

A large teal graphic on the left side of the page, consisting of a triangle at the top and a rectangle below it, with a diagonal line separating the two shapes.

Gate 2 EAR Carbon Appendix

South Lincolnshire Reservoir

November 2022

This page left intentionally blank for pagination.

Mott MacDonald
22 Station Road
Cambridge CB1 2JD
United Kingdom

T +44 (0)1223 463500
mottmac.com

Gate 2 EAR Carbon Appendix

South Lincolnshire Reservoir

November 2022

Registered office: Mott MacDonald House,
8-10 Sydenham Road, Croydon CR0 2EE,
United Kingdom

Issue and Revision Record

| Revision | Date | Originator | Checker | Approver | Description |
|----------|----------|------------|---------|----------|---------------------------------|
| 01 | 03/11/22 | AA | PD | NW | First issue for assurance |
| 02 | 08/11/22 | AA | PD | NW | Second issue following comments |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Document reference: 421065060-GT2-MMD-XX-XX-RP-Z-0018 | 02 | [Click or tap here to enter text.](#)

Information class: Standard

This document is issued for the party which commissioned it and for specific purposes connected with the abovecaptioned project only. It should not be relied upon by any other party or used for any other purpose.

We accept no responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose, or containing any error or omission which is due to an error or omission in data supplied to us by other parties.

This document contains confidential information and proprietary intellectual property. It should not be shown to other parties without consent from us and from the party which commissioned it.

Contents

| | | |
|-------|--|---|
| 1 | Introduction | 1 |
| 1.1 | Scheme Overview | 1 |
| 1.2 | Carbon assessment overview | 1 |
| 1.3 | Uncertainty within carbon estimates and assessment | 3 |
| 2 | Capital Carbon | 4 |
| 2.1 | Capital Carbon Components and Emissions Factors | 4 |
| 2.2 | Summary of Capital Carbon Estimate | 5 |
| 2.3 | Capital Carbon Hotspots | 7 |
| 2.3.1 | Reservoir Embankment Works | 7 |
| 2.3.2 | Reservoir Roads and Car Parks | 8 |

| | |
|--|-----------|
| 2.3.3 Reservoir Brick/Concrete Office Structures | 8 |
| 2.3.4 Transfer pipelines | 8 |
| 2.3.5 INNS and WTW | 8 |
| 2.4 Replacement Capital Carbon | 9 |
| 3 Operational Carbon | 10 |
| 3.1 Summary of Operational Carbon Estimate | 10 |
| 3.2 Operational Carbon Hotspots | 11 |
| 3.2.1 Grid Power Consumption | 11 |
| 3.2.2 Chemicals | 11 |
| 3.2.3 Maintenance (M&E and Civils) | 11 |
| 4 Whole-Life Carbon | 13 |
| 4.1 Whole-Life Carbon Estimate Components | 13 |
| 4.2 Summary of Whole-Life Carbon Estimate | 13 |
| 5 ACWG Carbon Mitigation Reservoir Assessment | 18 |
| 6 SLR Carbon Mitigation Strategy Recommendations | 20 |
| 6.1 Capital Carbon | 21 |
| 6.1.1 Capital Carbon Mitigation Incorporated into Current Design | 21 |
| 6.2 Capital Carbon Mitigation Opportunities | 21 |

Tables

| | |
|--|----|
| Table 2.1: Summary of emission sources by water resource planning asset class | 5 |
| Table 2.2: Summary of Asset Life categories used in SLR Reservoir whole life carbon assessment | 9 |
| Table 4.1: Summary of whole life carbon emissions and associated carbon NPV | 16 |
| Table 5.1: Summary of asset classes and % capital carbon emissions reductions applied under ACWG mid and best-case scenarios | 19 |
| Table 6.1: Carbon mitigations embedded within the existing design | 20 |
| Table 6.2: Carbon mitigations opportunities as scheme evolves | 21 |

Figures

| | |
|--|----|
| Figure 1.1: IEMA Greenhouse Gas Management Hierarchy | 2 |
| Figure 2.1: Capital Carbon Estimate break down by scheme area | 6 |
| Figure 2.2: Capital carbon breakdown of reservoir construction element of SLR scheme | 7 |
| Figure 3.1: Effect of Grid Decarbonisation on Whole Life Operational Carbon Emission | 10 |
| Figure 4.1: SLR – Whole-Life Emissions by Category (Annual) | 14 |

| | |
|---|----|
| Figure 4.2: SLR – Whole-Life Emissions by Category (Cumulative) | 15 |
| Figure 5.1: Possible reductions in capital carbon emissions through review of ACWG Low capital carbon alternatives for SROs (for 2025-2040 construction period) | 18 |

Click or tap here to enter text.

1 Introduction

1.1 Scheme Overview

The South Lincolnshire Reservoir (SLR) scheme includes the development of a new embanked raw water reservoir for water storage for public water supply. It also comprises abstractions from the River Trent and River Witham, raw water transfers, treatment works, and distribution into supply. This includes transfer elements and reservoir elements, summarised as follows:

- Intake and abstraction assets at each river,
- INNS Treatment at the River Trent abstraction,
- Raw water transfer pumping and conveyance pipelines,
- Water storage reservoir and associated components, amenity, and environmental measures,
- Water treatment works for potable water,
- Potable water transfer pumping stations, pipelines, and water storage and brake pressure tanks
- Connection to existing potable water supply systems.

Following on from the gate one submission and subsequent site selection, the project promoters have undertaken additional work to both rationalise and refine existing and additional options in order to ensure that feasible solutions resilience criteria has been explored in more detail for the SLR programme of works.

Design maturity remains at an early stage of concept planning and thus the carbon estimate produced in this report while further developed from those derived at the gate one still presents a representative scale of expected emissions with further detail to be developed as the design progresses.

The basis of the gate two carbon assessment is based on:

- Raw water intake to reservoir of up to 400 MI/d.
- Potable water distribution output of 150 MI/d¹.

It is noted that a change has been made to this deployable output following the development of the carbon assessment within this report.

1.2 Carbon assessment overview

The SLR scheme has the potential to deliver significant water security benefits but could also be a significant source of carbon emissions through its construction and operation. This report estimates the scale of expected carbon emissions and key emissions sources to help inform focus areas for decarbonisation.

To align with the latest RAPID gate two guidance, the carbon assessment is required to consider:

- Assessment of whole life carbon cost of the solution.
- Consideration and discussion of whole life carbon reduction including how carbon has been considered in the best value planning approaches, metrics and decision making with due

¹ The proposed capacity of the water treatment works and transfer pipelines has been updated since this assessment was completed. The figures quoted in the gate two report include a scheme deployable output of 166MI/d and works capacity up to 180MI/d. These changes will be incorporated into future carbon assessments.

consideration to the six main greenhouse gasses. (This is covered by the regional planning approach delivered through Water Resources East and the WRMP process)

- Demonstration of use of relevant policy, frameworks, and approaches to drive down carbon emissions.
- Assessment of key emission areas (scope 1, 2 and 3), considerations for reduction and inclusions of material selection choice (including explanation of where low carbon materials have been discounted).
- Consideration of the impact between cost and carbon reduction.

