will include detailed plans of the site which highlight where the permitted activities are undertaken and show the location of the following, as applicable, in accordance with the EA guidance "Develop a management system: environmental permits"[66]:

- Buildings and other main constructions including treatment plants, incinerators, storage silos and security fencing;
- Storage facilities for hazardous materials like oil and fuel tanks, chemical stores, waste materials;
- Location of items for use in accidents and emergencies;
- Entrances and exits to be used by emergency services;
- Pollution control points such as inspection and monitoring points;
- Trade effluent or sewage effluent treatment plants;
- Site drainage plan;
- Effluent discharge points; and
- Emission point plan.

10.4 STORAGE OF WASTE AND OTHER RESIDUES

In accordance with the requirements of Article 4 (Waste Hierarchy) of the Waste Framework Directive, which sets out the priorities for the prevention and management of waste, Cory will review the options for recovery and recycling of all residues generated by the CCF.

A waste and residues management plan (also referred to as the Site Waste Management Plan in the Environmental Statement) will be incorporated into the EMS, post detailed design, in accordance with the requirements of EA Guidance "Develop a management system: environmental permits".

The operation of the CCF will seek to minimise material consumption and waste generation. Riverside 1 and/or Riverside 2 would be used for treatment of residual wastes, subject to waste compliance with permitted waste codes and acceptance criteria and operational availability. If capacity is not available, alternative recovery facilities will be considered.

Waste recovery and disposal techniques will be conducted in accordance with the indicative BAT Requirements.

Prior to the transfer of residues off-site, where appropriate, the residues would be tested in accordance with the requirements of Technical Guidance "WM3: Waste Classification – Guidance on the classification and assessment of waste"[67].

Any materials which are to be transferred to landfill from the CCF would be Waste Acceptance Criteria (WAC) tested for leachability to ensure that they meet the WAC for the landfill that they are to be transferred to.

10.5 SITE AND EQUIPMENT MAINTENANCE PLAN

Plant maintenance will be undertaken in accordance with the relevant UK legislation ensuring that all plant will be certified fit and proper for use, subject to appropriate internal/external testing and maintained in accordance with the manufacturers' guidance. All mobile plant will be subject to daily pre-use checks, ensuring that all defects are reported and repaired within an appropriate timescale.

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[66] Develop a management system: environmental permits - GOV.UK
[67] Waste classification technical guidance - GOV.UK

Only technically competent maintenance staff will be able to advise on when plant should and should not be used and their decision is final.

Major routine and planned maintenance of the CCF will be coordinated with regulatory inspection requirements and outage schedules for Riverside 1 and Riverside 2 (once operational), where practicable. This approach aims to reduce the number of scheduled outages and minimize the quantity of CO_2 emitted to the atmosphere during the maintenance of the CCF.

The routine and planned maintenance of activities that are anticipated to be undertaken during scheduled outages will include inspections of the column intervals (Absorber Column(s), Solvent Regeneration Systems and DCC), inspections of the key Heat Transfer Systems (to identify corrosion and replacing oil) and inspections of the key components of the CO_2 Processing Plant.

Operational procedures, including maintenance, will be set out in an OEMP, as part of the EMS, which will be prepared prior to the CCF commencing operation which is secured by a requirement in the DCO.

An Emergency Response and Preparedness Plan will be prepared in accordance with the Outline Emergency Preparedness and Response Plan (EPRP)[68] as prepared for the DCO.

10.5.1 MAINTENANCE OF SUDS DRAINAGE

A Maintenance and Management Plan for drainage network and SuDS elements will be developed at the detailed design stage and presented as part of the detailed drainage strategy required to be approved pursuant to the DCO. This plan will ensure the effective functioning and longevity of these systems to manage surface water runoff effectively, efficiently and sustainably, keeping surface water runoff “clean” and separate from process effluents.

At this stage it is assumed that all maintenance activities will be carried out by a suitable supplier selected by Cory. The appointed company will be responsible for carrying out routine inspections, maintenance and repairs of drainage infrastructure and SuDS features.

All maintenance activities should be in line with the requirements outlined in the CIRIA SuDS Manual C753[69] and should include regular, occasional and remedial maintenance activities. Typical maintenance measures from the SuDS Manual required for the drainage system include, but are not limited to, those listed in Table 10-1.

Table 1010-1 – Operation and Maintenance Requirements

Maintenance Schedule	Required Action	Typical Frequency
Requirements for Attenuation Basin		
Regular Maintenance	Remove litter and debris	Monthly
	Cut grass – for spillways and access routes	Monthly (during growing season), or as required
	Cut grass – meadow grass in and around basin	Half yearly (spring – before nesting season, and autumn)

[68] OUTLINE EMERGENCY PREPAREDNESS AND RESPONSE PLAN: 7.11
[69] CIRIA C753: The SuDS Manual, dated December 2015, updated in February 2021, Item Detail (ciria.org)

Maintenance Schedule	Required Action	Typical Frequency
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage.	Monthly
	Inspect inlets and facility surface for silt accumulation.	Monthly
	Establish appropriate silt removal frequencies.	Monthly (for first year), then annually, or as required
	Check any penstocks and other mechanical devices	Annually
	Tidy all dead growth before start of growing season	Annually
	Remove sediment for inlets, outlet and forebay	Annually (or as required)
	Manage wetland plants in outlet pool – where provided	Annually (as set out in Chapter 23 of The SuDS Manual, CIRIA 2015)
Occasional maintenance	Reseed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every 2 years, or as required
	Remove sediment from inlets, outlets, forebay and main basin when required	Every 5 years, or as required (likely to be minimal requirements where effective upstream source control is provided)
Remedial actions	Repair erosion or other damage by reseeding or returfing	As required
	Realignment of rip-rap	As required
	Repair/rehabilitation of inlets, outlets and overflows	As required
	Relevel uneven surfaces and reinstate design level	As required
Filter Drains		
Regular Maintenance	Remove litter (including leaf litter) and debris from filter drain surface, access chambers and pre-treatment devices	Monthly (or as required)

Maintenance Schedule	Required Action	Typical Frequency
	Inspect filter drain surface, inlet/outlet pipework and control systems for blockages, clogging, standing water and structural damage	Monthly
	Inspect pre-treatment systems, inlets and perforated pipework for silt accumulation, and establish appropriate silt removal frequencies	Six monthly
	Remove sediment from pre-treatment devices	Six monthly, or as required
Occasional maintenance	Remove or control tree roots where they are encroaching the sides of the filter drain, using recommended methods (e.g. NJUG, 2007 or BS 2998:2010)	As required
	At locations with high pollution loads, remove surface geotextile and replace, and wash or replace overlaying filter medium	Five yearly, or as required
	Clear perforated pipework of blockages	As required

SuDS Manual, CIRIA 2015[70]

10.6 PERSONNEL

An estimated workforce of approximately 27 Full Time Equivalent (FTE) staff will be required for operation and maintenance activities. The administrative and human resources personnel for Riverside 1 and Riverside 2 (upon becoming operational) are anticipated to be shared across the Riverside Campus. Consequently, additional administrative and human resources staff are not expected to be necessary.

Day to day operation and maintenance of the CCF will be undertaken by Cory. Cory will ensure that sufficient resource and numbers of staff, across a variety of grades are available to manage, operate and maintain the plant on a continuous basis throughout the year. The plant would be led, managed and maintained by experienced managers, operational staff and maintenance staff. The key environmental management responsibilities would be allocated similarly as described below.

Site/Plant Manager. The Site manager will have overall responsibility for the plant and compliance with the operating permit. They must be fully conversant with all compliance obligations and make sure that all services are completed as required, as per the IMS. Meeting these requirements may be undertaken by the Site Manager themselves or delegated to other employees or support functions. The site manager will have extensive experience relevant to their responsibilities.

Deputy Plant Manager. In the event the Site/Plant Manager is unavailable, responsibility will pass to the Operations/Shift Manager. If the Operations/Shift Manager is also absent, the Engineering or Maintenance Manager will assume the Deputy Manager role. The Deputy Manager, when acting in place of the Plant Manager, will be responsible for the overall control and management of the site, including implementing emergency response procedures. Additionally, the Deputy Manager will be

[70] CIRIA C753: The SuDS Manual, dated December 2015, updated in February 2021, Item Detail (ciria.org)

tasked with organising, recording, and evaluating training drills and sessions to effectively prepare for and manage foreseeable emergency incidents.

Operations/Shift Manager. The Operations manager will have day to day responsibility for the plant to ensure that the CCF is operated in accordance with the requirements of the Environmental Permit and that the environmental impact of the plant's operations would be minimised. In this context, they would be responsible for designing and implementing operating procedures which incorporate environmental aspects.

EHS Manager. The EHS manager would be responsible for the development and management of the EMS, for the monitoring of authorised releases and for interaction with the EA.

Maintenance Manager. The Maintenance Manager would be responsible for the management of maintenance activities, for maintenance planning and for ensuring that the plant continues to operate in accordance with its design.

10.7 COMPETENCE, TRAINING AND AWARENESS

Cory uses a Competence Management System designed by Energy and Utility Skills. This system addresses the delivery of waste management services, including treatment and recovery, in compliance with current environmental permits such as Riverside 1 and Riverside 2.

Cory will aim to ensure that any persons performing tasks for it, or on its behalf, which have the potential to cause significant environmental impact, are competent on the basis of appropriate education and training or experience.

The EMS will contain a training procedure to make employees aware of:

- The importance of conformity with the environmental policies and procedures and with the requirements of the EMS;
- Potentially significant environmental aspects associated with their work;
- Their roles and responsibilities in achieving conformity with the requirements of the EMS, in accordance with the APRP;
- The relevance and importance of their activities and how they contribute to the achievement of the environmental and quality objectives; and
- The potential consequences of the departure from specified procedures.

Cory will comply with the industry standards or codes of practice for training (e.g. WAMITAB), where they exist and are applicable.

10.7.1 COMPETENCE

As stated above, Cory applies a Competence Management System. Cory will identify the minimum competencies required for each role. These will then be applied to the recruitment process to ensure that key roles and responsibilities are satisfied. Particular attention will be given to a potential candidate's experience, qualifications, knowledge and skills.

10.7.2 INTRODUCTION AND AWARENESS

Staff induction programmes are location and job role specific and will include, as a minimum, coverage of:

- The Environmental Policy;
- Introduction to the Environmental Permit;

- The relevant Health and Safety Policy and Procedures; and
- The EMS Awareness Training.

10.7.3 TRAINING

Cory will provide training to operational staff as part of the commissioning prior to operation of the CCF. Line Managers will identify and monitor staff training needs as part of the appraisal system. The training needs of employees would be addressed using on-the-job training, mentoring, internal training and external training courses/events.

Training records would be maintained onsite. Cory will comply with industry standards or codes of practice for training, where they exist and are applicable.

10.8 RISK IDENTIFICATION & MITIGATION

The CCF will be incorporated into Cory's EMS, and Risk Assessment, Hazard Identification and Determining Controls Procedure (IMS-MP-02) will be implemented at the facility. This procedure explains how the site can identify safety hazards and environmental aspects associated with the operations, products and services in an ongoing and proactive way. Consideration will be given to how work is organised, social factors and hazards arising from equipment, machinery, materials and substance, and human factors. It gives directions on how and where to look for hazards and aspects, including routine and non-routine tasks under normal operating conditions and abnormal conditions such as SU/SD and maintenance, and potential emergency conditions, considering planned or new developments that can impact on the environment due to pollution or use of natural resources, or the safety of those throughout the process. It helps to prioritise action to reduce these risks. Significant impacts can also occur in the area of direct control and in the sphere of influence exerted over contractors/suppliers and, to a lesser extent customers.

This procedure includes a practical risk-based methodology for scoring the relative significance of the hazards on different areas/individuals they are likely to affect. This facilitates and prioritises the setting of improvement plans. The process takes into consideration how the tasks/activities are designed and who/what may be affected to ensure adequate controls are in place to eliminate or manage the risk to an acceptable level. Those elements with the potential to cause the greatest risk to occupational health and safety or cause significant impact on the environment are determined as 'high risk'. The procedure dictates the documenting of the significant hazards and environmental aspects, with details of how these are mitigated using the hierarchy of control. The overall aim is to minimise health, safety and environmental risk.

Participation of workers is a key element of the process to ensure that all those involved in the organisations' operations understand that risk assessment is a proactive measure, undertaken prior to an activity commencing, or when changing an activity, and that they take ownership of the assessment of risk and flagging of hazards, which is essential to mitigate residual risk.

An Environmental Risk Assessment (ERA) identifying the risks relevant to the CCF has been undertaken and considers:

- Hazard – What has the potential to cause harm.
- Receptor – What is at risk?
- Pathway – How can the hazard get to the receptor?
- Risk Management – What measures will Cory implement to reduce the risk?
- Possibility of Exposure – How likely is the contact?

- Consequence – What is the harm that can be caused by the hazard?
- Overall Risk – What is the risk that remains?

The CCF ERA has been prepared to consider the proposed activities on site as part of this environmental permit application. The risk assessment is provided in Appendix B.

Cory's Emergency Preparedness and Response (IMS-MP-09) will be applied to the CCF. Documented plans are used to summarise response details for potential non-conformances, emergency situations and incidents. The plans will be subject to periodic review and testing to ensure their adequacy. Training, procedures and/or work instruction provide the detail for how to respond to emergency situations. There is also a Crisis Communications Summary that is used to escalate incidents and emergencies as appropriate.

10.9 CLIMATE CHANGE AND FLOOD RISK

The potential impacts of climate change (including flood risk) have been and will continue to be considered in the context of the design and operation of the site.

The most significant flood risk to the CCF is the residual risk associated with a breach in the River Thames Flood Defences. An assessment of the residual flood risk is presented in the Flood Risk Technical Note – Breach Assessment Scenarios. The assessment concluded that the hydraulic modelling undertaken to support the assessment demonstrates that there is a negligible change to peak flood levels in the majority of the flood cell modelled, when considering the maximum platform level of 1.3m AOD to the north of the Thames Water Access Road, and a level of 1.5m AOD to the south of the Thames Water Access Road. The modelling considered a review of alternative development layouts and platform levels and indicated localised increases to peak flood depths of up to 0.25m during the 200-year plus climate change event. Equipment that is considered to be sensitive to flood water inundation will be protected by either locating equipment on a platform raised to a height above the maximum breach flood level (including welfare facilities required for safe refuge), or protecting equipment by an impervious bund raised to a height above the maximum breach flood level.

The hydraulic modelling was also used to assess the fluvial and pluvial flood risk as a result of the CCF. The assessment concluded that the fluvial only model outputs are largely limited to the watercourse channel cross section and do not indicate flooding that extends beyond the top of the bank of channel. The assessment of pluvial flood risk indicated that a negligible flood risk to the Development Platform should a failure of the Great Breach Pumping Station occur. As such, the CCF is not considered to be at risk of flooding from either fluvial or pluvial sources associated with the network of watercourses around the Site and is not considered to lead to an increase in risk elsewhere.

Cory will monitor the full effects of extreme weather-related incidents (for example, road surface deformation, flooding, storm damage and debris, snow and ice etc) and identify any maintenance required. Inspections by an appropriately qualified professional will be carried out following an intense rainfall event, heatwave, high wind or storm event to monitor any damage and implement appropriate mitigation as necessary.

10.10 KEEPING RECORDS

All records will be required to be retained in accordance with the relevant timescales indicated in the Environmental Permit. Cory's EMS will be updated to include all records associated with the CCF, likely to include, but not limited to:

- The Environmental Permit for the CCF;
- Environmental Risk Assessment;
- Required Management Plans;
- Staff competence and training for additional staff;
- Emissions and associated monitoring required as per the Environmental Permit;
- Complaints procedure along with a list of complaints made, investigations and associated actions taken as a result of the complaints; and
- Audits, findings and actions taken with management system audits.

In line with Cory's Document Control Procedure (IMS-MP-12), all documentation within the IMS is controlled. Documentation is approved for adequacy before use, reviewed and updated as necessary. All documentation shows the current revision status. Out-of-date documentation will be removed from circulation and destroyed.

Documentation from external origin, necessary for the planning and operation of the IMS, will be identified and controlled by the relevant manager. They will be responsible for ensuring that only the most-up-to-date information is available.

All records within the IMS will be appropriately identifiable, stored, protected, retained, disposed of and retrievable, as specified in the management procedure.

10.11 REVIEW OF MANAGEMENT SYSTEMS

Cory's Management Review Procedure (IMS-MP-05) will be applied to the proposed CCF. Top management shall review the continuing suitability, adequacy and effectiveness of the IMS throughout the year. The Executive Leadership Team review will include opportunities for improvement and the need to change associated IMS procedures and documentation. Management Review meetings will also be held at least once annually with site management and may be held more frequently if necessary.

Records of management reviews are to be retained in the form of agenda, minutes and presented materials i.e. PowerPoint slides.

10.12 MANAGEMENT OF CHANGE

Cory's IMS has a Modification Management Procedure (RIV-WI-048), also used at Riverside 1 and Riverside 2, and this procedure will be updated to incorporate the proposed CCF.

During the lifecycle of the CCF, changes are made to plant and processes for a number of reasons, e.g. for safety/environmental improvements, business improvements or end of life of original equipment. Such modifications or changes could introduce danger into equipment that is otherwise safe and must be controlled to mitigate the risk of danger and help to ensure continued safe operation of the CCF.