To respond to the above requirements, this report provides an overview of the current estimate for capital carbon (Section 2) and operational carbon (Section 3). These have subsequently been used to assess the whole-life carbon emissions of the scheme (Section 4). Aspects on which to focus mitigation measures as the scheme moves forward into the next stages of design have been considered in Section 5 and Section 6.

The carbon assessment for SLR has followed the IEMA emissions reduction hierarchy shown in Figure 1.1 to identify opportunities to reduce and mitigate carbon emissions from the scheme. This aligns well with the carbon reduction hierarchy from PAS2080 and helps focus initial efforts on reducing emissions rather than offsetting them.

Figure 1.1: IEMA Greenhouse Gas Management Hierarchy



Updated from original IEMA GHG Management Hierarchy, first published in 2009

It is acknowledged that a significant proportion of capital and operational carbon emissions associated with the scheme are considered to be Scope 3 emissions and outside of the direct control of the project promoters. However, it is also acknowledged that there are significant opportunities to work with the supply chain (prior to scheme delivery) to support accelerated

decarbonisation of external systems and supply chains to help reduce the carbon impact. For, example the availability, at sufficient scale, of alternative fuels and construction plant for the earthworks and haulage activities associated with reservoir construction are a key area for engagement to enable decarbonisation of the SLR scheme.

The carbon emissions mitigation efforts have been split into two areas:

- Opportunities directly under the control of the project promoters, including areas which can reduce emissions through design decisions that can be embedded and costed into the scheme.
- Longer term opportunities where the scheme and sector can influence external systems and supply chains to decarbonise major components of the scheme. These longer-term mitigation opportunities have been covered by a collaborative project commissioned by the All Company Working Group (ACWG) which has identified a consistent view across SROs of how these external systems may decarbonise in the future to inform future decarbonisation potential and engagement priorities for individual SROs.

The report then presents priority focus areas of a carbon management strategy for the SLR to take forward onto the next stages of design and planning.

Whilst no specific emissions reduction target has been put in place for the SLR scheme, the aim of the carbon assessment and strategy is to continue to drive emissions down from the scheme as much as possible whilst continuing to provide the substantial water supply and security value the scheme delivers.

1.3 Uncertainty within carbon estimates and assessment

There is inherent uncertainty in carbon estimating due to the developing maturity of carbon accounting practices and associated data. There is also additional uncertainty driven by scope uncertainty associated with level of design information available at given stages within the project lifecycle.

There is currently no standardised or established guidance to assess uncertainty in carbon estimates in a consistent way and directly applying the range of uncertainty associated with cost estimates and optimism bias would likely overstate the level of uncertainty associated with the gate two carbon estimate.

Whilst further ongoing work is required at a carbon estimating and accounting discipline level and within the infrastructure sector to establish a more formalised approach to assessing carbon uncertainty, a range of +/-30% has been applied based on expert judgement for the gate two estimate. This uncertainty range accounts for:

- Uncertainty in carbon factors related to the quality and representativeness of industry level emissions factors to the specific activities undertaken and materials used on the SLR scheme.
- Scope uncertainty associated with ensuring the carbon estimate has captured all scope requirements to fully deliver the scheme.

These uncertainty estimates will be reviewed and refined at future stages of SLR design development to build on any further industry wide efforts to assess uncertainty in carbon estimating.

2 Capital Carbon

Under the Greenhouse Gas Protocol, capital carbon emissions from construction are typically categorised as Scope 3 emissions of the sector/organisation. The main Scope 3 categories of relevance for the construction of the SLR scheme are:

- Category 1 and 2 – Covering purchased goods and services and capital goods. This will cradle-to-gate embodied carbon emissions associated with construction materials.
- Category 4 – Covering upstream transport of products and materials to the SLR location
- Category 5 – Covering waste generated in operations, this could include removal of surplus excavated materials for the reservoir and removal and disposal of site clearance or surplus construction materials.

Capital carbon emissions from construction and maintenance activities are the result of materials (extraction and processing), manufacturing effort, transportation, and any disposal of construction waste. The capital carbon assessments within this section cover lifecycle modules A1-A5 (as per PAS2080:2016) and are only associated with the embodied carbon of materials used and associated construction activities to get the reservoir up to commissioning stage. The assessments also considered a cradle-to-built asset boundary (as per UKWIR, 2012).

Asset construction will be a significant emissions source for most SROs and quantification of these emissions is a key element to identifying efficient mitigation opportunities. This section provides an overview of the capital carbon emissions estimate undertaken for SLR and describes some of the key carbon hotspots.

2.1 Capital Carbon Components and Emissions Factors

A capital carbon assessment has been carried out using current design information alongside the breakdown of asset scope inputs used for the gate two cost estimate. The asset information used for costing was aligned to carbon models based on industry standard data to enable an estimate of capital carbon.

The assessment for the reservoir construction activities has predominantly used emissions factor rates from Civil Engineering Standard Method of Measurement (CESMM4), these cover activities such as topsoil stripping, excavation, stockpiling and placing of excavated materials.

Additionally, carbon models have been used to determine capital carbon emissions for other types of assets that would be constructed as part of SLR, such as models for site service roads and temporary fencing. These models have been developed using typical industry generic designs and supplier information for products and materials, alongside emissions factor data from the Inventory of Carbon and Energy (ICE).

Typically, CESMM4 factors have been applied to construction activities and ICE database factors have been used for construction material carbon intensities. Over time, as more detail is built into material specifications and specific locations of supply, it is expected that more supplier specific emissions data could be utilised in place of industry generic emissions inventories.

2.2 Summary of Capital Carbon Estimate

The capital carbon assessment has been presented in Table 2.1 and under the standard asset life classes for water resources as proposed in the Cost Consistency Methodology².

The capital carbon associated with the construction of the SLR is shown in Table 2.1. The breakdown into the ACWG asset life categories helps to identify the aspects which contribute more significantly to higher emissions. The largest capital carbon contributor for the SLR is the reservoir, with pipelines and WTW categorised as the other divisions. A full breakdown of the SLR capital carbon estimate is shown in Figure 2.2, with the most significant divisions of the reservoir discussed further as capital carbon hotspots.