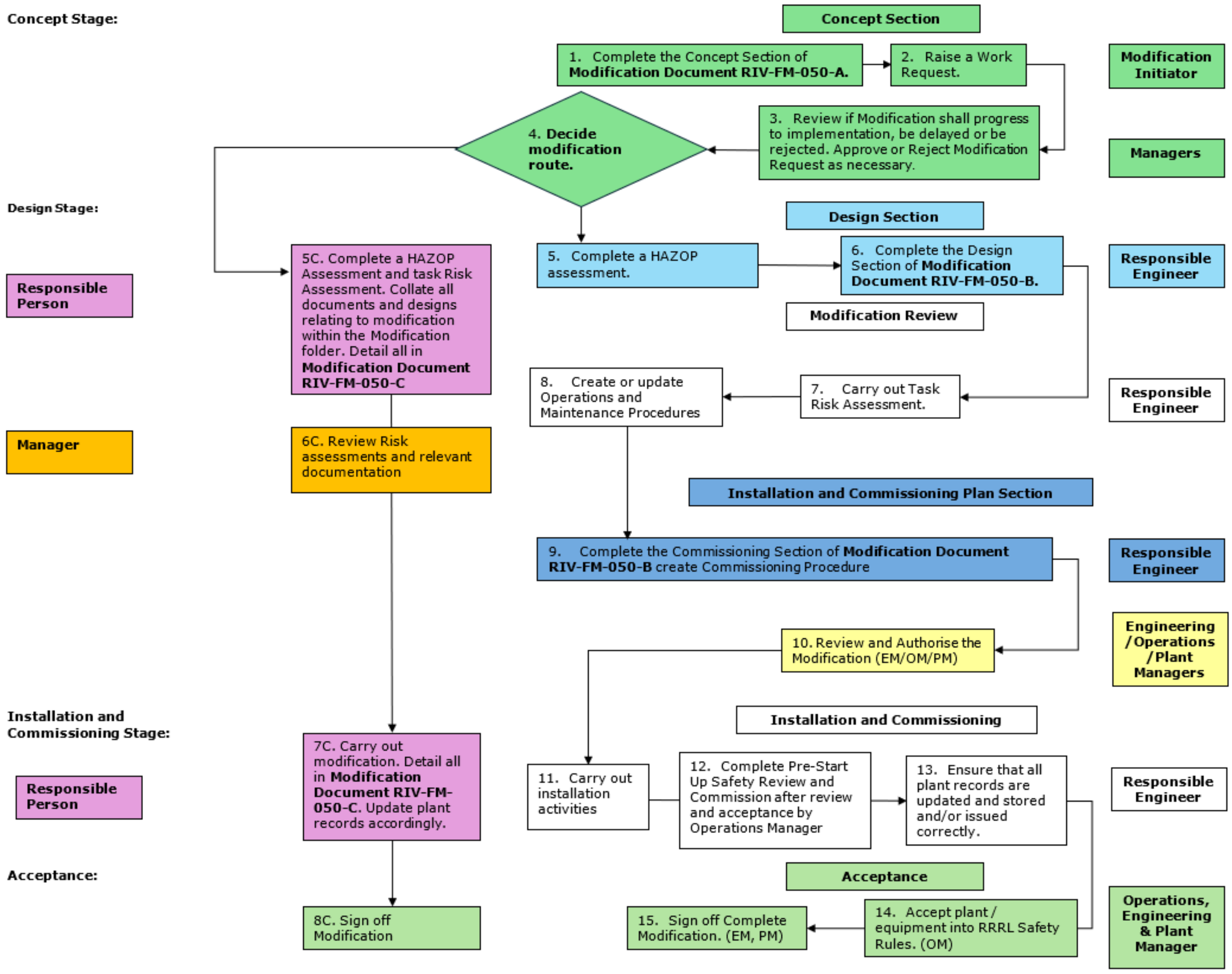
The Modification Management Procedure (RIV-WI-048) describes in detail the steps necessary for the control of modifications/changes. This procedure also identifies Roles and Responsibilities and provides instructions to be carried out when considering modifications to ensure safe operation.

Generally speaking, there are four stages to all modifications. Each stage should be completed and documented prior to starting the next stage. The stages are as follows:

- Initiation or conception;
- Detailed design;
- Implementation and Commissioning; and
- Acceptance.

The modification procedure is summarised in the flow chart shown in Figure 10-1.

Figure 10-1 - Modification Flow Chart



10.13 CONTACT INFORMATION FOR THE PUBLIC

A notice board will be displayed near the entrance for the CCF telling the public key contact information for the site. Contact information is also available online at https://corydecarbonisation.co.uk/get-in-touch/.

10.14 COMPLAINTS

Cory has a Managing Complaints Procedure (RIV-WI-40) which outlines the procedure for recording, investigating and responding to both internal and external complaints. This procedure will be extended to the CCF.

10.15 OPERATING AND MAINTENANCE PROCEDURES

Cory's Operational Control (IMS-MP-08) will be extended to cover the CCF. Management procedures and/or work instructions are established for all activities relating to the IMS to ensure that processes are carried out in a controlled way to meet compliance obligations. Planned changes to operations will be reviewed by Site and Senior Management and existing procedures amended or new procedures created as needed.

Externally controlled services will be managed using contracts and the contractor management procedure to ensure compliance obligations are met at all times.

The operational procedures including maintenance will be set out in an OEMP, as part of the EMS, which will be prepared prior to commencing of the CCF. The OEMP, part of the EMS, will likely include aspects covering:

- As-built drawings of the CCF;
- Raw materials storage and handling procedures; and
- Maintenance and service programme.

10.16 SITE CLOSURE

10.16.1 INTRODUCTION

The CCF is intended to operate for at least 25 years. However, for the purpose of assessing a reasonable worst-case scenario it is anticipated that it could have a design life of 50 years, as per typical design life of the civil and structural elements of the CCF.

At the end of the 50-year period, the CCF may have some residual life remaining, and an investment decision will be made as to whether the operational life of the CCF is to be extended. If it is not appropriate to continue operation, the plant will be decommissioned.
When the CCF has reached the end of its operational life, it may be redeveloped for extended use or demolished as part of a redevelopment scheme and the site cleared and left in a "satisfactory state. Should the site remain operational for more than 50 years from the date of final commissioning,

- No later than 45 years following the date of final commissioning, Cory must notify the EA whether it anticipates that the operation of the CCF will continue past the 50th anniversary of the date of final commissioning.
- An updated flood risk assessment must, unless otherwise agreed by the Environment Agency, be submitted to the EA for written approval.

Cory recognises the need to ensure that the design, the operation and the maintenance procedures facilitate decommissioning in a safe manner without risk of pollution, contamination or excessive disturbance to noise, dust, odour, groundwater and surface watercourses. To achieve this, a site closure plan would be prepared.

10.16.2 SITE CLOSURE PLAN

The following is a summary of the measures to be considered within the Site Closure Plan to ensure the objective of safe and clean decommissioning. A detailed Closure Plan would be developed and submitted to the EA, for approval, prior to the commencement of commissioning. A Decommissioning Environmental Management Plan will also be prepared in accordance with the DCO.

General Requirements

- Underground pipework for the transfer of process chemicals to be avoided except for supply and discharge utilities such as mains water supply, electrical connections, sewerage lines and gas supply;
- Safe removal of all chemical and hazardous materials;

- Adequate provision for drainage, vessel cleaning and dismantling of pipework;
- Disassembly and containment procedures for insulation, materials handling equipment, material extraction equipment, fabric filters and other filtration equipment without significant leakage, spillage, release of dust or other hazard substance;
- Where practicable, the use of construction material which can be recovered (such as metals);
- Methodology for the removal/decommissioning of components and structures to minimise the exposure of noise, disturbance, dust and odours and for the protection of surface and groundwater; and
- Soil and groundwater sampling and testing of sensitive areas to ensure the minimum disturbance (sensitive areas to be selected with reference to the initial site report and any ongoing monitoring undertaken during operation of the CCF).

Specific Details

The specific details associated with implementation of the site closure plan will include, but not be limited to, the following:

- A list of recyclable materials/components and current potential outlet sources.
- A list of materials/components not suitable for recycling and potential outlet sources.
- A list of materials to go to landfill with current recognised analysis, where appropriate.
- A list of all chemicals and hazardous materials, location and current containment methods.
- A Bill of Materials detailing total known quantities of items throughout the site such as:
    - Steelwork;
    - Plastics;
    - Cables;
    - Concrete and civil materials;
    - Oils;
    - Chemicals;
    - Consumables;
    - Contained water and effluents; and
    - Solvent.

Disposal Routes

Each of the items listed within the sites Bill of Materials will have a recognised or special route for disposal identified, e.g. landfill by a licensed contractor, disposal by high sided, fully sheeted road vehicle or for sale to a scrap metal dealer, disposal by skip/fully enclosed container, or dealer to collect and disposal by container via road.

10.17 NOISE AND VIBRATION MANAGEMENT PLAN

An Outline Noise and Vibration Management Plan (ONVMP) in relation to the CCF has been prepared for this submission. The aims of the ONVMP are to:

- Identify activities with the potential to cause a noise impact; and
- Set out an effective noise management strategy to minimise noise pollution from the CCF.

This ONVMP is based on information from the Environmental Statement accompanying the application for a Development Consent Order for the Cory Decarbonisation Project (the ES).. Therefore, the ONVMP sets the principles for noise management of the CCF, and it will be updated to a detailed Operational Noise and Vibration Management Plan to take account of any material changes that would affect the mitigation or management of noise emissions from the Site.

The ONVMP is included in Appendix H.

10.18 VENTING MANAGEMENT PLAN

Cory understands that the EA is currently preparing guidance as to what should be included in a venting management plan.

As stated in the pre-application advice (EPR/JP3020LL/P001) and consistent with other determined permit applications and issued permits, a suggested pre-operational condition, requiring the provision and implementation of a venting management plan, is included for consideration below in Section 13. However, we have included a preliminary assessment on venting within Section 12.10, as well as within the ERA, included in Appendix B.

The CO_2 venting assessment, included in Appendix J, and its recommendations will be used to inform the process design by ensuring that CO_2 venting does not pose a significant risk to human health or sensitive receptors; this will include details such as the location, height and diameter of the venting stack(s).

Through this assessment, management practices and assessment of risk associated with the plant design will be considered. Please see section 12.10.1 for information relating to the venting scenarios.

11 BAT GUIDANCE REVIEW

The CCF will operate in accordance with the conditions met in the new Bespoke Environmental Permit, and applicable EA Sector guidance, namely:

- Post-combustion carbon dioxide capture: Emerging techniques on how to prevent or minimise the environmental impacts of post-combustion carbon dioxide capture. Published 2 July 2021 (updated 27 March 2024)1 to advise on the Best Available Techniques Activities.
- Best Available Techniques [BAT] Conclusions: Emissions from Storage, July 2006.
- Best Available Techniques [BAT] Conclusions: Energy Efficiency, amended September 2021.
- Best Available Techniques [BAT] Conclusions: Industrial Cooling Systems, December 2001.
- Best Available Techniques [BAT] Conclusions: Best Available Techniques (BAT) Reference Document for Common Wastewater and Waste Gas Treatment/Management Systems in the Chemical Sector, 2016

11.1 POST-COMBUSTION CARBON DIOXIDE CAPTURE

Emerging techniques are novel technologies for an industrial activity that, if commercially developed, could provide one of the following:

- A higher general level of protection of the environment; and
- At least the same level of protection of the environment and higher cost savings than existing best available techniques.

These techniques were developed by the regulators along with the UK CCS Research Centre[71]. It is noted that, except where regulations apply, this guidance for emerging techniques is not a requirement but identifies the best proactive approach to address important environmental issues. The EA does expect operators to follow this guidance, or to propose an alternative approach to provide the same or greater level of protection for the environment. The guidance note covers:

- Power plant selection and integration with the Post Combustion Carbon Capture Plant;
- Post Combustion Carbon Capture Plant design and operation;
- Cooling; and
- Discharge to water.

Table 11-1 shows an indicative assessment against this guidance and emerging techniques. It should be noted that the Post-Combustion Carbon Dioxide Capture: emerging techniques refers to a “PCC Plant” which can be understood to be synonymous in this section with the term “CCF” as used throughout this document.

[71] UKCCSRC - Carbon Capture & Storage (CCS) CCS EXPLAINED - UKCCSRC

Table 11-1 – Post-Combustion Carbon Dioxide Capture BREF

BAT Requirement	Current/Proposed Arrangements	BAT?
Power Plant Selection and Integration with the PCC Plant		
BAT for efficiency of fuel use in power and CHP plants with PCC		
You must maximise the thermal energy efficiency of the plant and of the supply of heat for the associated PCC plant. For natural gas power plants, lower heating value efficiencies of 60% or above without CO_2 capture are reported in the LCP BREF to be achievable for large-scale new combined cycle gas turbine installations. New biomass power plant efficiencies will depend on: the size and type of boiler whether you use sub- or super-critical steam conditions You can reduce the impact of adding PCC by using power plant technologies that have the highest thermal efficiencies, since these have low specific CO_2 emissions (tonnes CO_2 per megawatt hour). If you expect to use more fuel to meet the heat or power needs of PCC, you should select the most efficient power plant technologies for that fuel and capture any additional CO_2 from that process. You should apply fuel input, electricity output and CO_2 emission metrics in the same way as you would to a power plant with fully integrated PCC (see section 2.3 on supplying heat and power for PCC operation).	This is not relevant in terms of Riverside 1 and Riverside 2 efficiency; however, opportunities will be made to maximise the overall energy efficiency of the combined Riverside 1 and Riverside 2 plants and CCF plant, and the supply of heat for the associated CCF plant. The selected amine capture technology minimises energy consumption, when compared against a generic monoethanolamine (MEA) solvent. No additional fuel will be required for the Riverside 1 and Riverside 2 to meet the heat and power needs of the CCF. General energy efficiency measures are implemented across the CCF as stated in Section 5, and a review of the Best Available Techniques [BAT] Conclusions: Energy Efficiency, amended September 2021 has been completed in Section 11.3.	Yes
Dispatchable Operation		
Where you plan to install CO_2 capture onto a CHP plant, you must design the plant so that it can operate efficiently during periods of power only mode. The primary purpose of an EfW plant is to treat waste. Therefore, they need to operate continuously. The PCC plant design and operation must be compatible with this.	The Riverside 1 and Riverside 2 plants operate at baseload rather than as a dispatchable power facility. Riverside 1 and Riverside 2 plants will not foreseeably operate in power only mode. If waste is being treated, then steam will be raised. It is foreseeable that one of Riverside 1 and Riverside 2 plants might operate in heat only mode, for example if a plant turbine is offline. In this case, the CCF plant would preferentially use steam from the Riverside 1 and Riverside 2 facilities unable to produce electricity.	N/a