Table 2.1: Summary of emission sources by water resource planning asset class

| Asset types | Scheme area | Capital Carbon tCO ₂ e | % of scheme capital carbon |
|---------------------------------------|--|--------------------------------------|-------------------------------|
| Reservoir embankment earthworks | Reservoir | 99,680 | 27% |
| Roads and car parks | Reservoir | 22,500 | 6% |
| Buildings | Reservoir | 18,250 | 5% |
| Power supply, including renewables | Reservoir | 15,770 | 4% |
| Pipework (within reservoir footprint) | Reservoir | 15,250 | 4% |
| Underwater assets | Reservoir | 14,580 | 4% |
| Tunnels sections | Reservoir | 2,030 | 1% |
| Mechanical and Electrical equipment | Reservoir | 1,950 | 1% |
| Bridges | Reservoir | 1,700 | 0% |
| Service diversions | Reservoir | 1,490 | 0% |
| Landscaping/Environmental Works | Reservoir | 890 | 0% |
| Fencing | Reservoir | 430 | 0% |
| Other civil structures | Reservoir | 380 | 0% |
| Water towers | Reservoir | 130 | 0% |
| SLR to Etton transfer | Transfer pipeline and pump stations | 57,320 | 15% |
| SLR INNS | Treatment (invasive species) | 52,700 | 14% |
| SLR WTW | Treatment (potable water) | 31,980 | 9% |
| River Witham to SLR transfer | Transfer pipeline and pump stations | 21,150 | 6% |
| River Trent to River Witham transfer | Transfer pipeline and pump stations | 14,420 | 4% |
| Total | | 372,600 | 100% |

² Table 4-3 Cost Consistency Methodology Rev E (Feb 2022)

Figure 2.1: Capital Carbon Estimate break down by scheme area

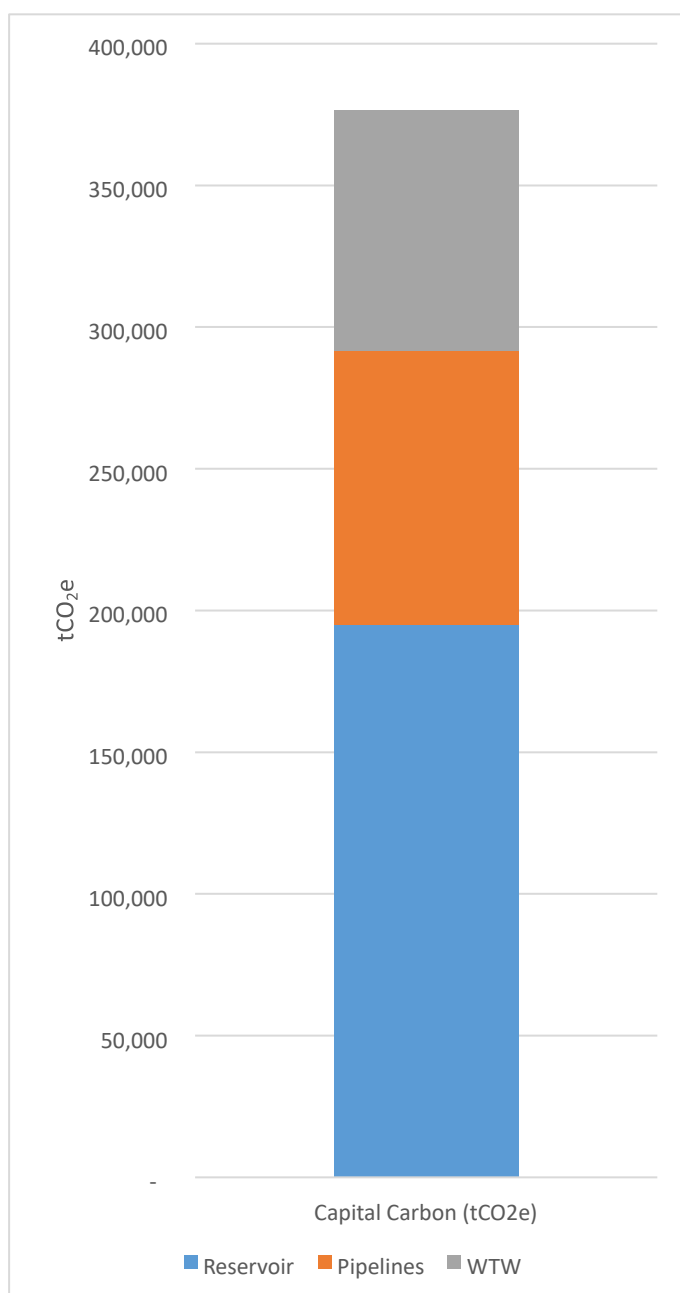


Figure 2.1 highlights the main scheme areas and their contribution to capital carbon. It highlights that the reservoir construction has the most significant capital carbon impact, accounting for 52% (195,030tCO₂e) of capital carbon.

The transfer pipelines are then the next largest contributors, accounting for 26% of scheme capital carbon emissions. This is split between 3 sections of the abstraction and transfer infrastructure, covering:

- Trent to Witham – 4% of capital carbon emissions emission (14,420tCO₂e)
- Witham to SLR – 7% (24,800 tCO₂e) of capital carbon emissions
- SLR to Supply – 15% (57,320 tCO₂e)