BAT Requirement	Current/Proposed Arrangements	BAT?
	The CCF plant will be designed and operated to capture CO_2 from the Riverside 1 and Riverside 2 plants based on them operating continuously.	
Supplying Heat and Power for PCC Operation		
You will need to use low grade (for example 130°C) heat and electrical power to operate the PCC plant. You should work out the amounts needed based on factors that include the: • selected solvent • PPC plant configuration • CO_2 capture rate • CO_2 delivery pressure	Based on using the selected solvent, the CCF plant configuration, and the CO_2 capture rate (95% in normal operation. The specific electrical and heat demands will be determined as part of the detailed design based on the solvent, plant configuration, CO_2 capture rate and delivery pressure. Medium- and low-pressure steam will be used by the CCF plant. There is not sufficient waste low-grade heat available from the Riverside 1 and Riverside 2 plants to supply the CCF plant. It is not possible to supply enough steam at the required conditions to the CCF plant by extracting steam from the existing condensing turbines, so high-pressure steam from the Riverside 1 and Riverside 2 plants will be directed to the CCF plant and let down via a back-pressure turbine. This will produce some of the electricity required by the CCF plant, as well as the low and medium-pressure steam.	Yes
You should supply this heat and electricity from the main plant. Where not possible, this will need to be by fuel combustion in ancillary plants (with CO_2 capture) that are then also treated as a power or CHP plant system for performance calculations. The ratio between heat supplied as steam (or otherwise) and electricity output lost will depend on the: • temperature at which you need to supply heat • steam condenser cooling water temperature		Yes
You should consider using a back-pressure turbine if it is not possible to supply enough steam to the PCC plant by extracting steam from a condensing turbine.		Yes
If the plant needs to supply heat for district heating, and extracting steam to supply the PCC plant will mean there is insufficient steam to do this, you should consider using heat pumps or other plant to reduce the amount of steam required to meet that heat demand.	District heating is not currently supplied by the Riverside 1 and Riverside 2 plants. This is previously assessed in both Sections 5.1.2 and 8.1.1.	N/a
PCC Plant Design and Operation		
Purpose		
You should aim to design your plant to achieve a CO_2 capture rate of at least 95% during normal operating conditions, although operationally this can vary, up or down.	The CCF plant will be designed to achieve a CO_2 capture rate of at least 95% during normal operating conditions.	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
You will need to justify proposing a design CO_2 capture rate of less than 95% as an annual average of all normal operating conditions. You can submit a cost benefit analysis as part of your application.		
You will need to deliver CO_2: • at local transport system pressures (gas phase such as 35 bar or dense phase such as 100 bar) • with levels of water, oxygen and other impurities as required for transport and storage such as that for the system operator National Grid (NGC/SP/PIP/25 Dec.2019)	CO_2 will be shipped offsite, having had water, oxygen and other impurities reduced to the limits required, and been liquefied. It is anticipated that custody transfer will occur as part of the ship loading process where the CO_2 becomes the responsibility of the network operator for transport and storage.	Yes
The PCC plant must also have acceptable environmental risks through preventing or minimising emissions or render them harmless. You must achieve environmental quality standards for air emissions from the PCC plant and their subsequent atmospheric degradation products (including, for example, nitrosamines and nitramines). You should confirm this using: • atmospheric dispersion and reaction modelling tools • specific site parameters which will define plant-specific ELVs	Emissions from the CCF will be prevented and minimised to the extent practicable. The CCF will achieve the environmental quality standards for air emissions and their subsequent atmospheric degradation products (including, for example, nitrosamines and nitramines). This will be confirmed using: • atmospheric dispersion and reaction modelling tools • specific site parameters which will define plant-specific ELVs	Yes
Your PCC system design should aim to minimise the overall electricity output penalty on the EfW, power or CHP plants from all aspects of PCC plant operation, as much as possible. It should do this while meeting the CO_2 capture requirements set out in this guidance.	The CCF plant has been designed to minimise the overall electricity output penalty on the Riverside 1 and Riverside 2 plants to the extent practicable while meeting the CO_2 capture requirements set out in the BAT guidance.	Yes
Solvent Selection		
Your air emissions risk assessment should assess your plant design and operation, taking into account local environmental factors. It should include: • direct emissions of solvent components	An air emissions risk assessment and H1 assessment have been undertaken to assess the CCF design and operation, considering local environmental factors. It includes: • direct emissions of solvent components	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
• formation of additional substances in the PCC system and emissions of those substances • formation of further additional substances in the atmosphere from emissions from the PCC system	• formation of additional substances in the CCF system and emissions of those substances • formation of further additional substances in the atmosphere from emissions from the CCF system Further consideration of emissions has been considered as part of the Environmental Risk Assessment, included in Appendix B. Detailed air emissions is contained within Appendix I. Information regarding the H1 assessment is contained within Section **Error! Reference source not found.**.	
The potential for solvent reclaiming and other cleaning methods is also an important factor in solvent selection. You should make sure it is practicable to remove all non-solvent constituents from the solvent inventory as fast as they are added during operation, to avoid accumulation. Your assessment should demonstrate that you will: • recover a high fraction of the solvent in the feed to the reclaimer during reclaiming • minimise reclaimer wastes and that they can easily be disposed of	The proposed reclaiming system will remove non-solvent constituents from the solvent inventory as fast as they are added during operation, to prevent accumulation. Until operation commences, it will not be possible to determine how much solvent can be reclaimed. By maximising the amount of solvent reuse, the reclaimer waste is also minimised.	Yes
You must work out the performance of your solvent, including reclaiming requirements and modelling emissions to atmosphere. Determine this through realistic pilot (or full scale) tests using fully representative (or actual) flue gases and power plant operating patterns over a period of at least 12 months. You do not need to do this for your plant if information on the solvent performance is already available from pilots, tests, or regular operation at a similar plant.	Shell has studied the solvent performance, reclaiming requirements and emissions to atmosphere at commercial scale on other plants. Additionally, the solvent has been commercially deployed since 2012 with the first large scale capture of CO_2 from a coal-fired power station (Boundary Dam) commencing in 2014.	N/a
Features to control and minimise atmospheric and other emissions		
Flue Gas Cleaning		
Sulphur oxides (SO_x) removal (and hydrochloric acid (HCl) for EfW) SO_x in the flue gas will readily react with amines to produce heat stable salts. These products are typically stable under reclaimer conditions, but the heat stable salt formation with SO_x can be, at least partly,	The existing flue gas treatment systems at the Riverside 1 and Riverside 2 plants reduce the level of SO_x in the flue gas to levels compliant with the environmental permits for each plant before it is directed to the CCF plant. Shell has done testing to establish the levels of impurities entering the CCF plant that are within the tolerances of their process and SO_x levels	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
reversed by alkali addition in the solvent reclaiming process. SO_x levels will affect solvent consumption but are expected to have a limited effect on emissions. For most gas, biomass and waste fuels that have intrinsically low S levels, adding more upstream SO_x removal (and HCl removal for EfW) is likely to be primarily an economic decision. SO_x removal can be in the power plant flue gas desulphurisation unit, flue gas treatment system or in the PCC direct contact cooler. SO_x levels in the existing flue gases from an amine PCC plant will be expected to be at extremely low levels.	in the incoming flue gas are sufficiently low following abatement. Additionally, on entering the CCF plant, the flue gas is passed through a direct contact cooler (DCC) dosed with NaOH, further reducing SO_x levels. The thermal reclaiming process includes the addition of NaOH to treat any heat stable salts present in the solvent stream.	
NO_x removal The impact of NO_x in the flue gas will vary significantly with the solvent composition. If the amine blend will form stable nitrosamines with NO_x in the flue gas, then you must reduce NO_x to as low a level as practicably possible using selective catalytic reduction (SCR) EfW plants may be fitted with selective non catalytic reduction (SNCR) which does not reduce NO_x in flue gas as much as SCR. If you are retrofitting PCC plant to an EfW plant which has SNCR NO_x abatement, you should make sure the selected solvent is compatible with the abated flue gas. Both SCR and SNCR can result in ammonia (NH_3) slip. If necessary, it is expected that (NH_3) slip could be addressed in a suitably designed PCC unit. In all cases, you must assess the effects of NO_x in the flue gas on atmospheric degradation reactions, and this may also affect the need for SCR. If SCR is not fitted to a new build power plant, it is generally considered BAT to maintain space so it could be retrofitted, should this be considered necessary to meet ELVs in the future.	The solvent is compatible with the expected levels of NO_x in the flue gas. Riverside 1 EfW plant has selective non-catalytic reduction (SNCR) to reduce NO_x levels in the flue gas. Riverside 2 is currently under construction and will utilise Selective Catalytic Reduction (SCR) to abate NO_x levels. The processes have been optimised to reduce levels of NO_x within the flue gas that will be compatible with the solvent. The flue gas from Riverside 1 and Riverside 2 can contain traces of ammonia (NH_3) as both SCR and SNCR can result in ammonia slip. This will be addressed in the CCF plant design. Solvent pilot testing has demonstrated very low ammonia emissions, in some instances even lower than before treatment by the CCF plant.	Yes
Aerosols Sulphur trioxide (SO_3) droplets and fine particulates should not be present in the flue gas. If they arise in the PCC process, they can cause significant amine emissions.	Mist elimination will be added to the top of the Absorber Column(s) if required to remove aerosols. Regular sampling will be carried out in the operational CCF plant to assess total vapour and droplet emission levels.	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
The level of emissions (mainly solvent amines) is not directly related to aerosol measurements. Monitoring aerosols is difficult, and aerosol quantities may also vary significantly over time. Aerosols might be present, for example, because of significant SO_x in the flue gas. Where they are present, you should carry out long-term testing on a pilot plant or the actual plant, with all planned countermeasures in place, to show satisfactory operation. You should also carry out regular isokinetic sampling in the operational plant to assess total vapour and droplet emission levels. Other amine aerosol emission abatement techniques include: • cooling the flue gas gradually through the acid dewpoint • Brownian Demister Units • wet electrostatic precipitators • high lean solvent temperatures These techniques can reduce aerosol emission by enhancing aerosol growth in the top of the column, and the water wash. You may need to use a combination of these or other techniques.		
Other flue gas impurities You may need to remove materials in the flue gas that would accumulate as impurities in the solvent to lower concentrations than is required under the relevant BAT AELs. This is to ensure satisfactory PCC plant operation. Whether you need to do this will depend on the specific solvent properties and the effectiveness of the solvent management equipment (such as filtering and reclaiming). You should assess the effects of flue gas impurities through realistic, long term pilot testing. In general, your PCC plant must abate these types of flue gas impurities before the residual flue gases are finally released to atmosphere.	Flue gas impurities have been considered in the CCF plant design, and it has not been deemed necessary to provide further abatement, at this stage of the design, other than that discussed in Sections 3.2.1, 6.1.2 and 7.4.1.	Yes
PCC System Operation		
Operation Temperatures		
You must establish and maintain optimum temperature and appropriate limits in the solvent stripping process.	The CCF plant will be designed to operate consistently at the optimum conditions for the solvent.	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
Elevated temperatures can cause some thermal degradation of the solvent. But higher peak average temperatures during regeneration are also likely to promote reduced energy requirements and higher CO_2 capture levels. You must balance both to ensure the right environmental outcome. Where feasible, you should avoid locally higher metal skin temperatures, such as from the use of superheated steam in heaters, as this provides no benefit and can result in degradation.	Steam will be supplied to the CO_2 stripper at a temperature that will minimise degradation of the solvent.	
Solvent Degradation		
You should minimise oxidative degradation of the solvent by limiting solvent residence times in the Absorber Column(s) sump and other hold-up areas. Direct O_2 removal from rich solvent may be developed in the future but has not yet been proven at scale.	The CCF plant will be designed to optimise the conditions for the solvent, including consideration of residence times.	Yes
Absorber Emissions Statement		
Water Wash		
You must use 1 or 2 water washes or a scrubber before returning amine or other species to the solvent inventory. Capture levels are limited by vapour or liquid equilibrium, with volatile amines captured less effectively. Any aerosols present will also not be captured effectively. Water washes alone are ineffective in preventing NH_3 emissions, as concentrations will increase until the rate of release balances the rate of formation (and possibly addition from SCR or SNCR slip).	There will be a water wash at the top of the Absorber Column(s), to help retain solvent, reducing levels of amines, and soluble amine degradation products i.e. nitrosamines, and nitramines in the CCF plant emissions. Both the amine solvent and its main degradation products have low volatility, meaning that a single stage water wash is anticipated to be sufficient to limit emissions of these components well below ppm levels and thus are expected to ensure compliance with ELVs. Where required, mist elimination will be installed at the top of the Absorber Column(s) to remove aerosols and minimise solvent carryover. Some levels of ammonia may be removed in the capture process through the water washing processes. Ammonia emissions will be minimal from the operational CCF plant. Therefore, no additional abatement is required.	Yes
Acid Wash		
An acid or other chemically active wash or scrubber after the water wash will react with	An acid wash is not expected to be necessary to further reduce amine, ammonia or other	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
amines, NH_3 and other basic species and reduce them to very low levels (for example, 0.5mg to 5mg per m3 per species or lower). You should implement an acid wash as it is considered to be BAT, unless: • emission levels are already at acid wash levels with a water wash • you can show that the need to dispose of the acid wash waste outweighs the benefits of the additional reduction in emissions to atmosphere Depending on PCC system configuration, an Absorber Column(S) acid wash can also counteract NH_3 slip from an SCR system. If an acid wash is not fitted, you should consider a second water wash as an acid wash if: • emissions performance is worse than expected • you wish to change to a more volatile solvent • An acid wash is not likely to trap aerosols.	pollutants from the process, based on the anticipated emission concentrations. However, this will be reviewed at detailed design. The solvent supplier has stated that the both the amine solvent and its main degradation products have low volatility, meaning that a single stage water wash is anticipated to be sufficient to limit emissions of these components well below ppm levels and thus are expected to ensure compliance with ELVs. However, this is dependent on the characteristics of the incoming flue gas, which will be fully evaluated as part of the detailed design. If required, a “mist elimination” system will be included at the top of the Absorber(s), to provide further mitigation against aerosol emissions.	
Droplet Removal		
You must prevent emissions of aerosols. To do this you could use standard droplet removal sections after washes. These will prevent droplet carryover from the wash. However, they are not effective against very fine aerosols arising from SO_3 or other aerosol mists.	If required, mist elimination will be located at the top of water wash section to remove droplets and aerosols from the residual flue gas from the CCF plant before emission.	Yes
Stack Height		
Where modelling predicts that you may need to raise the temperature at the point of release to aid dispersion, you can: • increase the design stack height • add flue gas reheating Flue gas reheating can also reduce the plume visibility. Heat from cooling the flue gas before the PCC plant or waste heat from the PCC process should be used for flue gas reheating (see section 4 on cooling).	Detailed dispersion modelling has been carried out to identify the optimal stack height and temperature required to enable adequate dispersion of the flue gas. The incoming flue gas to the CCF plant will be cooled by/used to reheat the outgoing flue gas to the required temperature. This will have the added benefit of reducing plume visibility.	Yes
Process and Emissions Monitoring		

BAT Requirement	Current/Proposed Arrangements	BAT?
Role of monitoring		
The main purpose of monitoring the PCC process is to show that the emissions from the process, primarily to air, are not causing harm to the environment. You must also carry out monitoring to show that resources are being used efficiently. This includes: • energy and resource efficiency • CO_2 capture rate • verification that the CO_2 product is suitable for safe transport and storage You will need to develop a monitoring plan for both a commissioning phase and routine operation. During the commissioning phase you will need to optimise the operating envelope for the process. When you have achieved this the process operation will then become routine, along with the monitoring. It is likely that you will need to do more extensive monitoring during commissioning than during routine operation. As PCC is an emerging technique, you will need to develop monitoring methods and standards. You should include proposals for this in your permit application. You must demonstrate compliance with ELVs in the permit by monitoring emissions at authorised release points. You must also show that you are managing the process to prevent (or minimise) the formation of solvent degradation products. Where monitoring shows that degradation products are being formed (and may be released), you must reduce these and any solvent emissions to the permitted level. This process control monitoring will also be part of the permit conditions.	The CCF plant energy and resource efficiency, and levels of CO_2 treated and captured, and associated capture rate will be continuously monitored and periodically reported. The CO_2 product will be monitored to ensure that it is of a quality suitable for onsite storage and onward transport by ship. Commissioning and operational monitoring plans will be developed during the detailed design process for provision to the EA as a Pre-operational Condition of the Environmental Permit.	Yes
Point source emissions to air		
You must include monitoring to demonstrate compliance with: • IED Chapter III ELVs and Chapter IV • LCP BREF BAT AELs • WI BREF BAT AELs and normalised conditions	LCP BRef BAT-AELs are not applicable. Monitoring by the use of existing CEMs units will be carried out by Riverside 1 and Riverside 2 to demonstrate compliance with the IED Chapter IV and WI BREF BAT AELs prior to the flue gas being transported to the CCF unit.	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
You must also monitor for: • Ammonia • Volatile components of the solvent capture • Likely degradation products such as nitrosamines and nitramines Your monitoring may be either: • Continuous emissions monitoring • Periodic extractive sampling Emission sampling points must also comply with M1 sampling requirements for stack emission monitoring.	Continuous emissions monitoring systems (CEMS) will be installed to monitor flue gases from the CCF Plant. It is intended that CEMs monitoring of the listed species will be included for the CCF Plant. However, the exact specification of equipment to monitor the amines and degradation products is yet to be confirmed. If no suitable equipment is available, these will be monitored by periodic extractive monitoring. Emission sampling points will comply with EA web guidance previously known as M1 sampling requirements for stack emission monitoring.	
Process control monitoring		
You should use process control monitoring or periodic sampling with offline analysis to control the CO_2 capture and the solvent reclaiming performance. Parameters you should consider monitoring include: • absorber solvent quality – percentage active solvent • CO_2 loading both rich and lean solvent • maximum solvent temperature • heat stable solvent content • solvent colour or opacity • soluble iron and other metals and degradation products • in water or acid washes and scrubbers – pH, conductivity, loading of abated substances, flow rate • solvent usage	The CCF Plant will include instrumentation to monitor and record CO_2 capture rates and purity. Sampling points will be provided to collect fluid samples of the solvent to ensure the quality of solvent reclaiming. Process monitoring is outlined in Section 7.4 and is expected to include: • Gas chromatography to determine solvent composition. • Visual inspection of solvent colour to assess the level of degradation products. • Periodic sampling, Coriolis flowmeters and chromatography to determine density, indicating amine loading and levels of degradation products, heavy metals and soluble iron. • Solvent temperature will be controlled at consistent temperatures, within the Absorber Column(s) and stripper to minimise solvent degradation. • Solvent colour (indication of degradation products), pH, conductivity etc. Will be checked regularly. • Periodic laboratory testing for contaminants such as heat stable salts and amine degradation products. • Further monitoring arrangements will be determined during detailed design.	Yes
Monitoring of CO_2		