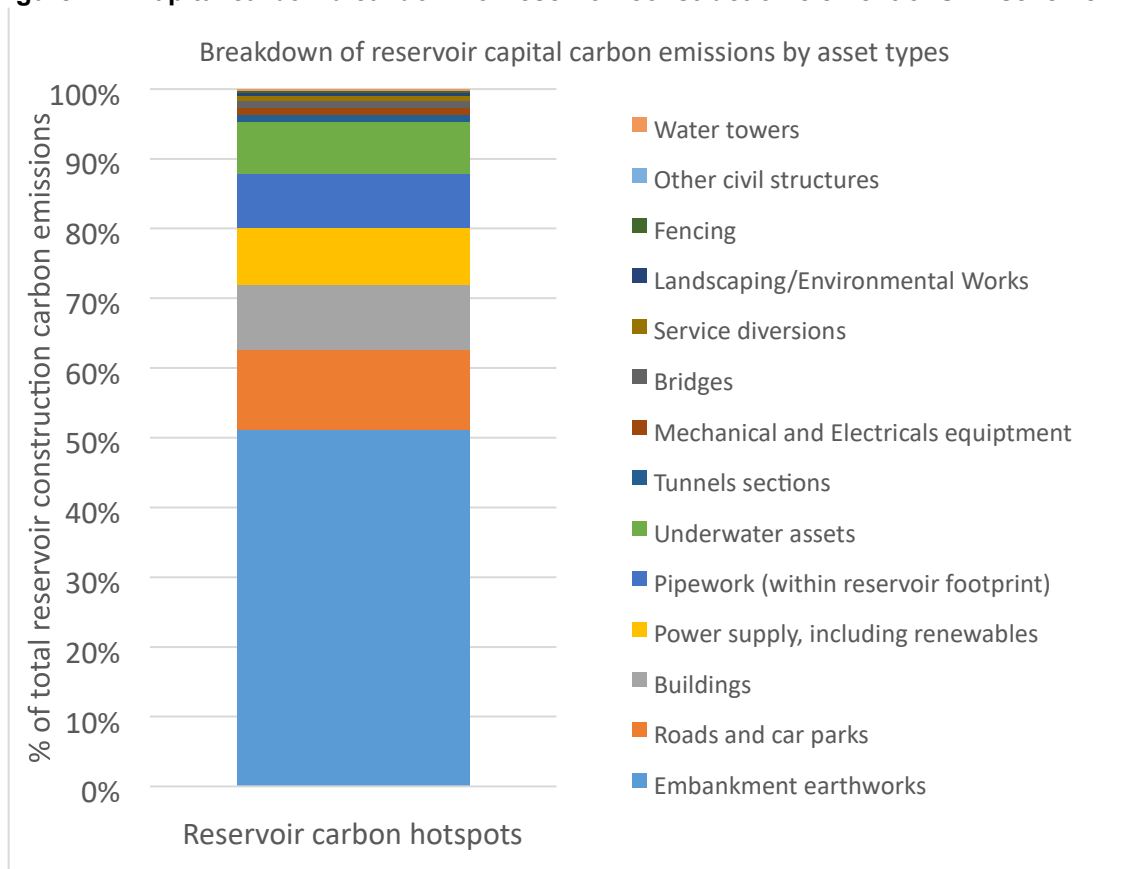
The Invasive Non-Native Species (INNS) treatment and potable Water Treatment Works (WTW) account for 14% (52,700tCO₂e) and 8% (31,980tCO₂e) respectively.

The reservoir construction clearly is the largest emissions contributor but there is still significant scale of emissions and associated decarbonisation opportunities within the transfer pipelines and treatment infrastructure to drive through the scheme development.

2.3 Capital Carbon Hotspots

Figure 2.2 presents a breakdown of the reservoir capital emissions by asset class category. The sub sections below provide an overview of the major hotspots associated with the construction of the SLR.

Figure 2.2: Capital carbon breakdown of reservoir construction element of SLR scheme



2.3.1 Reservoir Embankment Works

Across all the SLR options shown in Figure 2.2, the reservoir embankment works category is the largest carbon hotspot, accounting for 27% of the total capital carbon. The aspects that are grouped into this category relate primarily to the construction of the reservoir borrow pit and the reservoir embankments; this includes:

- Excavation of the borrow pit at the SLR site.
- Placement of the excavated material from the borrow pit to form the SLR reservoir embankment.
- Importing and placing sand and gravel to create drainage layers within the SLR reservoir embankment; and

- Importing and placing sand, gravel, and riprap on the inner face of the SLR reservoir embankment for protection against wave erosion.

The current design for the reservoir is based on achieving a balance between the volume of suitable material that would be excavated from the borrow pit and the volume of material that is required to form the main reservoir embankment. It is also important to ensure that any other material excavated from the borrow pit can be used on the site, so as to remove the need for export and disposal off-site and associated emissions, and the gate two concept design achieves this aim.

2.3.2 Reservoir Roads and Car Parks

The Roads and Car parks are another significant carbon hotspot for the scheme, accounting for 6% of the total capital carbon for the reservoir. The roads and car park category includes:

- Permanent roads (4.2km road for vehicular/cycle access to car parks & WTW, as well as 3km diversion around north end of reservoir).
- Temporary haul roads (across the reservoir site including access to the rail siding and the associated materials handling area); and
- Bridges (associated with the new roads and for various watercourse crossings)
- 260,000m² of car parking space across various visitor and operational areas around the reservoir
- Proposed new roads for vehicular/cycle access to the car parks and the water treatment works.

The current roads capital carbon emissions assume a road construction of paved and unpaved haul roads.

2.3.3 Reservoir Brick/Concrete Office Structures

The tunnels category accounts for 5% of the total capital carbon for the scheme. This category includes the material and construction efforts for:

- A 100x100m building that incorporates water sports facilities and an educational centre.
- A structure set into the embankment that houses the controls to the emergency drawdown valves.

Most carbon in this category is associated with the construction of car parks at the primary visitor centre, western visitor centre and BNG area.

2.3.4 Transfer pipelines

The various transfer pipelines are also a major emissions source. The majority of the emissions from these is associated with the large diameter steel pipelines currently assumed for the majority of the transfers. There is also a smaller but still significant carbon contribution associated with the excavation, reinstatement and transport elements required to install these pipelines.

2.3.5 INNS and WTW

The INNS and WTW components are also significant emissions areas. There are a number of hotspots within these components but are dominated by materials associated with process tanks currently assumed to be a mix of reinforced concrete and steel process units within the models used.

2.4 Replacement Capital Carbon

The whole life carbon assessment also provided an estimate of the likely carbon associated with replacing components of the scheme. Table 2.2 provides the asset life category that the capital carbon estimate was broken down into and the expected asset life of each category. These asset life categories have been aligned to those defined in the ACWG Cost Consistency Report³. The modelling assumes assets are replaced like for like at the end of their asset life and the initial modelled capital carbon for construction of that asset are repeated at that time. The same asset life categories have been used in the whole life cost modelling to derive the NPV and AIC values.

Table 2.2: Summary of Asset Life categories used in SLR Reservoir whole life carbon assessment

| ACWG Asset Life Category | Asset Life (years) |
|---|--------------------|
| Embankment Works | 250 |
| Other Non-Depreciating Assets (Non depreciating) | n/a |
| Roads and Car Parks | 60 |
| Tunnels | 100 |
| Treatment and Pumping Station Civils (incl. Intakes) | 60 |
| Reinforced Concrete Tanks / Service Reservoirs | 80 |
| Landscaping/Environmental Works | 30 |
| Pipelines | 100 |
| Brick/Concrete Office Structures | 50 |
| M&E (Mechanical and Electrical) Works on Pumping Stations and Treatment Works | 20 |
| Bridges | 40 |
| Underwater Assets | 60 |
| Water Towers | 60 |
| Fencing | 10 |
| Land (Non depreciating) | - |

³ ACWG Cost Consistency Methodology Rev E (February 2022)

3 Operational Carbon

An operational carbon assessment has been undertaken for the SLR scheme. These emissions would be considered as Scope 1 and 2 emissions of an organisation under the GHG Protocol, which cover direct and indirect emissions, respectively. Direct emissions in the water sector result from treatment process emissions, fossil fuel use and owned or leased transport emissions. Indirect energy emissions are the product of purchase and use of grid electricity by water company assets notably for water and wastewater pumping and treatment as well as use in buildings. Under the PAS2080:2016 life cycle modules, the current assessment covers use stages B1-B6 modules.

For SLR, the major operational emissions source is through emissions associated with electricity consumption required for pumping and treatment and chemical consumption for treatment. Maintenance activities also contribute to annual operational emissions but at a smaller scale than electricity and chemical consumption.

3.1 Summary of Operational Carbon Estimate

Figure 3.1 shows the annual operational carbon emissions for the SLR and has been compared at three different timeframes using the BEIS grid carbon intensity forecast:

- 2022 using BEIS grid carbon intensity forecasts 0.139 kgCO₂e/kWh
- 2040 using BEIS grid carbon intensity forecasts 0.015 kgCO₂e/kWh
- 2080 using BEIS grid carbon intensity forecasts 0.007 kgCO₂e/kWh

Figure 3.1: Effect of Grid Decarbonisation on Whole Life Operational Carbon Emission

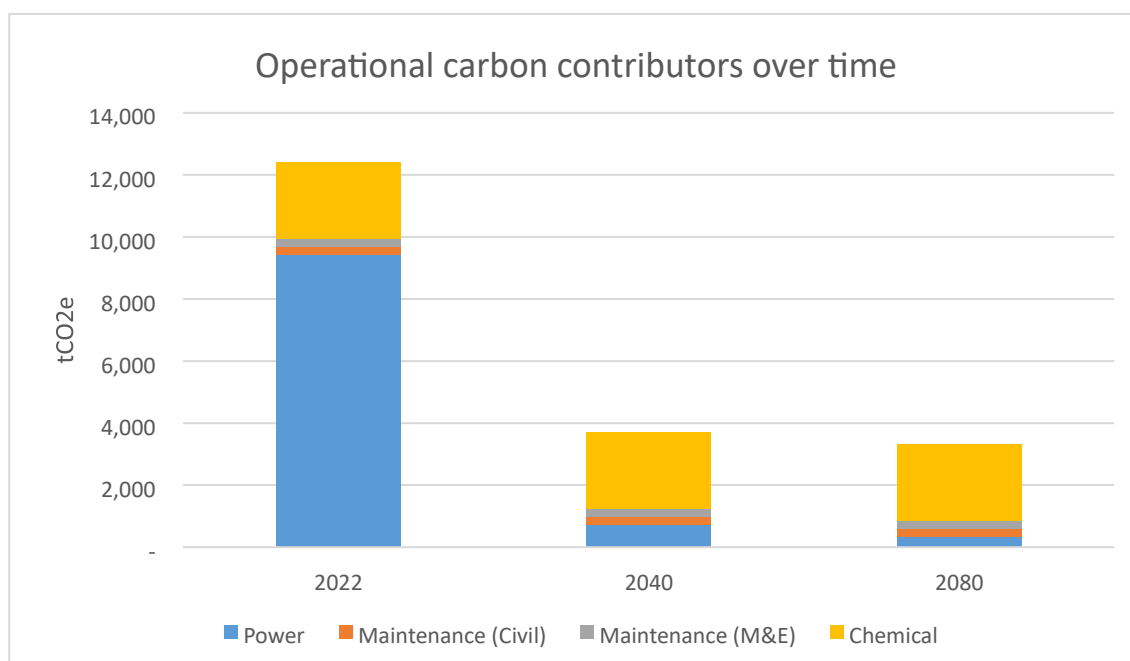


Figure 3.1 demonstrates the impact of the predicted grid decarbonisation on the carbon intensity of SLR's anticipated power consumption. There is expected to be an 89% decrease in annual power carbon emissions between 2022 and 2040 and it is predicted that the grid will have largely decarbonised by around 2050.

If SLR were to be constructed, it would only be completed by the late 2030s at the earliest, meaning that the 2040 carbon intensity of power consumption would be more representative of SLR's initial operational carbon.

3.2 Operational Carbon Hotspots

3.2.1 Grid Power Consumption

As noted in Figure 3.1, over time, the significance of power related carbon emissions is expected to decrease as grid decarbonisation projects take effect. If the scheme were to be constructed under the current expected programme, the earliest first year of operation would be in the late 2030s. By this time, it is expected that carbon emission intensity should be approximately 13% of its current level. Furthermore, by 2050 the forecast indicates a reduction to 5% of current levels.

3.2.2 Chemicals

The INNS and WTW elements have requirement for chemicals and media replacement or reactivation. Post-2040 when the scheme is currently expected to be required to be in operation chemical use is expected to be responsible for 54% of operational emissions in 2040, and 66% by 2060. Unlike power there are no established national or international trajectories for expected levels of decarbonisation of chemicals

3.2.3 Maintenance (M&E and Civils)

Maintenance associated with the scheme is estimated to account for 12% (6% civils-related, 6% M&E related) of gross operational carbon emissions in 2040.

Annual maintenance carbon estimates have been estimated based on a similar approach to annual operational costs. Annual maintenance costs are based on 0.25% of the initial

construction cost of the civil works components (excluding internal embankment works) and 1.5% of the initial cost of the E&M works. Consideration of the typical maintenance activities for reservoirs however indicates that the carbon intensity of these activities would be less than their cost intensity, as they would require relatively limited additional products, materials, and operational consumables. Some examples of the regular maintenance activities that would be required include:

- Valves (Greasing of spindles, ensure regular operation, Replacement of gland packing (occasional), Painting (occasional))
- Pro-active maintenance of M&E equipment, such as, pumps, blowers, generators, water mixing plant and Instrumentation (Check power connections, check for leakage/damage, greasing/oil)
- Turbines (inspection of electrical cabinet and gearbox, oil/lubrication, rotor blade servicing, alignment)
- Maintaining roads (e.g. resurfacing access roads as required)
- Landscape management
- Security fencing inspections

The activities above, while potentially labour / cost intensive, would have relatively limited consumables that would have a direct carbon impact. Furthermore, many of the products or consumables required would have already been accounted for in the replacement capital carbon. The additional operational maintenance carbon emissions are likely to be associated with:

- Transport fuel consumption for the maintenance visits.
- Embodied carbon associated with the limited amounts of grease and M&E replacement parts required.
- Fuel use for landscaping e.g. maintaining grass / vegetation on embankments

Therefore, to estimate carbon emissions associated with maintenance activities an additional factor of 0.1 was applied to account for the reduced carbon intensity of labour-intensive activities. This assessment will be refined at future stages of design development with a bottomup estimate to account for transport fuel as well as typical products and materials required for operational maintenance.