BAT Requirement	Current/Proposed Arrangements	BAT?
You should also include: • CO_2 mass balance • CO_2 in fuel combusted • CO_2 capture rate (as a percentage) • CO_2 released to the environment • CO_2 quality	These parameters will be monitored as part of the CCF plant operation. The CO_2 capture rate is designed to capture at least 95% of the CO_2 in normal operation. The incoming flue gas will contain 197.2 tph CO_2 on average. Of this, approximately 9.9 tph will be released to the environment. The CO_2 stream sent for storage will contain >99mol% CO_2.	Yes
Monitoring Standards		
The person who carries out your monitoring must be competent and work to recognised standards such as the Environment Agency's monitoring certification scheme (MCERTS) MCERTS sets the monitoring standards you should meet. The Environment Agency recommends that you use the MCERTS scheme where applicable. You can use another certified monitoring standard, but you must provide evidence that it is equivalent to the MCERTS standards. There are no prescriptive BAT requirements for how to carry out monitoring. Monitoring methods need to be flexible to meet specific site or operational conditions. You must use a laboratory accredited by the United Kingdom Accreditation Service to carry out analysis for your monitoring.	Any extractive monitoring carried out on the emissions from the CCF plant will be carried out by competent contractors to certified monitoring standards equivalent to MCERTS. UKAS accredited laboratories will be used for sample analysis for any monitoring.	Yes
Unplanned emissions to the environment		
You should propose a leak detection and repair programme that is appropriate to the solvent composition. This should use industry best practice to manage releases, including from joints, flanges, seals and glands. You must provide a hazard and mitigation assessment for the plant. This must consider the risks of accidental releases to environment. This should also consider the actual composition of the fluids, gases and vapours that could be released from the plant after an extended period of operation. (Not only fresh solvent as initially charged.)t	A leak detection and repair programme based on industry best practice will be developed during detailed design. Oxygen sensors will be installed to detect oxygen depletion indicating CO_2 leakage. The locations of these will be subject to detailed design. Pressure sensors in CO_2 streams/ storage will be installed to detect pressure loss in the case of leakage. In the case of solvent leakage, there will be level detection in the relevant bunds. A hazard and mitigation assessment for the plant, considering the composition of substances that could be released from the CCF plant operation will be developed as part of detailed design.	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
	Appropriate alarms will be linked back to the control room. The control and alarm philosophies will be developed during detailed design.	
3.6 Capture level, including during flexible operation, start-up and shutdown Capturing at least 95% of the CO_2 in the flue gas during normal operating conditions is considered BAT. You can base this on average performance over an extended period (for example, a year). To achieve this, you should make sure the design capture level for flue gas passing through the Absorber Column(S) equates to at least 95% of the CO_2 in the total flue gas from the plant. Over the averaging period, your capture level may vary up or down. You should set out any potential 'other than normal operating conditions' (OTNOC) for the CO_2 capture plant in your permit application. You should include a PCC OTNOC management plan in your management system to measure and minimise occurrence and impact of these periods. OTNOC includes periods of start-up and shut down. Your PCC OTNOC management plan must compliment any OTNOC management plan for the facility it serves and consider internal and external causes of OTNOC. An example of OTNOC would be when the CO_2 transport and storage network is down. As the fraction of intermittent renewable generation in the UK rises, many CCS enabled plants will need to start and stop more often, and possibly also operate at variable loads. It is therefore important, for current or future intermittent operation plant, that you aim to maximise CO_2 capture during these periods, including during start-up and shutdown, to maintain high average capture levels. You should therefore capture CO_2 during plant start-up and shutdown as part of using BAT. A method to maintain capture during start-up and shutdown using solvent storage has been identified in chapter 7 of the PCC evidence review This, or alternatives that can achieve equivalent results, is considered BAT. You will need to provide justification and a cost benefit analysis if you are not proposing capture during start-up and shutdown.	The CCF plant capture rate is designed to be 95% during normal operation. 'Other than normal operating conditions' (OTNOC) will include SU/SD of the Riverside 1 and Riverside 2 plants and CCF plant, off specification flue gas being provided by the Riverside 1 and Riverside 2 plants, and constraint or unavailability of the onward CO_2 transport. A CCF OTNOC management plan to measure and minimise occurrence and impact of these periods will be developed during detailed design, with consideration of the Riverside 1 and Riverside 2 plants operating under OTNOC. The Riverside 1 and Riverside 2 plants are primarily in place to treat waste; therefore, they operate at baseload rather than operating at variable loads, and do not frequently SU/SD, nor will they as the fraction of intermittent generation rises. SU/SD for the CCF is dependent on the availability of utilities, in particular power and steam. Cold start for each train takes approximately six hours, with a hot start/standby mode cutting that down to two hours. Therefore, the benefit of capturing CO_2 during SU/SD will be very limited. SU/SD is further discussed in Section 12.9. When the transport and storage system is constrained not available, it will not be appropriate to capture CO_2 beyond what can be stored onsite. Therefore, the CCF plant will be partially or fully bypassed as appropriate so that electricity generation and waste treatment can continue.	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
If your PCC plant is not initially constructed with this capability, your permit application should show how you may retrofit it. Your PCC OTNOC management plan should include measures to minimise any CO_2 emitted during start-up and shutdown periods. Some plants (including EfW) may not have frequent start-ups and shutdowns, so investment in solvent storage (or an alternative) is likely to be an economic decision. You should outline this in your cost benefit analysis. Where the CO_2 is being captured for secure geological storage, the transport and storage system may not always be available. When it is not, it is not appropriate to capture CO_2. You will need to make sure the PCC plant is bypassed so that electricity, CHP generation or waste incineration can continue. You must not include these periods in any capture efficiency calculation, but you must keep a record of these, and CO_2 quantities emitted for reporting purposes. The CO_2 transport and storage system (including non-pipeline transfer) may sometimes need to be constrained – that is, it cannot take all the CO_2 you are producing. You should plan how you would meet this constraint as far as is practicable. You should detail both situations in your permit application. You must show how you will manage the plant to minimise emissions to the environment, including during start-up and shutdown.		
3.7 Compression You should select CO_2 compressors based on the expected duty. You should consider how any waste heat arising may be used. For base load operation, you should use integrally geared units because they give the: • maximum full-load efficiency • minimum number of compression trains For flexible and part-load operation, smaller compression trains (for example 2 at 50% compared to 1 at 100%) may be preferable. The use of different types of compressor or pump in series may also be preferable, to give greater flexibility at the expense of slightly lower full-load efficiencies.	The type of compressor and configuration of each compressor train will not be confirmed until detailed design. However, the design of the CO_2 compression system, such as the use of integrally geared units or smaller compressor frame sizes, will be based on the specific project requirements to maximise efficiency as much as reasonably practicable.	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
3.8 Noise and Odour The LCP BREF and EFW BREF already cover noise impacts for the main power plant. You only need to consider additional process steps in PCC technology that have high potential for noise and vibration. In particular, CO_2 compression could be an area of concern. Once you have identified the main sources and transmission pathways, you should consider the use of common noise and vibration abatement techniques and mitigation at source wherever possible. For example: • use of embankments to screen the source of noise • enclosure of noisy plant or components in sound-absorbing structures • use of anti-vibration supports and interconnections for equipment • orientation and location of noise-emitting machinery • change of the frequency of the sound The handling, storage and use of some amines may result in odour emissions, so you should always use best practice containment methods. Where there is increased risk that odour from activities will cause pollution beyond the site boundary, you will need to send an odour management plan with your permit application.	A Noise Impact Assessment has been undertaken in support of this Environmental Permit application (Appendix G) and includes an assessment of all potential sources of noise from the CCF Plant, including but not limited to the CO_2 compression. Considering the industrial setting of the CCF Plant within the boundary of an existing Installation, the relative noise generated by the compressors is considered to be not significant. Odour is discussed in Section 6.5 and assesses potential odours as well the management and control measures associated with them. As suitable controls are in place, an Odour Management Plan is not considered to be required for the proposed installation. This is consistent with the Regulator's previous permit determinations for carbon capture within this sector and aligns with the post-combustion carbon dioxide capture: Emerging techniques on how to prevent or minimise the environmental impacts of post-combustion carbon dioxide capture. Published 2 July 2021 (updated 27 March 2024).	Yes
3.9 Hot potassium carbonate post combustion capture plant Using electrically powered hot potassium carbonate as an alternative solvent to amines for capturing CO_2 is an emerging technique that may have some advantages where the on-site availability of steam supply is insufficient for amine regeneration. Where you choose to use this carbon capture technique you should justify why in your permit application.	N/a	N/a
Cooling		
4. Cooling	Due to the limited water availability on site, direct water cooling and wet cooling are not possible. However, some water is expected to	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
You will be able to achieve the best power and CO_2 capture plant performance by using the lowest temperature cooling available. You should use the hierarchy of cooling methods as follows: • direct water cooling (such as seawater) • wet cooling towers • hybrid cooling towers • dry cooling – direct air-cooled condensers and dry cooling towers Power plants that are retrofitted with PCC using steam extraction, or that are intended to be able to operate without capture, can share water cooling between the power plant and the PCC system. This is because the cooling load on the main steam condensers falls with increased steam extraction rate. This shift away from condenser cooling will not apply for systems with direct air-cooled condensers. It may also be possible to reuse cooling water after the main condensers for higher-temperature cooling applications in the PCC plant. However, site specific water discharge temperature limits may be an issue for direct cooling.cA feature of PCC is that you have to remove heat from a flue gas stream that was originally not cooled. You can still achieve rejection of heat to atmosphere by heating the flue gas leaving the absorber, using heat from the incoming flue gas. You can do this either: directly – such as using a rotary gas-gas heater indirectly – such as using a heat transfer fluid or low-pressure steam clean and rich solvent storage may also help you achieve satisfactory PCC performance during periods of high cooling demand.	be available on site through the treatment of process effluent. This will allow a combination of hybrid and dry cooling to be utilised, to minimise the cooling footprint and optimise the cooling water temperature within the site water constraints compared to using dry cooling alone. The ETP conditions and dewaters the effluent stream by returning the vast majority of water from the process effluent back into the cooling system. The Riverside 1 and Riverside 2 plants have direct air-cooled condensers; therefore, these cannot be shared with the CCF plant. Direct cooling of the incoming flue gas using the outgoing flue gas via a rotary gas-gas heat exchanger is anticipated. This will be confirmed at detailed design. The BATs for Cooling are further assessed in Section 11.4.	
Discharges to Water		
For discharges to water, you should refer to the guidance on surface water pollution risk assessment for your environmental permit. For best practice in plume dispersal modelling, see the Joint Environmental Program report “A protocol on projects modelling cooling water discharges into TrAC waters within power station developments”.	The CCP installation will be zero liquid discharge with all process wastewater and cooling water blowdown being treated in the ETP, to recover water and produce a waste sludge. The waste sludge will be taken offsite for disposal, and the treated water re-used within the process, either directly or as cooling	N/a

BAT Requirement	Current/Proposed Arrangements	BAT?
	water make-up. As a result, there are no process emissions to water. Surface water collected in process areas, such as rainfall in bunds, will be tested for contamination prior to discharge to avoid any pollution of surface water systems. Contaminated water will be pumped out and disposed of in an appropriate manner. Domestic wastewater will be disposed via sewer.	

https://www.gov.uk/guidance/post-combustion-carbon-dioxide-capture-best-available-techniques-bat

11.2 EMISSIONS FROM STORAGE

This BREF addresses the storage and the transfer/handling of liquids, liquefied gases and solids, regardless of the sector or industry. It addresses emissions to air, soil and water. However, most attention is given to emissions to air. Energy and noise are also addressed but to a lesser extent. In particular for the storage of liquids and liquefied gases. An indicative BAT Assessment for this BREF is shown in Table 11-2.

Table 11-2 – Emissions from Storage

BAT Requirement	Current/Proposed Arrangements	BAT?
Storage of liquids and liquefied gases		
Tanks		
Tank design: BAT for tank design is for a proper design to take into account at least one of the following: • the physico-chemical properties of the substance being stored • how the storage is operated, what level of instrumentation is needed, how many operators are required, and what their workload will be • how the operators are informed of deviations from normal process conditions (alarms) • how the storage is protected against deviations from normal process conditions (safety instructions, interlock systems, pressure relief devices, leak detection and containment, etc.)	Given that Carbon Capture is a new and novel/emerging technology not everything can be considered applicable. All tanks will be designed and consider all the following. • Past experiences may not be applicable but will be considered where applicable using knowledge of Riverside 1, Riverside 2 and information obtained through material safety data sheets. • Maintenance and emergency situations will be implemented in accordance with Cory's integrated management system, which is certified to ISO 9001, ISO 14001 and ISO 45001. Cory also applies a competent management system developed by Energy and Utility Skills.	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
• what equipment has to be installed, largely taking account of past experiences of the product (construction materials, valve quality, etc.) • which maintenance and inspection plan needs to be implemented and how to ease the maintenance and inspection work (access, layout, etc.) how to deal with emergency situations (distances to other tanks, facilities and to the boundary, fire protection, access for emergency services such as the fire brigade, etc.).		
Inspection and maintenance: BAT for inspection and maintenance is to apply a tool to determine proactive maintenance plans and to develop risk-based inspection plans such as the risk and reliability-based maintenance approach. Inspection work can be divided into routine inspections, in-service external inspections and out-of-service internal inspections.	All tanks, pipework and bunding will be incorporated in the sites preventative maintenance plan which will be set out in the sites IMS in accordance with industry best practice.	Yes
Location and layout: For building new tanks, BAT is to locate a tank operating at, or close to atmospheric pressure above ground. However, for storing flammable liquids on a site with restricted space, underground tanks can also be considered. For liquified gases, underground, mounded storage or spheres can be considered, depending on the storage volume.	Solvent and reclaimer waste will be stored above ground. Other raw materials and wastes will be stored above ground in designated storage areas with appropriate bunding.	Yes
Tank colour: BAT is to apply either a tank colour with a reflectivity of thermal or light radiation of at least 70 % or a solar shield on aboveground tanks which contain volatile substances.	Not applicable as the solvent and reclaimer waste are non-volatile. Tank colours and coatings will be further considered as part of the detailed design.	N/a
Emission minimisation principle in tank storage: BAT is to abate emissions from tank storage, transfer and handling have a significant negative environmental effect. This is applicable to large storage facilities allowing a certain time frame for implementation.	Abatement for the solvent will be considered as part of the detailed design; however, the solvent is not volatile and has a boiling point higher than that of water. Vacuum tankers will be utilised by third party licensed contractors when appropriate to remove waste.	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
	Further abatement in tank storage will be implemented appropriately, if necessary, at detailed design.	
Monitoring of VOC: On sites where significant VOC emissions are to be expected, BAT includes calculating the VOC emissions regularly. The calculation model may occasionally need to be validated by applying a measurement method.	Significant release of VOC emissions is not expected given the low volatility of the solvent; however, this will be further considered as part of the detailed design.	N/a
Dedicated systems: BAT is to apply dedicated systems, where tanks and equipment are dedicated to one group of products. This means no changes in products. This makes it possible to install and use technologies specifically tailored to the products stored (and handled), thereby preventing and abating emissions efficiently and effectively.	Tanks and containers will be dedicated to the materials they will store, and waste will be segregated as appropriate.	Yes
Tank Specific Considerations		
Open top tanks: If emissions occur to air from open top containers used for storage, BAT is to cover the tank by applying: • A flexible cover • A flexible or tent cover • A rigid cover Additionally, with an open top tank covered with a flexible, tent or a rigid cover, a vapour treatment installation can be applied to achieve and additional emission reduction. The type of cover and the necessity for applying the vapour treatment system depend on the substances stored and must be decided on a case-by-case basis. To prevent deposition that would call for an additional cleaning step, BAT is to mix the stored substance.	Not applicable as open top tanks or vessels are not anticipated to be used at the CCF.	N/a
External floating roof tank: When external floating roof tanks are used for storage of e.g. crude oil, BAT is to apply direct contact floating roofs (double-deck), however existing non-contact floating roofs (pontoon) are also BAT. Additional measures to reduce emissions are: • Applying a float in the slotted guide pole • Applying a sleeve over the slotted guide pole • Applying ‘socks’ over the rood legs	Not applicable as floating roof tanks are not anticipated to be used at the CCF.	N/a

BAT Requirement	Current/Proposed Arrangements	BAT?
A dome can be BAT for adverse weather conditions. For liquids containing a high level of particles, BAT is to mix the stored substance to prevent deposition that would call for an additional cleaning step. BAT associate emission reduction level for a large tank is at least 97 %.		
Fixed roof tanks: Fixed roof tanks are used for storage of flammable and other liquids. For the storage or volatile substances with are toxic (T), very toxic (T+), or carcinogenic, mutagenic and reproductive toxic (CMR) categories 1 and 2 in a fixed roof tank, BAT is to apply a vapour treatment installation. For other substances, BAT is to apply a vapour treatment installations, or to install an internal floating roof. Direct contact floating roofs and non-contact floating roofs are BAT. For tanks < 50 m^3, BAT is to apply a pressure relief valve set at the highest possible value consistent with the tank design criteria. The BAT associated emission reduction is at least 98 %.	The solvent will be stored in a stainless-steel tank as per the BAT requirement. The need for vapour treatment will be established and implemented as part of the detailed design. Pressure relief requirements will be assessed, and all tank design criteria will be adhered to in order to comply with BAT.	Yes
Atmospheric horizontal tanks: Atmospheric horizontal tanks are used for the storage of flammable and other liquids. For the storage of volatile substances which are toxic (T), very toxic (T+), or CMR categories 1 and 2 in an atmospheric horizontal tank, BAT is to apply a vapour treatment installation. For other substances, BAT is to do all or a combination of the following, depending on the substances stored: • Apply pressure vacuum relief valves • Up rate to 56 mbar • Apply vapour balancing • Apply a vapour holding tank • Apply vapour treatment	Not applicable as there are minimal volatile substances anticipated to be used on site. BAT will be further considered during detailed design and incorporated if applicable.	N/a
Pressurised storage: Pressurised storage is used for storing all categories of liquified gases, from non-flammable up to flammable and highly toxic. The only significant emissions to air from normal operations are from draining. BAT for draining depends on the tank type but may be the application of a closed drain system connected to a vapour treatment installation. The selection of the vapour treatment technology has to be decided on a case-by-case basis.	There will be pressurised storage for LCO_2, and appropriate details for venting CO_2 will be further considered at detailed design and will comply with BAT.	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
Lifter roof tanks: For lifter roof tanks emissions to air, BAT is to use one of the following techniques: • Apply a flexible diaphragm tank equipped with pressure/vacuum relief valves • Apply a lifter roof tank equipped with pressure/vacuum relief valves and connected to a vapour treatment installation	Not applicable as lifter roof tanks are not anticipated to be used at the CCF.	N/a
Refrigerated tanks: No significant emissions from normal operation	Not applicable as refrigerated tanks are not anticipated to be used at the CCF.	N/a
Underground and mounded tanks: Underground and mounded tanks are used especially for flammable products. For the storage of volatile substances which are toxic (T), very toxic (T+), or CMR categories 1 and 2 in an underground or mounded tank, BAT is to apply a vapour treatment installation. For other substances, BAT is to do all, or a combination, of the following techniques depending on the substances stored: • Apply a pressure vacuum relief valves • Apply vapour balancing • Apply a vapour holding tank • Apply vapour treatment	Not applicable as underground and mounded tanks are not anticipated to be used at the CCF. It is proposed that all tanks are to be above ground.	N/a
Storage of Packaged and Dangerous Substances		
Safety and risk management: BAT in preventing incidents and accidents is to apply a safety management system that includes: • A statement of tasks and responsibilities • An assessment of the risks of major accidents • A statement of procedures and work instructions • Plans for responding to emergencies • The monitoring of the safety management system • The periodic evaluation of the policy adopted	All tanks, pipework and bunds will be included in a preventative maintenance programme in accordance with industry standards. As part of the design process, a series of hazard studies have been/will be conducted. A HAZID has been conducted as part of the pre-FEED, and a HAZOP will be undertaken as part of the detailed design. In accordance with EA Guidance[72], and included in Appendix B, an Environmental Risk Assessment has been conducted. The CCF will be incorporated into Cory's EMS, and Risk Assessment, Hazard Identification and Determining Controls Procedure (IMS-MP-02) will be implemented at the facility. This procedure explains how the Site can identify	Yes

[72] Risk assessments for your environmental permit - GOV.UK

BAT Requirement	Current/Proposed Arrangements	BAT?
BAT is to assess the risk using the following five steps: 1. Identify the hazards 2. Decide who and/or what may be harmed (and/or contaminated and how seriously) 3. Evaluate the risks arising from the hazards and decide whether existing precautions are adequate or if more needs to be done 4. Record significant findings 5. Review assessment from time to time and revise if necessary	safety hazards and environmental aspects associated with the operations, products and services in an ongoing and proactive way.	
Training and responsibility: BAT is to appoint a person or persons who are responsible for the operation of the store, and to provide them with specific training and retraining in emergency procedures. Other staff on site should be informed of the risks of storing packaged dangerous substances and the precautions necessary to safely store substances that have different hazards.	Cory has an integrated management system certified to ISO 9001, ISO 14001 and ISO 45001. The CCF will be incorporated into the IMS. Cory also applies a competence management system developed by Energy and Utility Skills. Staff induction programmes are location and job role specific and will include, as a minimum, coverage of the Environmental Policy, relevant health and safety policy and procedures, EMS Awareness Training.	Yes
Storage area: BAT is to apply a storage/building and/or an outdoor storage area covered with a roof. For storing quantities of less than 2500 litres or kilograms of dangerous substances, applying a storage cell is also BAT.	Chemicals will be stored and bunded in appropriate storage areas. This will be considered as appropriate due to detailed design and final volume.	Yes
Separation and segregation: BAT is to separate the storage area or building of packaged dangerous substances form ignition sources and from other buildings on- and off-site by applying sufficient distances, sometimes in combination with fire-resistant walls. BAT is to separate and/or segregate incompatible substances.	There will be no packaged dangerous substances. All substances will be stored in dedicated storage areas. All incompatible materials will be separated within dedicated storage and bunding areas.	Yes
Containment of leakage and contaminated extinguishant: BAT is to install a liquid-tight reservoir, which can contain all or a part of the dangerous liquids stored above such a reservoir. How much of the leakage needing to be contained depends on the substances stored and the location of the storage and is to be decided on a case-by-case basis.	Site drainage will be fitted with a shut-off alarm, linked to the fire detection systems to contain any firefighting water. The solvent is a CMR substance and liquid-tight bunding will contain the extinguishant.	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
BAT is to install a liquid-tight extinguishant collecting provision in storage buildings and storage areas. The collecting capacity depends on the substances stored, the amount of substances stored, the types of package used and the applied fire-fighting system and can only be decided on a case-by-case basis.		
Fire-fighting equipment: BAT is to apply a suitable protection level of fire prevention and fire-fighting measures. The appropriate protection level has to be decided on a case-by-case basis in agreement with the local fire brigade.	Fixed firewater hose reels and manual alarm activation points will be available and strategically placed in high-risk areas. Portable fire extinguishers will be accessible throughout the CCF and tested and inspected regularly. A consistent and reliable water supply dedicated to firefighting will be available. Adequate infrastructure necessary for effective firefighting (including fire water tanks, hydrants etc) and emergency response will be available. An automatic fire suppression system will be specified in consultation with fire safety experts, insurance advisors, and relevant authorities to ensure the most effective and compliment solution. The final specifications will be detailed and finalised for inclusion in the full Accident and Prevention Management Plan.	Yes
Preventing ignition: BAT is to prevent ignition at the source by taking appropriate actions based on potential sources of ignition.	Components required for ignition (fuel, heat and oxygen) will be physically separated as much as practicable to minimise risk of ignition. This will be further considered as part of safety studies, during the detailed design phase and finalisation of the CCF layout plan which will also incorporate Hazardous Area Classifications. Use and storage of fuel is minimised as much as possible, with potential ignition sources being diesel fuel (as part of emergency diesel generator), and ammonia or propane used as refrigerant. Any ignition source will be strictly controlled and handled in accordance with applicable codes, standards and regulations including but not limited to DSEAR 2002, COSHH ATEX regulations 2016, and BS EN 60079.	Yes
Basins and lagoons		
Where emissions to air from normal operation of a basin or lagoon are significant, BAT is to use one of the following:	N/a	N/a

BAT Requirement	Current/Proposed Arrangements	BAT?
• A plastic cover • A floating cover • A rigid cover (only for small basins) Additionally, where a rigid cover is used, a vapour treatment installation can be applied to achieve an extra emission reduction. The need for and type of vapour treatment must be decided on a case-by-case basis. To prevent overfilling due to rainfall in situations where the basin or lagoon is not covered, BAT is to apply a sufficient freeboard. Where substances are stored in a basin or lagoon with a risk of soil contamination, BAT is to apply an impervious barrier.		
Transfer and handling of liquids and liquified gases		
Inspection and maintenance: BAT is to apply a tool to determine proactive maintenance plans and to develop risk-based inspection plans such as, the risk and reliability-based maintenance approach.	All tanks, pipework and bunding will be incorporated in the sites preventative maintenance plan which will be set out in the sites OEMP in accordance with industry best practice.	Yes
Leak detection and repair programme: For large storage facilities, according to the properties of the products stored, BAT is to apply a leak detection and repair programme. Focus needs to be on those situations most likely to cause emissions.	All tanks, pipework and bunding will be included in a preventative maintenance programme. A leak detection and repair programme based on industry best practice will be developed during detailed design.	Yes
Emissions minimisation principle in tank storage: BAT is to abate emissions from tank storage, transfer and handling that have a significant negative environmental effect.	It is considered that CO_2 will be vented in insignificant amounts and will be considered as part of the detailed design. Venting will happen as part of emergency/OTNOC scenarios. In the event this happens, this will be recorded and logged as part of the EMS. Further consideration on whether there is a potential release due to the boiling point of the solvent and any significance of release will be undertaken as part of the detailed design.	Yes
Safety and risk management: BAT in preventing incident and accidents is to apply a safety management system.	Cory has an integrated management system certified to ISO 9001, ISO 14001 and ISO 45001. The CCF will be incorporated into the IMS. Cory also applies a competence management system developed by Energy and Utility Skills.	Yes
Operational procedures and training: BAT is to implement and follow adequate organisational	Cory has an integrated management system certified to ISO 9001, ISO 14001 and ISO	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
measures and to enable and training and instruction of employees for safe and responsible operation of the installation as described.	45001. The CCF will be incorporated into the IMS. Cory also applies a competence management system developed by Energy and Utility Skills. Staff induction programmes are location and job role specific and will include, as a minimum, coverage of the Environmental Policy, relevant health and safety policy and procedures, EMS Awareness Training.	
Considerations on transfer and handling techniques		
BAT is to apply aboveground closed piping in new situations. For existing underground, it is BAT to apply a risk and reliability-based maintenance approach. Bolted flanges and gasket-sealed joints are an important source of fugitive emissions, BAT is to minimise the number of flanges by replacing them with welded connections, within the limitations of operational requirements for equipment maintenance or transfer system flexibility. BAT for bolted flange connections include: • Fitting blind flanges to infrequently used fittings to prevent accidental opening • Using end caps or plugs on open-ended lines and not valves • Ensuring gaskets are selected appropriate to the process application • Ensuring the gasket is installed correctly • Ensuring the flange joint is assembled and loaded correctly • Where toxic. Carcinogenic or other hazardous substances are transferred, fitting high integrity gaskets, such as spiral wound, kammprofile or ring joints BAT is to prevent internal corrosion by: • Selecting construction material that is resistant to the product • Applying proper construction methods • Applying preventative maintenance	Pipework, including all of the main process piping, will be located aboveground, mainly on pipe bridge structures, as much as practicable. Piping systems located underground may include ancillary systems such as cooling water or fire water. The designs will be in accordance with UK applicable codes and standards and confirmed during the detailed design phase. Piping will be designed using industry standard design codes such as ASME B31, EN 13480 and API 570, based on project specific piping specifications which define suitable materials (e.g. stainless steel, carbon steel, plastic, etc.) and pressure class components, including joints, gaskets and valves, appropriately in context of the service(s) it will be used for.	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
• Where applicable, applying an internal coating or adding corrosion inhibitors BAT is to prevent external corrosion by applying a one-, two- or three-layer coating system depending on site specific conditions.		
BAT is to apply vapour balancing or treatment on significant emissions from the loading and unloading of volatile substances to (or from) trucks, barges and ships. The significance of the emission depends on the substance and volume that is emitted and has to be decided on a case-by-case basis.	The CCF will include a vapour return line from the Proposed Jetty for CO_2 boil off gas. This will be combined with boil off gas from above ground storage tanks and sent to be re-liquified in the CCF. The solvent is not volatile.	Yes
BAT for valves includes: • Correct selection of the packaging material and construction for the process application • With monitoring, focus on those valves most at risk • Applying rotating control valves or variable speed pumps instead of rising stem control valves • Where toxic, carcinogenic or other hazardous substances are involved, fit diaphragm, bellows or double walled valves • Route relied on valves back into the transfer or storage system or to a vapour treatment system	Specification of valves will be completed as part of overall pipe specifications, to select appropriate materials, fitting types and details for the service(s) it will be used for. Selection of valves will be based on industry standards including ASME B16 and British Standards including but not limited to BS 5351, BS 5352, BS EN ISO 28921-1 and undertaken as part of detailed design in order to comply with BAT.	Yes
Installation and maintenance of pumps and compressors: The design and installation and operation of the pump or compressor heavily influence the life potential and reliability of the sealing system. The following are some of the main factors which constitute BAT: • Proper fixing of the pump or compressor unit to its base-plate or frame • Having connecting pipe forces within producers' recommendations • Proper design of suction pipework to minimise hydraulic imbalance • Alignment of shaft and casing within producers' recommendations	Choice of final pumps and compressors will be undertaken as part of the detailed design and will comply with BAT. Pumps and compressors will be included in the maintenance plan which will be set out in the sites maintenance plan, which forms part of the EMS, in accordance with industry best practice.	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
• Alignment of driver/pump or compressor coupling within producers' recommendations when fitted • Correct level of balance or rotating parts • Effective priming of pumps and compressors prior to start-up • Operation of the pump and compressor within producers' recommended performance range • The level of net positive suction head available should always be in excess of the pump or compressor		
Sealing system in pumps: BAT is to use correct selection of pump and seal types for the process application, preferably pumps that are technologically designed to be tight such as canned motor pumps, magnetically coupled pumps, pumps with multiple mechanical seals and a quench or buffer system, pumps with multiple mechanical seals and seals dry to the atmosphere, diaphragm pumps or bellow pumps.	Choice of sealing system will be undertaken as part of the detailed design and will comply with BAT. Sealing systems for pumps will be captured as part of overall pump design, appropriate for the application, system use and operating requirements.	Yes
Sealing systems in compressors: BAT for compressors transferring non-toxic gases is to apply gas lubricated mechanical seals. BAT for compressors, transferring toxic gases is to apply double seals with a liquid or gas barrier and to purge the process side of the containment seal with an inert buffer gas. In very high-pressure services, BAT is to apply a triple tandem seal system.	Choice of sealing system will be undertaken as part of the detailed design and will comply with BAT. Sealing systems for compressors will be captured as part of overall pump design, appropriate for the application, system use and operating requirements.	Yes
BAT, for sample points for volatile products, is to apply a ram type sampling valve or a needle valve and a block valve. Where sampling lines require purging, BAT is to apply closed-loop sampling lines.	Not applicable. The solvent is not a volatile product. Sampling connections will be further considered as part of the detailed design and implemented in compliance with BAT if applicable.	N/a
Storage of solids		
Open Storage		
BAT is to apply enclosed storage by using, for example, silos, bunkers, hoppers and containers, to eliminate the influence of wind and to prevent the formation of dust by wind as far as possible by primary measures.	Not applicable. Silos, bunkers, hoppers and containers will not be utilised.	N/a

BAT Requirement	Current/Proposed Arrangements	BAT?
BAT for open storage is to carry out regular or continuous visual inspections to see if dust emissions occur and to check if preventive measures are in good working order. Following the weather forecast by, e.g., using meteorological instruments on site, will help to identify when the moistening of heaps is necessary and will prevent unnecessary use of resources for moistening the open storage. BAT for long-term open storage are one, or a combination of the following: Moistening the surface using durable dust-binding substances Covering the surface Solidification of the surface • Grassing-over the surface BAT for short-term open storage are one, or a combination of the following: • Moistening the surface using durable dust-binding substance • Moistening the surface with water • Covering the surface Additional measures to reduce dust emissions from both long- and short-term storage are: • Placing longitudinal axis of the heap parallel with the prevailing wind • Applying protective plantings, windbreak fences or upwind mounds to lower the wind velocity • Applying only one heap instead of several heaps as far as possible • Applying storage with retaining walls reduces the free surface • Placing retaining walls close together		
Enclosed Storage		
BAT is to apply enclosed storage by using, for example, silos, bunkers, hoppers and containers. Where silos are not applicable, storage in sheds can be an alternative. BAT for silos is to apply a proper design to provide stability and prevent the silo from collapsing. BAT for sheds is to apply proper designed ventilation and filtering systems and to keep the doors closed. BAT is to apply dust abatement, and a BAT associated emission level of 1 – 10 mg/m^3,	Not applicable. Silos, bunkers, hoppers and containers will not be utilised.	N/a

BAT Requirement	Current/Proposed Arrangements	BAT?
depending on the nature/type of substance stored. The type of abatement technique has to be decided on a case-by-case basis. For a silo containing organic solids, BAT is to apply an explosion-resistant silo, equipped with a relief valve that closes rapidly after the explosion to prevent oxygen entering the silo.		
Storage of packaged dangerous solids		
Safety and risk management: BAT in preventing incidents and accidents is to apply a safety management system that includes: • A statement of tasks and responsibilities • An assessment of the risks of major accidents • A statement of procedures and work instructions • Plans for responding to emergencies • The monitoring of the safety management system • The periodic evaluation of the policy adopted BAT is to assess the risk using the following five steps: • Identify the hazards • Decide who and/or what may be harmed (and/or contaminated and how seriously) • Evaluate the risks arising from the hazards and decide whether existing precautions are adequate or if more needs to be done • Record significant findings • Review assessment from time to time and revise if necessary	There will be no storage of packed dangerous solids at the CCF.	N/a
Training and responsibility: BAT is to appoint a person or persons who are responsible for the operation of the store, and to provide them with specific training and retraining in emergency procedures. Other staff on site should be informed of the risks of storing packaged dangerous substances and the precautions necessary to safely store substances that have different hazards.	There will be no storage of packed dangerous solids at the CCF.	N/a

BAT Requirement	Current/Proposed Arrangements	BAT?
Storage area: BAT is to apply a storage/building and/or an outdoor storage area covered with a roof. For storing quantities of less than 2500 litres of kilograms of dangerous substances, applying a storage cell is also BAT.	There will be no storage of packed dangerous solids at the CCF.	N/a
Separation and segregation: BAT is to separate the storage area or building of packaged dangerous substances form ignition sources and from other buildings on- and off-site by applying sufficient distances, sometimes in combination with fire-resistant walls. BAT is to separate and/or segregate incompatible substances.	There will be no storage of packed dangerous solids at the CCF.	N/a
Containment of leakage and contaminated extinguishant: BAT is to install a liquid-tight reservoir, which can contain all or a part of the dangerous liquids stored above such a reservoir. How much of the leakage needing to be contained depends on the substances stored and the location of the storage and is to be decided on a case-by-case basis. BAT is to install a liquid-tight extinguishant collecting provision in storage buildings and storage areas. The collecting capacity depends on the substances stored, the amount of substances stored, the types of package used and the applied fire-fighting system and can only be decided on a case-by-case basis.	There will be no storage of packed dangerous solids at the CCF.	N/a
Fire-fighting equipment: BAT is to apply a suitable protection level of fire prevention and fire-fighting measures. The appropriate protection level has to be decided on a case-by-case basis in agreement with the local fire brigade.	There will be no storage of packed dangerous solids at the CCF.	N/a
Preventing ignition: BAT is to prevent ignition at the source by taking appropriate actions based on potential sources of ignition.	There will be no storage of packed dangerous solids at the CCF.	N/a
Safety and risk management: BAT in preventing incidents and accidents is to apply a safety management system that includes: • A statement of tasks and responsibilities • An assessment of the risks of major accidents	There will be no storage of packed dangerous solids at the CCF.	N/a

BAT Requirement	Current/Proposed Arrangements	BAT?
• A statement of procedures and work instructions • Plans for responding to emergencies • The monitoring of the safety management system • The periodic evaluation of the policy adopted		
Transfer and handling of solids		
General approaches to minimise dust from transfer and handling		
BAT is to prevent dust dispersion due to loading and unloading activities in the open air, by scheduling the transfer as much as possible when the wind speed is low. Discontinuous transport (e.g. shovel or truck) generally generates more dust emissions than continuous transport such as conveyors. BAT is to make transport distances as short as possible and to apply, wherever possible, continuous transport modes. When applying a mechanical shovel, BAT is to reduce the drop height and to choose the best position during discharging into a truck. While driving, vehicles might swirl up dust from solids spread on the ground. BAT then is to adjust the speed of vehicles on-site to avoid or minimise dust being swirled up. BAT for roads that are used by trucks and cars only, is applying hard surfaces to the roads of, for example, concrete or asphalt, because these can be cleaned easily to avoid dust being swirled up by vehicles. BAT is to clean roads that are fitted with hard surfaces. Cleaning of vehicle tyres is BAT. The frequency of cleaning and type of cleaning facility applied has to be decided on a case-by-case basis. Where it neither compromises product quality, plant safety, nor water resources, BAT for loading/unloading drift sensitive, wettable products is to moisten the product. For loading/unloading activities, BAT is to minimise the speed of descent and the free fall height of the product. Minimising the speed of descent can be achieved by the following techniques that are BAT:	Consideration of small-scale chemical dosing will be part of the detailed design. Activated carbon and desiccant replacement will be carried out by licensed contractors, and they will follow BAT.	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
• Installing baffles inside fill pipes • Applying a loading head at the end of the pipe or tube to regulate the output speed • Applying a cascade • Applying a minimum slope To minimise the free fall height of the product, the outlet of the discharger should reach down onto the bottom of the cargo space or onto the material already piled up. Loading techniques that can achieve this, and that are BAT, are: • Height adjustable fill pipes • Height adjustable fill tubes • Height adjustable cascade tubes.		
Consideration on transfer techniques		
Conveyors and transfer chutes: For all types of substances, BAT is to design conveyor to conveyor transfer chutes in such a way that spillage is reduced to a minimum For non or very slightly drift sensitive products and moderately drift sensitive, wettable products , BAT is to apply an open belt conveyor and additionally, depending on the local circumstances, one or a proper combination of the following techniques: • Lateral wind protection • Spraying water and jet spraying at the transfer points • Belt/cleaning For highly drift sensitive products and moderately drift sensitive, not wettable products BAT for new situations, is to apply closed conveyors, or types where the belt itself or a second belt locks the material or to apply enclosed conveyor belts without support pullets. For existing conventional conveyors, transporting highly drift sensitive products and moderately drift sensitive, not wettable products , BAT is to apply housing. When applying an extraction system, BAT is to filter the outgoing air stream. To reduce energy consumption for conveyor belts, BAT is to apply a good conveyor design including idlers and idler spacing, An accurate installation tolerance, A belt with low rolling resistance	An enclosed conveyor may be required and will be considered if applicable to the ETP.	Yes

11.3 ENERGY EFFICIENCY

This BREF addresses energy efficiency improvement in industrial installations by giving generic guidance on how to approach, assess, implement and deal with energy efficiency related issues along with corresponding permit and supervising procedures. An indicative BAT Assessment of Energy Efficiency is shown below in Table 11-3.