4 Whole-Life Carbon

4.1 Whole-Life Carbon Estimate Components

The outputs from the capital and operational carbon assessments outlined above have been used to inform a whole-life carbon assessment.

In order to align with whole-life cost estimates, whole-life carbon for SLR has been assessed over 80 years (from 2022/23 to 2101/02) with the following assumptions based on initial outputs from WRE Emerging Regional Plan:

- A 6-year planning and development period (2024/25 – 2030/31) during which carbon emissions are assumed to be negligible.
- An 8-year construction period (2031/32 – 2038/39) during which the capital carbon emissions as described in Section 2 are applied.
- A 65-year operation period (2038/39 – 2101/02) during which the replacement capital carbon emissions as outlined in Section 2.3 are applied alongside the annual operational carbon emissions as described in Section 3.

Whilst capital carbon associated with replacements have been considered (see Section 2.3) the quantified assessment does not include for estimating the potential impact of decommissioning the scheme. The operational life is expected to be over 100 years and it is anticipated that the systems in place to re-use, recycle or dispose of assets would be substantially different to present day.

4.2 Summary of Whole-Life Carbon Estimate

A summary of estimated whole-life carbon emissions is presented annually in Figure 4.1. A summary of estimated cumulative whole-life carbon emissions is presented annually in Figure 4.2.

Table 4.1 provides a summary of the estimated whole life carbon results, with Table 4.2 showing a breakdown of how these are split across different carbon categories. The capital carbon emissions account for around 54.7% of emissions across the whole-life carbon estimate, with a further 12.3% associated with capital replacements of the assets across the 80-year period.

The operational carbon emissions are split into those associated with chemicals and maintenance (non-power) and power consumption (power related); these account for 27.9% and 5.1% of the whole-life carbon emissions respectively.

The large capital replacement emissions in 2096-98 are associated with the replacement of large civil components, such as roads, the river intake / outfall structure, and the pumping station. These, as shown in Table 2.2, are assumed to have an asset life of 60 years.

Figure 4.1: SLR – Whole-Life Emissions by Category (Annual)

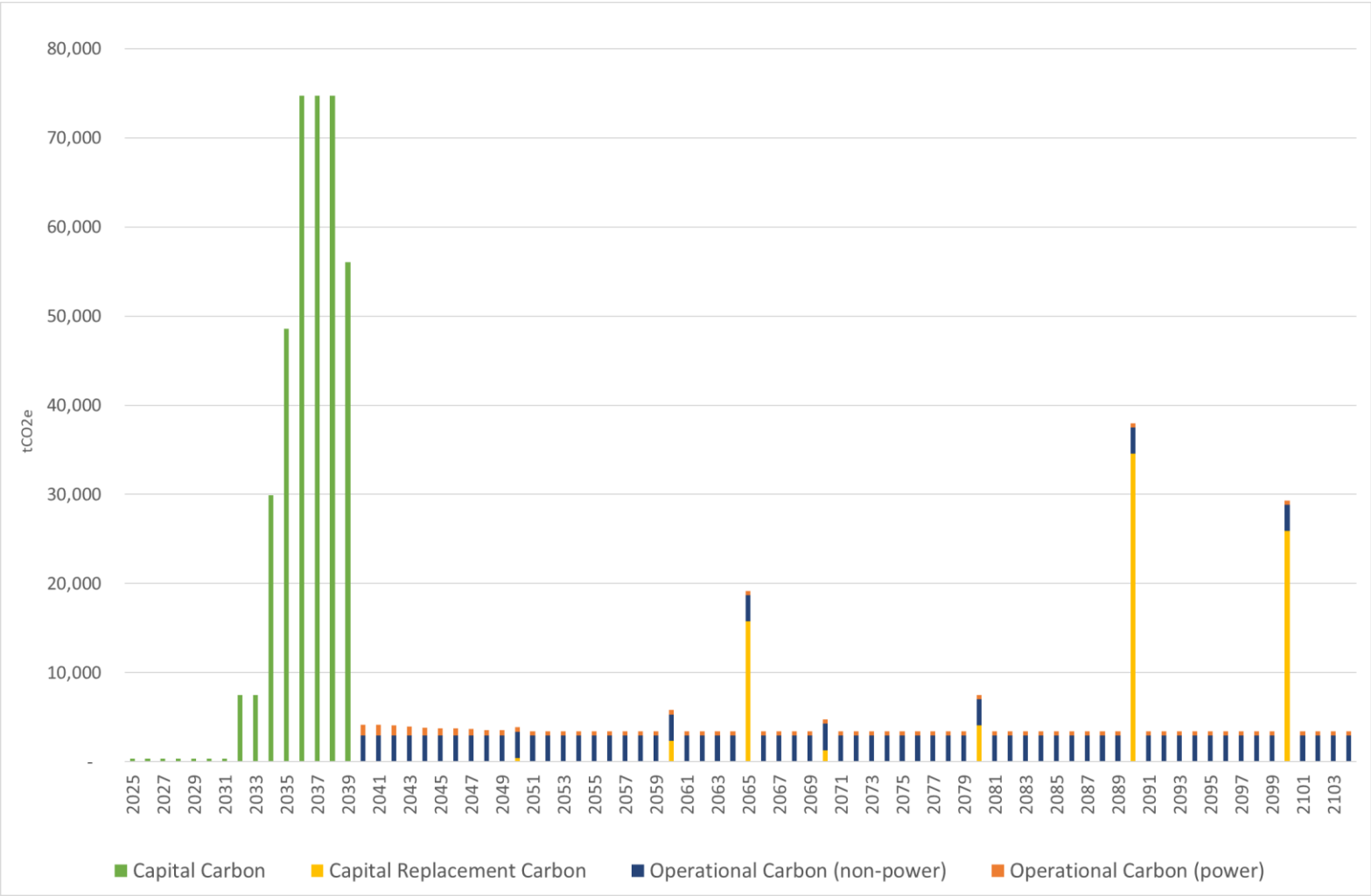


Figure 4.2: SLR – Whole-Life Emissions by Category (Cumulative)