Table 11-3 - Energy Efficiency

BAT Requirement	Current/Proposed Arrangements	BAT?
SBAT 1: In order to improve the overall environmental performance, BAT is to implement and adhere to an EMS that incorporates all of the features as set out in the BREF.	Cory has developed and operates an IMS which meets the requirements of management system standards ISO 14001 (Environmental), ISO 9001 (Quality), ISO 45001 (Occupational Health and Safety), ISO 27001 (Information Security). This IMS will be extended to include the operation of the CCF.	Yes
BAT 2: BAT is to continuously minimise the environmental impact of an installation by planning actions and investments on an integrated basis and for the short, medium and long term, considering the cost-benefits and cross media effects.	In order to minimise OTNOC, planned and preventative maintenance will coincide with that of Riverside 1 and Riverside 2. All actions and investments will consider the potential impacts on the environment.	Yes
BAT 3: BAT is to identify the aspects of an installation that influence energy efficiency by carrying out an audit. It is important that an audit is coherent with a systems approach	Energy efficiency audits will be incorporated into the IMS.	Yes
BAT 4: When carrying out an audit, BAT is to ensure that the audit identifies the following aspects: • Energy use and type in the installation and its component systems and process • Energy-using equipment, and the type and quantity of energy used in the installations • Possibilities to minimise energy use such as: ○ Controlling/reducing operating times ○ Ensuring insulation is optimised ○ Optimising utilities, associated	All audits covering energy efficiency will comply with BAT.	Yes

systems, processes and equipment • Possibilities to use alternative sources or use energy that is more efficient, in particular energy surplus from other processes and/or systems • Possibilities to apply energy surplus to other processes and/or systems • Possibilities to upgrade heat quality		
BAT 5: BAT is to use appropriate tools or methodologies to assist with identifying and quantifying energy optimisation, such as: • Energy models, databases and balances • A technique such as pinch methodology exergy or enthalpy analysis, or thermoeconomics • Estimates and calculations	BAT will be adhered to, and appropriate tools and methodologies will be further considered as part of detailed design and incorporated as part of the IMS.	Yes
BAT 6: BAT is to identify opportunities to optimise energy recovery within the installation, between systems within the installation and/or with a third party.	A gas-gas heat exchanger will be used to cool incoming flue gas and reheat outgoing flue gas prior to discharge. Opportunities for heat recovery into the district heating scheme will be considered as part of the detailed design.	Yes
BAT 7: The major energy efficiency gains are achieved by viewing the installation as a whole and assessing the needs and uses of the various systems, their associated energies and their interactions. BAT is to optimise energy efficiency by taking a systems approach to energy management in the installation.	A system's approach will be taken as part of the design of the CCF to identify and adopt feasible energy efficiency measures. Conditioning of steam for the carbon capture plant uses a back pressure turbine. This will maximise energy output from steam, generating electricity and therefore reducing the overall electrical demand of the installation. Insulation will be implemented on piping to reduce thermal losses. Cooling will be designed efficiently based on atmospheric conditions and process requirements (split of wet and dry based on ambient temperatures as discussed in Section 3.2.4.1).	Yes
BAT 8: BAT is to establish energy efficiency indicators by carrying out all of the following:	This will be considered as part of the detailed design.	Yes

• Identifying suitable energy efficiency indicators for the installations, and where necessary, individual processes, systems and/or units, and measure their change over time or after the implementation of energy efficiency measures • Identifying and recording appropriate boundaries associated with the indicators • Identifying and recording factors that can cause variation in the energy efficiency of the relevant process, systems and/or units		
BAT 9: BAT is to carry out systematic and regular comparison with sector, national or regional benchmarks, where validated data are available.	BAT will be adhered to.	Yes
BAT 10: BAT is to optimise energy efficiency when planning a new installation, unit or system or a significant upgrade by considering all of the following: • The energy-efficient (EED) design should be initiated at the early stages of the conceptual design/basic design phase, even though the planned investments may not be well-defined. The EED should also be taken into account in the tendering process • The development and/or selection of energy-efficient technologies • Additional data collection may need to be carried out as part of the design project or separately to supplement existing data or fill gaps in knowledge	Equipment types, operation and associated sizes within the design are selected based on typical energy efficiency factors consistent with industry standards to achieve an overall energy efficient design. This will be further considered and incorporated as the design progresses to ensure the most energy efficient design possible in line with project and process requirements. Where replacements or upgrades are required, the site's management systems will include management of change that will consider and assess the environmental performance factors such as energy efficiency.	Yes

• The EED work should be carried out by an energy expert The initial mapping of energy consumption should also address which parties in the project organisations influence for the future energy consumption and should optimise the energy efficiency design of the future plant with them.		
BAT 11: BAT is to seek to optimise the use of energy between more than one process system, within the installation or with a third party.	The CCF will receive energy and steam from Riverside 1 and Riverside 2 which is then supplied to the required processes. Once the steam has been used within the CCF, the resulting condensate will be returned to Riverside 1 and Riverside 2.	Yes
BAT 12: BAT is to maintain the impetus of the energy efficiency programme by using a variety of techniques such as: • Implementing a specific energy efficiency management system • Accounting for energy usage based on real (metered) values, which places both obligation and credit for energy efficiency on the user/bill payer • The creation of financial profit centres for energy efficiency • Benchmarking • A fresh look at existing management system, such as using operational excellence • Using change management techniques	An energy efficiency management system will be incorporated as part of the EMS, but core aspects of ISO 50001 intent will be incorporated within the CCF Management Systems.	Yes
BAT 13: BAT is to maintain expertise in energy efficiency and energy-using systems by using techniques such as: • Recruitment of skilled staff and/or training of staff • Taking staff off-line periodically to perform fixed term/specific investigations	Cory will aim to ensure that any persons performing tasks for it, or on its behalf, which have the potential to cause significant environmental impact, are competent on the basis of appropriate education and training or experience. Cory will comply with the industry standards or codes of practice for training, where they exist and are applicable. Cory will provide training to operational staff as part of the commissioning prior to operation of the CCF. Line	Yes

• Sharing in-house resources between sites • Use of appropriately skilled consultants for fixed term investigations • Outsourcing specialist systems and/or functions	Managers will identify and monitor staff training needs as part of the appraisal system. The training needs of employees would be addressed using on-the-job training, mentoring, internal training and external training courses/events. As part of the DCO, Cory has committed to preparing a Skills and Employment plan prior to operation of the CCF.	
BAT 14: BAT is to ensure that the effective control of processes is implemented by techniques such as: • Having systems in place to ensure procedures are known, understood and complied with • Ensuring that the key performance parameters are identified, optimised for energy efficiency and monitored • Documenting or recording these parameters	Cory will provide training to operational staff as part of the commissioning prior to operation of the CCF. Staff induction programmes are location and job role specific. Key performance indicators will be identified, and energy consumption will be monitored. These performance indicators will be both site wide and area specific as appropriate and will be determined as part of the detailed design and once operational. Whilst Cory's IMS is not ISO 50001 certified, the CCF will incorporate the standard's intent within their current IMS.	Yes
BAT 15: BAT is to carry out maintenance at installations to optimise energy efficiency by applying all of the following: • Clearly allocating responsibility for the planning and execution of maintenance • Establishing a structured programme for maintenance based on technical descriptions of the equipment, norms etc. as well as any equipment failures and consequences. Some maintenance activities may be best scheduled for plant shutdown periods. • Supporting the maintenance programme by appropriate record keeping systems and diagnostic testing • Identifying from routine maintenance, breakdowns	Only technically competent maintenance staff will be able to advise on when plant should and should not be used and their decision is final. Major routine and planned maintenance of the CCF will be coordinated with regulatory inspection requirements and outage schedules for Riverside 1 and Riverside 2 (once operational), where practicable. This approach aims to reduce the number of scheduled outages and minimize the quantity of CO_2 emitted to the atmosphere during the maintenance of the CCF. Records of maintenance carried out at the CCF will be documented as part of the EMS.	Yes

and/or abnormalities possible losses in energy efficiency, or where energy efficiency could be improved • Identifying leaks, broken equipment, worn bearings, etc. that affect or control energy usage, and rectifying them at the earliest opportunity		
BAT 16: BAT is to establish and maintain documented procedures to monitor and measure on a regular basis, the key characteristics of operations and activities that can have a significant impact on energy efficiency.	Cory's IMS procedure Monitoring, Measurement, Analysis and Evaluation (IMS-MP-06) outlines the processes deemed necessary to meet compliance obligations are managed and therefore subject to adequate monitoring and measurement. This is undertaken both internally and externally and includes both proactive and reactive methods.	Yes
BAT for achieving energy efficiency in energy-using systems, processes, or activities or equipment		
BAT 17: BAT is to optimise the energy efficiency of combustion by relevant techniques where applicable.	Not applicable as combustion will not occur as part of the CCF process.	N/a
BAT 18: BAT for steam systems is to optimise the energy efficiency by using various techniques where applicable.	Insulation will be fitted on pipework as appropriate, including on steam pipes and condensate return pipes. The selection of appropriate steam system piping, valves, fittings and vessels as well as their insulation will be completed as part of the detailed design. Condensate will be returned to Riverside 1 and Riverside 2 respectively. A gas-gas heat exchanger will be used to cool incoming flue gas and reheat outgoing flue gas prior to discharge	Yes
BAT 19: BAT is to maintain the efficiency of heat exchangers by both: • Monitoring the efficiency periodically • Preventing or removing fouling	Fouling of the heat exchanger will be monitored and addressed as part of standard maintenance procedures. The design of the CCF will specify appropriately designed heat exchangers to reduce fouling where possible. They will typically be of standard type (such as shell & tube or plate & frame) and positioned in locations to facilitate easy access for maintenance and inspections to ensure continued optimal operation of heat exchangers. The removal of heat exchanger fouling will be scheduled and completed during other preventative maintenance to reduce shut down time. Process instrumentation will allow for monitoring heat exchanger performance and efficiency.	Yes

BAT 20: BAT is to seek possibilities for cogeneration, inside and/or outside the installation.	Not applicable. Electricity and steam will both be supplied by the neighbouring Riverside 1 and Riverside 2 respectively.	N/a
BAT 21: BAT is to increase the power factor according to the requirements of the local electricity distributor by using techniques such as those below: • Installing capacitors in the AC circuits to decrease the magnitude of reactive power • Minimising the operation of idling or lightly loaded motors • Avoiding the operation of equipment above its rated voltage • When replacing motors, using energy-efficient motors	The requirement for reactive power compensation equipment will be determined by a load flow study during detailed design. Any shunt capacitors required to be installed on the main busbar will be designed in accordance with BS EN 60871 - Shunt Capacitors. Motor specification and performance will be designed in accordance with BS EN 60034 Series - Rotating Electrical Machines. Variable Speed Drive (VSDs) specification and performance will be designed in accordance with BS EN 61800 Series - Adjustable Speed Electrical Power Drive Systems.	Yes
BAT 22: BAT is to check the power supply for harmonics and apply filters if required.	Determining harmonic filtering requirements will be based on the methodologies outlined in ENA Engineering Recommendation G5/5. Determining harmonic emission contribution from equipment will be based on methodologies outlined in BS EN 61000 series on EMC. This will be completed during the detailed design phase.	Yes
BAT 23: BAT is to optimise the power supply efficiency by using techniques such as: • Ensure power cables have the correct dimensions for power demand • Keep online transformer(s) operating at a load above 40-50% of the rated power • Use high efficiency/low loss transformers • Place equipment with a high current demand as close as possible to the power source	Initial cable sizing has been completed in accordance with BS 7671 - Requirements for Electrical Installations (18th Edition Wiring Regulations) for low voltage (up to 1000V AC) cabling, and BS IEC 60183 (above 1000V AC). The finalisation of cable sizes will also comply with aforementioned codes and standards. Transformer specification will be in accordance with BS EN 60076 Series - Power Transformers. This will ensure that all of the design aspects are in line with BAT criteria.	Yes
BAT 24: BAT is to optimise electric motors in the following order: 1. Optimise the entire system the motor(s) are part of	Types and sizes of electric motors are determined by their functional requirements, including power, voltage, amperage, etc. Subsequently, starter equipment or	Yes

2. Then optimise the motor(s) in the system according to the newly determined load requirements 3. When the energy-using systems have been optimised, then optimise the remaining motors	variable speed drives are selected based on expected operation. The specification and selection of this equipment will target optimised energy efficiency whilst also ensuring that the operational performance requirements and guarantees are met.	
BAT 25: BAT is to optimise compressed air systems using various techniques where applicable.	Compressed air system design will be optimised by appropriate specification and selection to adequately meet system demands, including operating pressures, flow rates and air quality. The compressed air system will be driven by energy efficient motors and variable speed drives where appropriate to achieve improved efficiency across a wider operating range. This will be further considered as part of the detailed design.	Yes
BAT 26: BAT is to optimise pumping system by various techniques where applicable.	Pumping system design will be optimised by appropriate specification and selection of pump types, unit sizes and quantities to adequately meet pumping system flow rate and pressure demands. Piping within pumping systems will be designed in accordance with flow rates to minimise pressure drops and routed to reduce pipe lengths where possible. Pumping equipment will be driven by energy efficient motors and variable speed drives where appropriate to achieve improved efficiency across a wider operating range. This will be further considered as part of the detailed design.	Yes
BAT 27: BAT is to optimise heating, ventilation and air conditioning systems by using various techniques where applicable.	The CCF design reduces the requirement for heating, ventilation and air conditioning (HVAC) systems as much as practicable, with process equipment located outdoors whilst the number of enclosed spaces and buildings are kept to a minimum. Where required, HVAC systems will be optimised for operating duty and philosophy, based on appropriate sizing, specification, installation and maintenance, including but not limited to the selection of fans, ducting, motors and variable speed drives, filtering, building insulation and regular maintenance. Energy efficient HVAC design aspects will be addressed as part of the detailed design.	Yes
BAT 28: BAT is to optimise artificial lighting systems by using various techniques where applicable.	Management systems and training will be in place to utilise lighting equipment efficiently. Energy efficient lighting will be selected as part of the detailed design.	Yes

BAT 29: BAT is to optimise drying, separation and concentration process by using various techniques when applicable, and to seek opportunities to use mechanical separation in conjunction with thermal process.	The CCF's main objective is to separate CO_2 from the flue gas. This will be done through a chemical absorption process, supported by thermal processes to separate CO_2 from the solvent and regenerate the solvent for further use. This process is optimised by developing a bespoke CCF design for Riverside 1 and Riverside 2 flue gas flows and conditions. CO_2 will be conditioned before export. This includes dehydration using solid desiccant adsorption and distillation processes to separate non-condensable components during the liquefaction. The anticipated ZLD ETP design uses mechanical separation processes as part of the water treatment, separating ultrafiltration filtrate and reverse osmosis permeate from rejected waste streams. Water recovery from the waste streams is maximised in the ZLD evaporator.	Yes

11.4 INDUSTRIAL COOLING SYSTEMS

This section has been prepared using concept engineering information related to the initial design parameters of the CCF, available information about the local environment and the existing standards and guidelines presented in publishing guidance, including:

- Post-combustion carbon dioxide capture: Emerging techniques on how to prevent or minimise the environmental impacts of post-combustion carbon dioxide capture. Published 2 July 2021 (updated 27 March 2024);
- Cooling water options for the generation of nuclear power stations in the UK, June 2010;
- Best Available Techniques [BAT] Conclusions: Industrial Cooling Systems, December 2001; and
- Environment Agency: Risk assessments for your environmental permit (April 2022).

11.4.1 KEY CONSIDERATION

Nearby residential receptors are considered to be the most sensitive receptors to visual and noise impacts from the CCF Cooling.

At its closest point the River Thames is located approximately 50m to the north of the installation boundary, this relates to the exhaust gas ducting pipeline which connects to Riverside 2. The CCF is located within the Thames Middle Transitional (FD) Water Body catchment (GB530603911402). The 2019 (current) classification has a 'Moderate' ecological status and a chemical status of 'Fail' due to priority hazardous substances mercury and its compounds and polybrominated diphenyl ethers (PBDE). The CCF process , as part of this application submission, does not seek to abstract or discharge to the River Thames.

The middle section of the River Thames is also designated as a heavily modified water body, which may potentially be impacted by:

- The abstraction of estuarine water, with mitigation required to avoid entrainment of aquatic organisms (this is not relevant to the proposed CCF plant and associated activities);

- Impacts on estuarine water chemistry and biodiversity from the discharge of water with thermal plume and potential water treatment chemicals, requiring mitigation in the form of treatment prior to discharge, and specific discharge requirements (this is not relevant to the proposed CCF plant and associated activities) but was considered in the Environmental Statement prepared as part of the DCO submission[73];
- Visual impacts of evaporative water plumes (visible plumes) from cooling towers, and cooling towers themselves, on adjacent and nearby residential receptors (considered as part of this application); and
- Noise from pumps or fans with mitigation required to avoid impacts on local residential receptors (considered as part of this application).

11.4.2 COOLING OPTIONS CONSIDERED

The CCF does not result in different cooling loads for summer and winter operation of the CCF.

There is no spare capacity within the cooling systems for either Riverside 1 or Riverside 2. This assessment therefore considers the overall cooling capacity of each option, water consumption, water source and necessary treatment, parasitic energy load and pipework.

The following technology options were considered:

- Option 1 – Air Cooling: Using fin-fan air coolers to cool the process streams directly;
- 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.

Solely using Options 1 or 2a is not the preferred or most efficient configuration however, it can be used in combination with other cooling techniques. Its operation is limited by ambient temperature conditions, meaning the Carbon Capture Technology Vendors' cooling requirements may not be met during certain weather conditions. Cory will 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.

In Option 2a, operation of the dry closed circuit cooling towers is limited by ambient temperature conditions, as with Option 1, 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- or hybrid cooling, due to having a relatively low cooling capacity per unit. However, dry cooling

[73] EN010128-000883-Cory Environmental Holdings Limited (CEHL) - 6.3 Environmental Statement - Appendix

eliminates the requirement for make-up water and blowdown, together with any potential concerns over a visible plume.

Option 2b, wet open circuit cooling towers, and Option 3, wet-dry cooling towers, were identified as two technically feasible options. This is subject to water demand being met.

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.

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 invasive non-native species, which may cause the degradation or loss of native benthic species.

Therefore, a combination of Options 2a and 3 is currently identified to be the preferred cooling configuration for the CCF to ensure an appropriate solution across all expected weather conditions without exceeding the water availability.

11.5 DIRECT COOLING

The European Commission Reference Document on Application of Best Available Techniques to Industrial Cooling Systems (BREF Cooling, December 2001) identifies direct cooling as BAT for large power plant cooling systems, stated as follows:

"In an integrated approach to cooling an industrial process, both the direct and indirect use of energy are taken into account. In terms of the overall energy efficiency of an installation, the use of a once-through system is BAT, in particular for processes requiring large cooling capacities (e.g. > 10 MWth). In the case of rivers and/or estuaries once-through can be acceptable if also:

- extension of heat plume in the surface water leaves passage for fish migration;
- cooling water intake is designed aiming at reduced fish entrainment;
- heat load does not interfere with other users of receiving surface water.

For power stations, if once-through is not possible, natural draught wet cooling towers are more energy-efficient than other cooling configurations, but application can be restricted because of the visual impact of their overall height."

It may be concluded from the BREF that direct cooling would not be BAT for large power stations if any of the three conditions were not met. Given that the cooling system is operating alongside a zero liquid discharge approach to wastewater, and there is no discharge or heat plume in surface water, and no cooling water intake from surface water, direct cooling is considered BAT.

11.5.1 WATER REQUIREMENTS AND EMISSIONS TO WATER

Cory will operate with zero liquid discharge. A combination of wet cooling and dry cooling will be used in order to meet the cooling demand with the cooling water makeup available from the effluent treatment plant. This approach recirculates water on site, eliminating the demand for towns water and the need for an adequate receiving water, whilst still achieving the required cooling capacity. As the CCF will recirculate water, emissions to water and reduction of entrainment of organisms are not applicable to the design.

The split of wet cooling and dry cooling can be adjusted depending on the ambient weather conditions and the volume of water recovered from the process. The combination of wet and dry cooling allows the treated water available from the process to be used for cooling without need for disposal, whilst also avoiding the need for additional towns water during normal operation.

11.5.2 EMISSIONS TO AIR

Hybrid cooling is considered BAT when reducing plume formation. For both the dry cooling and wet cooling technologies, the air emission temperature from the cooling towers must be below the returning hot cooling water temperature to achieve practicable and reasonable approach temperatures (i.e. temperature differences between emitted air temperature and incoming cooling water temperature) of approximately no less than 4°C. As the returning hot cooling water temperature is dependent on the final CCF design, the design of the cooling water system will be finalised during the detailed design phase.

11.5.3 ENERGY EFFICIENCY

A combination of wet /hybrid and dry cooling system will be utilised, which is considered BAT in regards of overall energy efficiency with the additional benefits of saving water and reducing visible plumes.

The detailed design of the cooling system will identify measures to lower the energy requirement and choose appropriate material for equipment in contact with process substances and cooling water. The detailed design will include measures such as:

- reducing resistance to water and airflow
- apply high efficiency/low energy equipment
- reduce the amount of energy demanding equipment
- apply optimised cooling water treatment

11.5.4 NOISE

Dry and wet cooling will be forced, i.e. making use of mechanical draughts. System will be designed to minimise number of cooling towers and therefore number of fans whilst ensuring that overall process cooling duty can be met, thereby reducing individual fan noise emissions and compounded noise emissions. Fan diameter and operating characteristics such as rotational speed will be determined as part of finalising the cooling system design during the detailed design phase, considering noise emitting factors where appropriate.

Cooling fans will be located at height (e.g. the top of the cooling tower), mitigating noise emissions at ground level.

Fans will be “boxed up”/enclosed within the cooling tower structure, thereby providing additional noise attenuation measures.

Noise from the cooling system has been accounted for in the Noise Impact Assessment within Appendix G, and the CCF and associated cooling will not lead to a significant adverse noise effect at receptors.

11.5.5 REDUCTION OF RISK OF LEAKAGE

All equipment, equipment components and materials will be selected in accordance with overall cooling system design and requirements.

Cooling water control measure requirements (temperature, pressure, flow and composition (i.e. water quality) instrumentation) will be incorporated in the final cooling system design as part of the detailed design phase.

BAT is met by the following measures:

- Expected temperature increase of cooling water in heat exchangers is less than 50°C
- Shell and Tube heat exchangers correctly specified based on process requirements.
- Equipment constructed by reputable vendors in accordance with codes and standards.
- Cooling water temperature expected to be below 60°C under normal operating conditions.
- Monitoring of cooling system performance during operation.

11.5.6 REDUCING BIOLOGICAL GROWTH

To reduce the biological risk due to cooling system operation, the following measures will be implemented:

- Typical percentage of cooling water (approximately 2%) routed as blowdown for treatment (i.e. reverse osmosis, ultrafiltration and chlorine);
- Stagnant zones will be avoided as part of the detailed design;
- A combination of both mechanical and chemical cleaning will be used; and
- Periodic monitoring of pathogens in the cooling systems will be in place.

11.6 COMMON WASTEWATER AND WASTE GAS TREATMENT/MANAGEMENT SYSTEMS IN THE CHEMICAL SECTOR

Whilst the ETP will not be regulated as an “installation activity” as it is treating the condensate generated during the carbon capture process for re-use. However, whilst not directly created for effluent treatment in carbon capture, the BREF for “Common Wastewater and Waste Gas Treatment/Management Systems in The Chemical Sector” is considered the most applicable in order to demonstrate BAT. An indicative BAT Assessment is presented below in Table 11-4.

Table 11-4 – Common Wastewater and Waste Gas Treatment/Management Systems in the Chemical Sector

BAT Requirement	Current/Proposed Arrangements	BAT?
BAT 1: In order to improve the overall environmental performance, BAT is to implement and adhere to an EMS	Cory has developed and operates an IMS which meets the requirements of management system standards ISO	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
that incorporates all of the features as set out in the BREF.	14001 (Environmental), ISO 9001 (Quality), ISO 45001 (Occupational Health and Safety), ISO 27001 (Information Security). This IMS will be extended to include the operation of the CCF.	
BAT 2: In order to facilitate the reduction of emissions to water and air and the reduction of water usage, BAT is to establish and to maintain an inventory of waste water and waste gas streams, as part of the environmental management system, which incorporates all the techniques set out in the BREF	The ETP is designed to operate with ZLD, and reclaimed water is recycled back into the process. An inventory of waste sludge and gas streams will be developed as part of the detailed design process and maintained when the ETP is operational.	Yes
BAT 3: For relevant emissions to water as identified by the inventory of waste water streams (see BAT 2), BAT is to monitor key process parameters (including continuous monitoring of waste water flow, pH and temperature) at key locations (e.g. influent to pretreatment and influent to final treatment).	Each waste stream generated will be monitored in accordance with BAT. Any materials which are to be transferred to landfill from the CCF would be Waste Acceptance Criteria (WAC) tested for leachability to ensure that they meet the WAC for the landfill that they are to be transferred to.	Yes
BAT 4: BAT is to monitor emissions to water in accordance with EN standards with at least the minimum frequency given below. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.	Not applicable as the CCF is designed to operate with ZLD. The recycled effluent is to be reused in the carbon capture process.	N/a
BAT 5: BAT is to periodically monitor diffuse VOC emissions to air from relevant sources by using an appropriate combination of the techniques I – III or, where large amounts of VOC are handled, all of the techniques I – III. I. Sniffing methods associated with correlation curves for key equipment; II. Optical gas imaging methods III. Calculation of emissions based on emissions factors, periodically validated by measurements.	Not applicable due to absence of VOC emissions and generating substances.	N/a
BAT 6: BAT is to periodically monitor odour emissions from relevant sources in accordance with EN standards.	The CCF will be subject to a daily inspection, and any unusual odours will be assessed in accordance with appropriate EMS procedures. Any odours detected will be logged with any corrective actions undertaken.	Yes
BAT 7: In order to reduce the usage of water and the generation of waste water, BAT is to reduce the volume and/or pollutant load of waste water streams, to enhance	The CCF is designed to operate with ZLD. The recycled effluent is to be	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
the reuse of waste water within the production process and to recover and reuse raw materials.	reused in the carbon capture process.	
BAT 8: In order to prevent the contamination of uncontaminated water and to reduce emissions to water, BAT is to segregate uncontaminated wastewater streams from wastewater streams that require treatment.	Wastewater that has been contaminated with amines will be segregated to reduce the volume of wastewater streams that require disposal.	Yes
BAT 9: In order to prevent uncontrolled emissions to water, BAT is to provide an appropriate buffer storage capacity for waste water incurred during other than normal operating conditions based on a risk assessment (taking into account e.g. the nature of the pollutant, the effects on further treatment, and the receiving environment), and to take appropriate further measures (e.g. control, treat, reuse).	Not applicable as the CCF is designed to operate with ZLD. The recycled effluent is to be reused in the carbon capture process.	N/a
BAT 10: In order to reduce emissions to water, BAT is to use an integrated wastewater management and treatment strategy that includes an appropriate combination of the techniques given in the BREF	Not applicable as the CCF is designed to operate with ZLD. The recycled effluent is to be reused in the carbon capture process.	N/a
BAT 11: In order to reduce emissions to water, BAT is to pretreat wastewater that contains pollutants that cannot be dealt with adequately during final wastewater treatment by using appropriate techniques.	Not applicable as the CCF is designed to operate with ZLD. The recycled effluent is to be reused in the carbon capture process.	N/a
BAT 12: In order to reduce emissions to water, BAT is to use an appropriate combination of final wastewater treatment techniques.	Not applicable as the CCF is designed to operate with ZLD. The recycled effluent is to be reused in the carbon capture process.	N/a
BAT 13: In order to prevent or, where this is not practicable, to reduce the quantity of waste being sent for disposal, BAT is to set up and implement a waste management plan as part of the environmental management system (see BAT 1) that, in order of priority, ensures that waste is prevented, prepared for reuse, recycled or otherwise recovered.	Following completion of the detailed design, a waste management plan will be developed and incorporated into the CCF's EMS. The design of the ETP enables all wastewater generated by the CCF to be reused as part of ZLD.	Yes
BAT 14: In order to reduce the volume of wastewater sludge requiring further treatment or disposal, and to reduce its potential environmental impact, BAT is to use one or a combination of the techniques given below. a. Conditioning b. Thickening/dewatering c. Stabilisation d. Drying	The ETP conditions and dewaters the effluent stream by returning the vast majority of process effluent back into the cooling system. The ETP contains evaporation and crystallization steps which may be considered stabilisation and drying (i.e. production of concentrated crystallised salts and minerals).	Yes
BAT 15: In order to facilitate the recovery of compounds and the reduction of emissions to air, BAT is to enclose	Not applicable as there is no fugitive or point source emissions to air from the ETP.	N/a

BAT Requirement	Current/Proposed Arrangements	BAT?
the emission sources and to treat the emissions, where possible.		
BAT 16: In order to reduce emissions to air, BAT is to use an integrated waste gas management and treatment strategy that includes process-integrated and waste gas treatment techniques.	Not applicable as there is no fugitive or point source emissions to air from the ETP.	N/a
BAT 17: In order to prevent emissions to air from flares, BAT is to use flaring only for safety reasons or non-routine operational conditions (e.g. start-ups, shutdowns) by using one or both of the techniques given below. a. Correct plant design b. Plant management	Not applicable as there is no fugitive or point source emissions to air from the ETP.	N/a
BAT 18: In order to reduce emissions to air from flares when flaring is unavoidable, BAT is to use one or both of the techniques given below. a. Correct design of flaring devices b. Monitoring and recording as part of flare management	Not applicable as there is no fugitive or point source emissions to air from the ETP.	N/a
BAT 19: In order to prevent or, where that is not practicable, to reduce diffuse VOC emissions to air, BAT is to use a combination of the techniques set out in the BREF.	Not applicable as there is no fugitive or point source emissions to air from the ETP.	N/a
BAT 20: In order to prevent or, where that is not practicable, to reduce odour emissions, BAT is to set up, implement and regularly review an odour management plan, as part of the environmental management system (see BAT 1), that includes all of the following elements: I. A protocol containing appropriate actions and timelines II. A protocol for conducting odour monitoring III. A protocol for response to identified odour incidents IV. An odour prevention and reduction programme designed to identify the source(s), to measure/estimate odour exposure, to characterise the contributions of the sources, and to implement prevention and/or reduction measures.	Not applicable. An odour management plan is not considered necessary for the installation, which is consistent with the regulator’s previous permit determinations for Carbon Capture within this sector and aligns with the EA guidance for post-combustion carbon capture. Cory will implement good management practices in accordance with their certified IMS. This will contain protocols for daily inspections and assessing of odours. Any odours will be logged along with any corrective actions taken.	N/a
BAT 21: In order to prevent or, where that is not practicable, to reduce odour emissions from wastewater collection and treatment and from sludge treatment, BAT is to use one or a combination of the techniques given below. a. Minimise residence times	Wastes will be promptly collected from the ETP in order to reduce residence time. Sludge arising from the ETP will be stored in an enclosed skip prior to collection by a licensed contractor.	Yes

BAT Requirement	Current/Proposed Arrangements	BAT?
b. Chemical treatment c. Optimise aerobic treatment d. Enclosure e. End-of-pipe treatment	Pending detailed design, sludge will be transferred via either an enclosed conveyor or a sludge pump.	
BAT 22: In order to prevent or, where that is not practicable, to reduce noise emissions, BAT is to set up and implement a noise management plan, as part of the environmental management system (see BAT 1), that includes all of the following elements: I. A protocol containing appropriate actions and timelines II. A protocol for conducting noise monitoring III. A protocol for response to identified noise incidents IV. A noise prevention and reduction programme designed to identify the source(s), to measure/estimate noise exposure, to characterise the contributions of the sources and to implement prevention and/or reduction measures.	Cory has developed and operates an IMS which meets the requirements of management system standards ISO 14001 (Environmental), ISO 9001 (Quality), ISO 45001 (Occupational Health and Safety), ISO 27001 (Information Security). This IMS will be extended to include the operation of the CCF.	Yes
BAT 23: In order to prevent or, where that is not practicable, to reduce noise emissions, BAT is to use one or a combination of the techniques given below. a. Appropriate location of equipment and buildings b. Operational measures c. Low-noise equipment d. Noise-control equipment e. Noise abatement	All equipment relating to the ETP will be enclosed within buildings. The ETP will be located at a designated location within the overall CCF. Noise emitting equipment relating to the ETP will be located in buildings or noise attenuating enclosures. Noise emissions are predominately associated with the operation of pumps, which will be specified in line with existing codes and standards, industry practices and considering BAT. This applies also to other noise emitting equipment within the ETP, including but not limited to fans, blowers, compressors and evaporators.	Yes

12 OPERATING TECHNIQUES

12.1 RELEVANT STANDARDS AND TECHNICAL GUIDANCE

The CCF will operate in accordance with the permit issued by the Environment Agency and follow relevant sector guidance including EA Guidance "How you'll be regulated: environmental permits"[74] and, in the absence of a specific BAT guidance document for Carbon Capture Facilities, EA Guidance "Post-combustion carbon dioxide capture: emerging techniques"[75]. This guidance was developed by the EA, Natural Resources Wales and Northern Ireland Environment Agency, who worked with the UK Carbon Capture and Storage Research Centre[76].

It should be noted that "*Except where regulations apply, this guidance for emerging techniques is not a regulatory requirement but identifies best practice to address important environmental issues. The regulators expect operators to follow this guidance or to propose an alternative approach to provide the same or greater level of protection for the environment.*"

The CCF will also operate in accordance with the below guidance, relevant and applicable to its operational activities:

- Post-combustion carbon dioxide capture: Emerging techniques on how to prevent or minimise the environmental impacts of post-combustion carbon dioxide capture[77]. Published 2 July 2021 (updated 27 March 2024) to advise on the Best Available Techniques Activities.
- Best Available Techniques [BAT] Conclusions: Emissions from Storage[78], July 2006.
- Best Available Techniques [BAT] Conclusions: Energy Efficiency[79], amended September 2021.
- Best Available Techniques [BAT] Conclusions: Industrial Cooling Systems[80], December 2001.
- Best Available Techniques [BAT] Conclusions: Best Available Techniques (BAT) Reference Document for Common Wastewater and Waste Gas Treatment/Management Systems in the Chemical Sector[81], 2016.