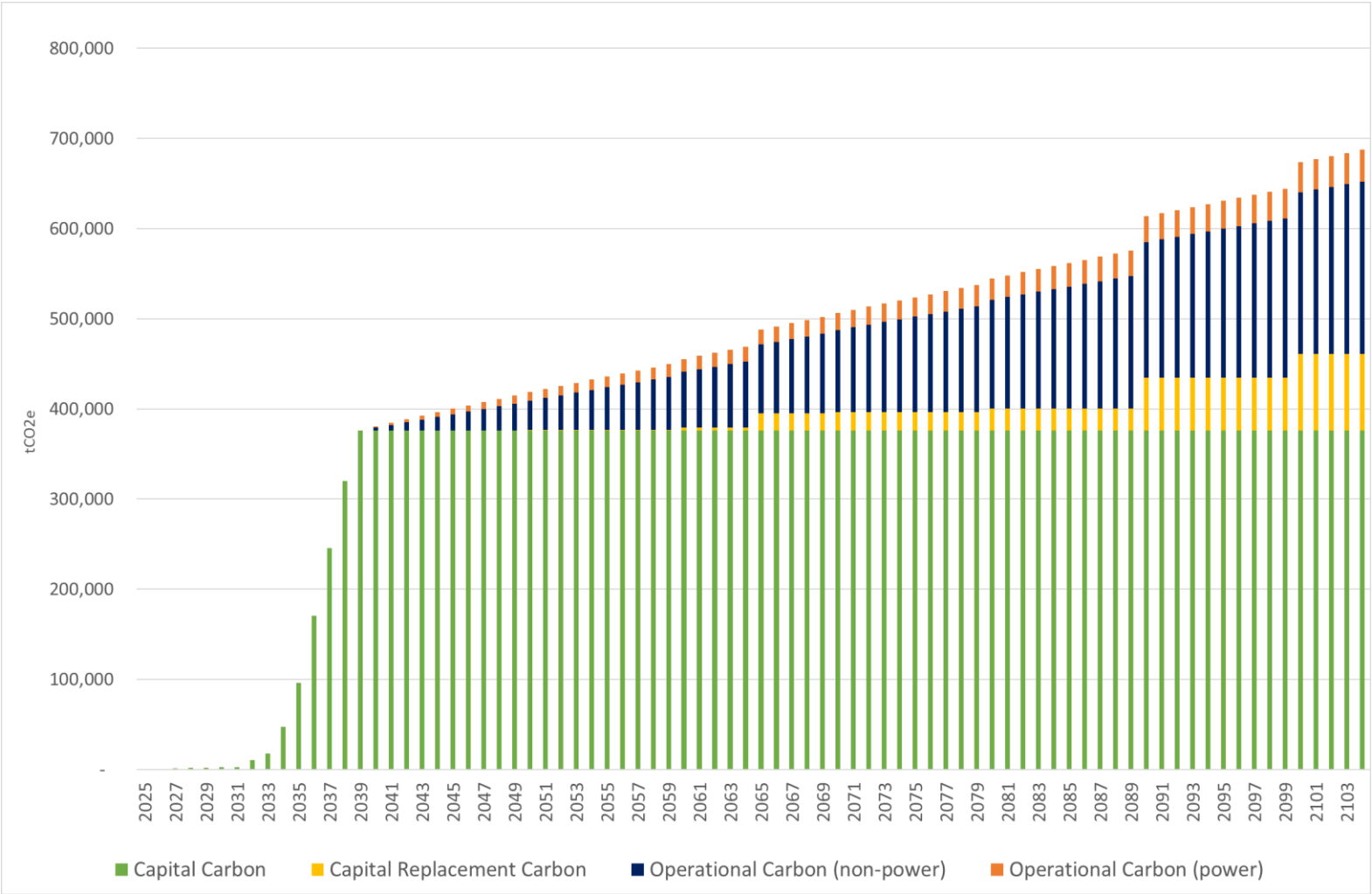


Table 4.1: Summary of whole life carbon emissions and associated carbon NPV

| Emissions type | tCO2e | % Total emissions | Carbon £M NPV | % Carbon costs |
|--------------------------------------|----------------|-------------------|---------------|----------------|
| Capital Carbon | 376,250 | 55% | 74.8 | 69% |
| Capital Replacement Carbon | 84,440 | 12% | 7.5 | 7% |
| Operational Carbon (nonpower) | 191,450 | 28% | 21.8 | 20% |
| Operational Carbon (power) | 35,250 | 5% | 4.3 | 4% |
| Total | 687,390 | | 108.4 | |

5 ACWG Carbon Mitigation Reservoir Assessment

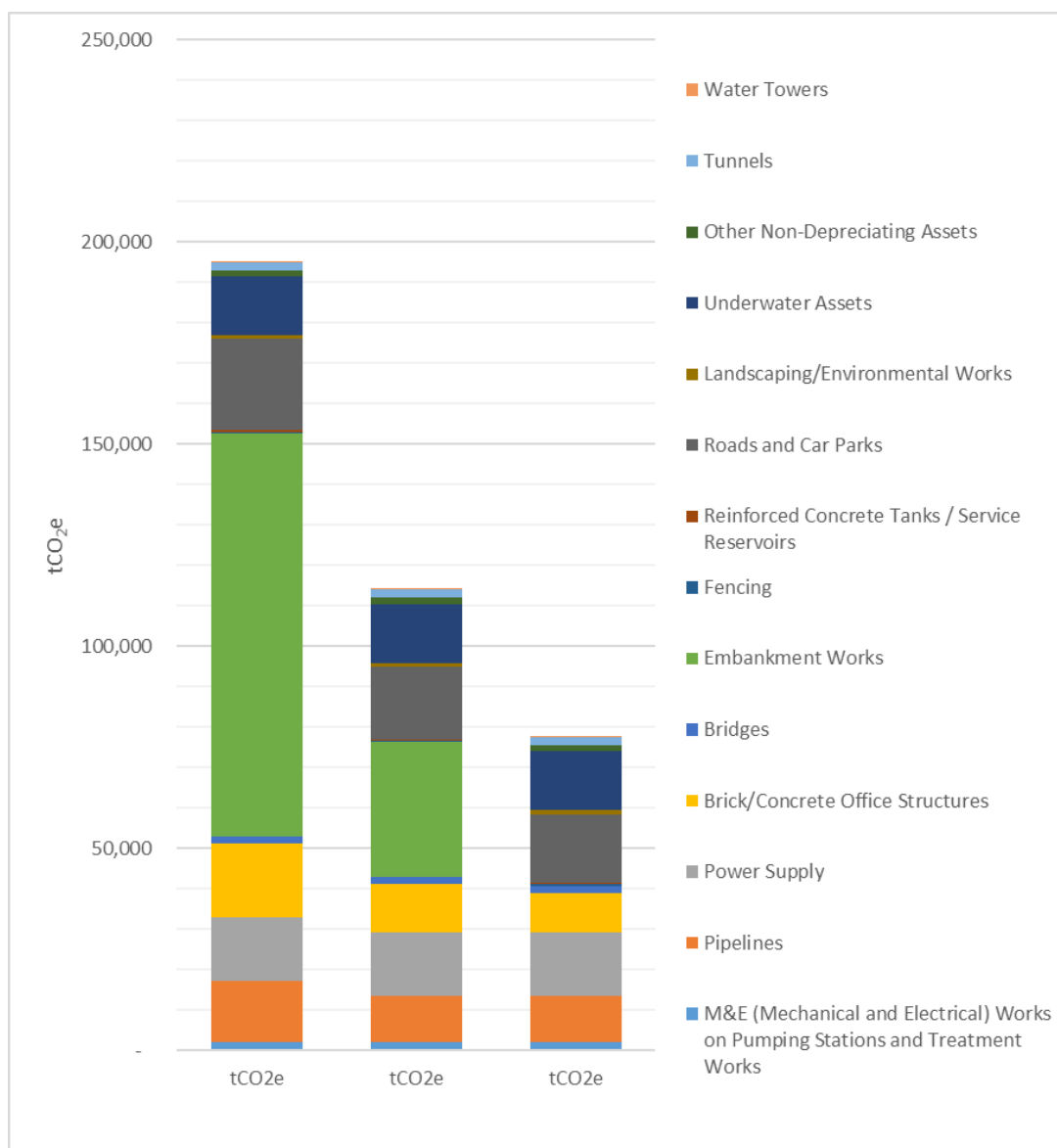
The All Company Working Group (ACWG) commissioned a study to identify potential decarbonisation opportunities for the different types of SROs with a focus on 'build clever' and 'build efficiently' measures. 'Build-nothing' and 'build less' measures in the PAS 2080 carbon reduction hierarchy (or 'eliminate' and 'reduce' measures as noted in the IEMA framework shown in Figure 1.1) are site specific and will have been considered through regional planning and earlier design development stages.