A comprehensive BAT Appraisal is available in Section 11.

12.2 EQUIPMENT AND PROCESS DESCRIPTION

The CCF will use an amine-based solvent to strip CO_2 from the treated flue gas streams from Riverside 1 and Riverside 2 within packed Absorber Column(s). The CO_2-depleted flue gas will then

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[74] How you'll be regulated: environmental permits - GOV.UK
[75] Post-combustion carbon dioxide capture: emerging techniques - GOV.UK
[76] UKCCSRC - Carbon Capture & Storage (CCS) Welcome to the UKCCSRC - UKCCSRC
[77] Post-combustion carbon dioxide capture: emerging techniques - GOV.UK
[78] Emissions from Storage | EU-BRITE
[79] Energy Efficiency | EU-BRITE
[80] Industrial Cooling Systems | EU-BRITE
[81] Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector | EU-BRITE

pass through washing and mist elimination stages in the Absorber Column(S) prior to its release to atmosphere via a dedicated stack(s). This will comprise two Emission Points (A1 and A2).

The CO_2 will be removed from the CO_2-rich solvent in a CO_2 stripper (or regeneration column) by heat, using the steam provided by the adjacent Riverside 1 and Riverside 2 facilities, which is let down to the required pressure through dedicated back-pressure turbines. This releases the CO_2 for further processing and onsite LCO_2 Buffer Storage and enables the lean amine-solvent to be recycled back into the absorption process for reuse.

The CO_2 gas will undergo compression, dehydration and liquefaction ahead of on-site LCO_2 Buffer Storage before being exported off-site to a third-party for transportation by ship for future underground geological storage.

Over time, the solvent can accumulate impurities and heat stable salts, as a result of contaminants in the flue gas and continued thermal cycling of the solvent. To prevent the build-up of these compounds, a slip stream of the solvent is taken from the solvent recirculation system and treated in the thermal reclaimer using sodium hydroxide and medium pressure steam. The waste produced by the reclamation process is considered hazardous and will be taken off-site for disposal.

A complete process description is included in Section 3 of this document. This process description will be included in the CCF's EMS along with all manufacturer documentation related to equipment and process descriptions.

12.3 MAINTENANCE AND SERVICE PLANS

Detailed Maintenance and Service Plans will be developed and incorporated in the EMS as detailed in Section 10.5 of this Technical Supporting Document.

Plant maintenance will be undertaken in accordance with relevant UK legislation ensuring all plant will be certified fit and proper for use in accordance with manufacturers' guidance.

Major routine and planned maintenance of the CCF will be coordinated with regulatory inspection requirements and outage schedules for Riverside 1 and Riverside 2 (once operational), where practicable. This will reduce the number of scheduled outages and minimise the quantity of CO_2 emitted to the atmosphere during the maintenance of the CCF.

Operational procedures, including maintenance, will be set out in the OEMP, as part of the EMS, which will be prepared prior to the CCF commencing operation.

12.4 RAW MATERIALS AND WASTE STORAGE AND HANDLING PROCEDURES

All raw materials and wastes will be stored and handled in accordance with CIRIA 736 Guidance - Containment Systems for the Prevention of Pollution, Secondary, tertiary and other measures for industrial and commercial premises and all relevant guidance as per Section 12.1. An indicative list of the raw materials and wastes stored on site are included in Section 4 and Section 9 of this document respectively. All Material Safety Data Sheets will be included in the EMS and made available to staff.

12.5 HEALTH AND SAFETY PROCEDURES

Staff induction programmes are location and job role specific and will include all relevant health and safety policy and procedures.

The CCF will be incorporated into Cory's EMS and a detailed assessment of hazards to human health and safety will be implemented in accordance with Risk Assessment, Hazard Identification and Determining Controls Procedure (IMS-MP-02). This will inform the health and safety procedures for the CCF which will be developed prior to commissioning.

12.6 AS BUILT DRAWINGS

Following the completion of the detailed design, as built drawings will be made available on site and incorporated into the sites EMS. This will include but not be limited to:

- Buildings and other main constructions including treatment plants, storage silos and security fencing;
- Storage areas and facilities for hazardous and non-hazardous materials, such as oil and fuel tanks, chemical stores, waste materials;
- Location of items for use in accidents and emergencies;
- Entrances and exits to be used by emergency services;
- Pollution control points such as inspection and monitoring points;
- ETP;
- Site drainage plan;
- Discharge points; and
- Emission point plan.

Indicative drawings are included in Appendix A.

12.7 NORMAL OPERATING CONDITIONS

All operating conditions will be controlled through Cory's IMS and recorded. In the event of an incident or emergency, all relevant procedures will be followed in accordance with Cory's Accident Prevention and Management Plan, a preliminary Accident Prevention and Management Plan has been provided in Appendix E but will be subject to further review and update through detailed design.

Any accidents and deviation from permitted ELVs will be documented and recorded as part of the EMS and reported to the EA.

12.8 OTHER THAN NORMAL OPERATING CONDITIONS

At this stage of the design, an OTNOC Management Plan cannot be accurately produced with all necessary information. It is requested that the Environment Agency set a Pre-Operational Condition, requesting that Cory prepare an OTNOC Management Plan, which will identify and refer to operational scenarios outside of normal operating conditions including but not limited to periods of SU/SD, limited operations and maintenance activities and periods when the CO_2 transport and storage network is down. The OTNOC will be developed in accordance with the EA Guidance "Develop a management system: environmental permits"[82], and will establish how to measure and

[82] Develop a management system: environmental permits - GOV.UK

minimise the occurrence and impact of these periods. As consistent with other determined permit applications and issued permits, a suggested pre-operational condition is included for consideration below in Section 13.

The OTNOC Management Plan will include consideration of, and complement, the OTNOC management plan for Riverside 1 and Riverside 2 (once operational) as EA Guidance[83]. The CCF is not expected to capture CO_2 during the startup and shutdown of Riverside 1 and Riverside 2, as there are likely to be deviations in the quality of the flue gas that could lead to problems in the CCF as the level of contaminants may lead to degradation of the solvent. As the EfW intended operation is at a stable baseload, there is limited benefit to designing for occasional SU/SD. Given that the CCF will have a limited number of planned SU/SD per year, incorporating significant amine storage to allow for CO_2 capture during SU/SD is not considered necessary.

SU/SD for the CCF is dependent on the availability of utilities, in particular power and steam. Cold start for each train would take approximately six hours, with a hot start/standby mode cutting that down to two hours. The initial start-up consists of starting the circulating pumps and establishing levels in required columns/vessels. Following this, the system inventory is heated, using steam from the existing facility. The specific requirements and interdependencies between Riverside 1 and Riverside 2 and the CCF will be determined during detailed design.

Incoming flue gas will be monitored and diverted back to the Riverside 1 and Riverside 2 Stacks if impurity levels exceed limits. Flue gas will also be monitored at Riverside 1 and Riverside 2, before diversion of the gas stream, to demonstrate compliance with the Riverside 1 and Riverside 2 environmental permit[s] emission limit values. The DCC cools and scrubs the incoming flue gas with NaOH to reduce levels of acid gases. The CCF process will be controlled in line with incoming flue gas flow and CO_2 concentration to reduce formation of degradation products.

Consistent with BAT11 for Large Combustion Plants[84]: BAT is to appropriately monitor emissions to air and/or water during OTNOC. Monitoring will be carried out by direct measurement of emissions or by monitoring surrogate parameters if this proves to be equal of better scientific quality than the direct measurement of emissions.

The OTNOC management plan will detail measures to reduce emissions to air during OTNOC and is expected to include:

- Preventative maintenance plan for relevant systems;
- As Riverside 1 and Riverside 2 are designed to operate continuously, the CCF will be expected to operate continuously alongside Riverside 1 and Riverside 2. In order to minimise OTNOC, planned and preventative maintenance of the CCF will coincide with that of Riverside 1 and Riverside 2; and
- Review and recording of emissions during OTNOC, to include frequency of event, cause of event, emissions quantification/estimation and implementation of any corrective actions taken.

[83] Post-combustion carbon dioxide capture: emerging techniques - GOV.UK
[84] Implementing decision - 2021/2326 - EN - EUR-Lex

The design carbon capture rate during normal operating conditions is 95%. The annual average capture rate will however be lower than this, allowing for both planned and unplanned outages and other OTNOC.

12.9 STARTUP AND SHUTDOWN

As described above in Section 12.8, the CCF will not capture CO_2 from Riverside 1 and Riverside 2 during Start Up (SU)/Shut Down (SD).

SU/SD for the CCF is dependent on the availability of the utilities, in particular power and steam. Cold start for each train is expected to take approximately 6 hours, with a hot start/standby mode cutting that down to 2 hours. The initial start-up consists of starting the circulating pumps and establishing levels in required columns/vessels. Following this, the system inventory is heated, using steam from Riverside 1/Riverside 2. The specific requirements, timings for SU/SD and CCP start-up would interact with that of Riverside 1/Riverside 2 will be determined as part of the detailed design.

12.10 CO_2 VENTING

12.10.1 CO_2 VENTING SCENARIOS

There will be times where venting of CO_2 is needed for operational and emergency situations. There will be separate supported CO_2 Vents for small volumes of CO_2 venting, with larger volumes of CO_2 (in the form of unabated / partially abated flue gas), such as during SU/SD, to be routed back into the new Stack(s) located at the CCF. The venting scenarios anticipated are:

- SU/SD, Outage and Maintenance – These are expected to be relatively small, short duration venting scenarios to ensure the equipment is safely shutdown and ready for maintenance. SU/SD procedures have not yet been developed at this stage, but it is anticipated that these will be developed to avoid unnecessary venting. Some venting is likely to be unavoidable for a safe SU/SD, but this will be further assessed as part of the OTNOC Management Plan which is further discussed in Section 12.8.
- Compressor or liquefaction trip – A compressor or liquefaction trip would result in full flow from the CCF being vented for a short period of time, and may be followed by an outage as described above.
- External fire near storage – this will produce a high volume of gas quickly by evaporating the LCO_2. The quantity of gas will be further considered as part of the detailed design. The risk of external fire has been considered through a HAZID and will be further considered as part of detailed design. Control systems to prevent external fire near storage are listed in Section 11.2.
- Over pressure compression – If the CO_2 reaches pressure too high in the CO_2 processing plant, a small mass of CO_2 which contributes to the flow being over-pressurised, would be emitted.
- The CO_2 vapour returned from the vessels during loading operations will be combined with the BOG from the Above Ground Storage Tanks and sent to be re-liquefied in the Carbon Capture Plant. If there is any BOG that is unable to be re-liquefied, it would be vented via a CO_2 Vent.

The specific venting requirements and final location of the CO_2 Vents will be confirmed and determined as part of the detailed design of the CCF but have been included as part of the Indicative Emission Point Plan contained within Appendix A and relevant assumptions have been made in the CO_2 Venting Assessment in Appendix J.

No monitoring of the CO_2 vents are proposed, other than recording mass of CO_2 released, times and duration of when venting occurs.

At this stage of the design, it is not possible to determine how long venting may take, and this will be confirmed later during the detailed design process. However, given the baseload operation of Riverside 1 and Riverside 2, it is envisaged that these venting scenarios will be infrequent. The CO_2 venting assessment uses an estimate of likelihood of occurrence for each venting scenario and the potential duration. These estimates are based on indicative events in which these scenarios may likely occur, rather than refined emergency procedures based on calculated release scenarios, these will be determined as part of the later design stages.

12.10.2 OPERATING TECHNIQUES TO MINIMISE THE RISKS ASSOCIATED WITH VENTING OF CO_2

CO_2 venting risks were evaluated in the ERA (Appendix B), Noise Impact Assessment and the CO_2 Venting Report, and were determined to be low risk and not significant to the general population. Noise from venting may affect nearby residences, with the closest approximately 120m south of the Site Boundary and 600m from expected vents (see Indicative Emission Point Plan, Appendix A).

CO_2 venting can also contribute to atmospheric pollution but, given the small quantities that are anticipated to be vented, this is not considered to be a significant risk. In the event of venting at low load e.g. where the compressor over pressurises gas or liquid CO_2 boils off from onsite storage. This would likely result in slumping (negatively buoyant gas) impacting dispersion.

The risks associated with CO_2 venting will be further minimised in accordance with the following measures:

- Any operational venting will be required to meet any ELVs set out within the Environmental Permit;
- Flue gas from the Stack(s) to be continuously monitored via a Continuous Emissions Monitoring System (CEMS) pursuant to the Environmental Permit;
- The detailed design of the CCF will ensure venting and respective noise emissions will be minimised as far as possible;
- Suitable automated control systems will be installed to provide early detection and alarms for warning of a CO_2 release to allow personnel to move to a safe place and avoid harm occurring;
- Any noise complaints would be dealt with under the complaint's procedure in the EMS and the NMP;
- The design of the LCO_2 pipework and proposed jetty will be installed with leak detection systems;
- A planned preventative maintenance system will be implemented at the CCF;
- Any venting of CO_2 will be in line with applicable Health and Safety guidelines;
- Continuous monitoring of pressure and flow as appropriate; and
- On detection of a potential leak, the above ground pipelines will be shut down and isolated to minimise the volume of CO_2 released.

12.10.3 CO_2 VENTING ASSESSMENT

A preliminary dispersion model and assessment of CO2 vent points has been undertaken using DNV's Phast software.

A provision within the CCF design has been made for several CO_2 vent points throughout the system and each carbon capture train. These vent points will be routed to one of two vent stacks which will be located within the site boundary (emission points A4 and A5). As there are no expected scenarios where venting will be required from both vent stacks simultaneously and the routing of vent lines is yet to be determined, all venting scenarios, as part of the detailed CO_2 venting assessment, have been modelled based on one vent stack as this would be viewed as both the most likely and worst-case scenario. The exit conditions of the stack are dependent on the venting point within the system that is used.

Overall, this model and risk assessment is robust and precautionary; the results indicate that there is low risk that sensitive members of the public might experience mild but transient effects during some venting events, but the general population will experience no significant health effects during the foreseeable venting scenarios.

Further refinement of the venting scenarios and specifications will be undertaken post detailed design.

The full details of the assessment and methodology undertaken can be found in Appendix J.

13 PROPOSED IMPROVEMENT AND PRE-OPERATIONAL CONDITIONS

Cory propose the following pre-operational and improvement conditions, which are consistent with those previously set out by the Regulator for other CCFs within the sector. As the design stages progress, additional information and finalisation of the design, will be communicated and shared with the EA through both pre-operational conditions and improvement conditions as required.

13.1 IMPROVEMENT CONDITION

13.1.1 CARBON CAPTURE EFFICIENCY

The operator shall submit a written report to the EA for assessment and written approval detailing the carbon capture efficiency of the CCF under normal operating conditions averaged over one year of operation. This will be completed within 15 months from the completion of commissioning of the CCF.

Should the carbon capture efficiency during normal operating conditions be reported to be less than the design capture performance specification of 95%, the operator shall carry out an analysis of the issues affecting the performance of the plant with respect to achievement of the 95% carbon capture rate and either:

- Submit written proposals for remedial actions designed to improve capture efficiency to the EA for approval; or
- Provide an acceptable justification to the EA that a 95% capture rate is not reasonably achievable, and that no further remedial action is to be taken.

13.2 PRE-OPERATIONAL CONDITION

Based on precedent set from the determination of other carbon capture permit applications, we recognise the need to include site specific pre-operational conditions. We have included suggested conditions below but recognise these may be subject to amendment.

13.2.1 OTNOC MANAGEMENT PLAN

Following the completion of the final design of the carbon capture plant and prior to the commencement of commissioning of the CCF, the Operator shall submit to the Environment Agency for assessment and written approval a post combustion CCF OTNOC management plan. The plan shall include:

i. Any potential 'other than normal operating conditions (OTNOC)' for the Carbon Capture Plant(s), taking into consideration both internal and external causes of OTNOC.

ii. Details of measures to:

   a. Minimise the occurrence of OTNOC that are within the operator's control;

   b. Reduce the impact of OTNOC events.

iii. Proposals for reviewing and optimising capture performance periodically so capture rates are as high as reasonably practicable during these periods

The OTNOC plan shall be included in the EMS.

13.2.2 VENTING MANAGEMENT PLAN

Following the completion of the final design of the installation and at least 12 months prior to the commencement of commissioning the Operator shall submit a report for assessment and written approval by the Environment Agency. The report shall include:

- A report that validates the assumptions used in the CO_2 Venting Emissions to Air Risk Assessment.
- If any of the input parameters to the CO_2 Venting Assessment are different to those submitted as part of the original application, an updated CO_2 impact assessment of emissions on human health from the short duration venting that may be required during the start-up sequence of the CCF, during other than normal operating conditions and plant commissioning. The assessment shall be carried out in accordance with environmental risk assessment methodology set out in Environment Agency guidance Air emissions risk assessment for your environmental permit - GOV.UK, with impacts compared with CO_2 acute exposure levels to humans.
- A management plan detailing operating techniques to minimise potential CO_2 phase changes, solid effects and dense gas behaviour when venting CO_2 to atmosphere.

Appendix A

SITE PLANS AND DRAWINGS

Appendix B

ENVIRONMENTAL RISK ASSESSMENT

Appendix C

INDICATIVE DRAINAGE LAYOUT

Appendix D

MANAGEMENT SYSTEM MANUALS AND CERTIFICATIONS

Appendix E

PRELIMINARY ACCIDENT PREVENTION AND MANAGEMENT PLAN

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Appendix F

SITE CONDITION REPORT

Appendix G

NOISE IMPACT ASSESSMENT

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Appendix H

NOISE AND VIBRATION MANAGMENT PLAN

Appendix I

AIR QUALITY RISK ASSESSMENT

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Appendix J

CO2 VENTING ASSESSMENT

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