The ACWG - Low capital carbon alternatives for SROs study identified that, for reservoirs, the majority of carbon emissions would be associated with on-site excavation, production of quarried material off-site, transporting materials to and from site, and the construction plant on site. This aligns with the assessment for SLR outlined in the previous sections of this report. The ACWG report also found that for large diameter transfer pipelines, the majority of carbon emissions are associated with the chosen pipe material.

The majority of carbon emissions, as highlighted in the capital and whole life carbon assessment, arising from the SLR are associated with initial construction with earthworks activities, including importing material to site; excavating material from the borrow pit; and moving / placing material on site. The SLR concept design has already mitigated some of the associated emissions by, for example, the site selection exercise that identified a site where a cut fill balance could be achieved reducing the need for imported materials or disposal of surplus materials. Whilst these have been considered in the development of the scheme to date this section focusses on the potential decarbonisation opportunities possible linked to external system decarbonisation through collaboration with the supply chain and provides some indicative estimates of the scale of carbon reductions that may be possible based on the scenarios produced in the ACWG report.

Figure 5.1 presents an interpretation of the mid and best-case scenarios from the ACWG report, which has been used to derive % reductions against each of the tCO₂e values for each asset class, as presented in Table 5.1. The ACWG report looked at three different time horizons to estimate how decarbonisation opportunities may change over time. The results presented in Figure 5.1 represent the time period between 2025 and 2040, which aligns with the expected programme of the SLR scheme. This timeframe is governed by the water resources modelling of when the additional water resource will be required, hence alternative timeframes have not been reviewed at this time. These reduction opportunities currently only focus on the major hotspots of the reservoir construction but will be further reviewed in regard to the transfer pipelines and treatment components at the next gate stages.

Figure 5.1: Possible reductions in capital carbon emissions through review of ACWG Low capital carbon alternatives for SROs (for 2025-2040 construction period)



The application of the possible reductions available through the ACWG study show potential reductions in capital carbon between 42% in the mid-case and 60% in the best case. These are purely indicative scales of emissions reduction possibilities based on the high-level study undertaken by the ACWG and extrapolated through the SLR scheme. A continued in-depth review of decarbonisation opportunities will continue as part of the scheme development and priority areas of focus are presented within Section 6.

Table 5.1: Summary of asset classes and % capital carbon emissions reductions applied under ACWG mid and best-case scenarios

| Base case | | ACWG Mid-case | | ACWG best-case | |
|-----------|-------------|---------------|-------------|----------------|-------------|
| tCO2e | % Reduction | tCO2e | % Reduction | tCO2e | % Reduction |
| | | | | | |

| | | | | | |
|---|---------|-----|---------|------|--------|
| M&E (Mechanical and Electrical) Works on Pumping Stations and Treatment Works | 1,950 | | 1,950 | | 1,950 |
| Pipelines | 15,250 | 25% | 11,440 | 25% | 11,450 |
| Power Supply | 15,770 | | 15,770 | | 15,770 |
| Brick/Concrete Office Structures | 18,250 | 33% | 12,160 | 46% | 9,850 |
| Bridges | 1,700 | | 1,700 | | 1,700 |
| Embankment Works | 99,680 | 67% | 33,230 | 100% | - |
| Fencing | 430 | | 430 | | 430 |
| Reinforced Concrete Tanks / Service Reservoirs | 380 | 20% | 310 | 24% | 290 |
| Roads and Car Parks | 22,500 | 20% | 18,010 | 24% | 17,030 |
| Landscaping/Environmental Works | 890 | | 890 | | 890 |
| Underwater Assets | 14,580 | | 14,580 | | 14,580 |
| Other Non-Depreciating Assets | 1,490 | | 1,490 | | 1,490 |
| Tunnels | 2,030 | | 2,030 | | 2,030 |
| Water Towers | 130 | 20% | 100 | 24% | 100 |
| | 195,030 | 42% | 114,090 | 60% | 77,560 |

Note: blank values represent asset classes where the ACWG did not review potential reduction opportunities as they were not significant hotspot areas within the reference designs reviewed in their study. The carbon reduction potential of these asset classes can be reviewed by each individual scheme further as the design develops.

6 SLR Carbon Mitigation Strategy Recommendations

The carbon assessment and analysis presented above has been used to inform focus areas for carbon mitigation efforts. Some of these have already been implemented as part of the development of the gate two design, while others are identified as future strategic priorities. If the scheme is to continue to the next stage of design development, the carbon mitigation strategy will also need to advance. This would involve acting on recommendations from the ACWG study (discussed in Section 5) including engagement with relevant external stakeholders.

Section 6.1 below summarises capital carbon mitigation measures already considered as well as those identified for consideration and the next stage of design development. An initial list of stakeholders for engagement is also provided in Tables 6.1 and 6.2, which could help broaden the dialogue and promote early collaboration to maximise opportunities and accelerate the pace emissions reductions.

6.1 Capital Carbon

6.1.1 Capital Carbon Mitigation Incorporated into Current Design

Table 6.1 highlights the areas of carbon mitigation that have already been embedded into the scheme design to help reduce whole life carbon impacts.

Table 6.1: Carbon mitigations embedded within the existing design

| Scheme area | Mitigation measures | Supply chain engagement requirements |
|---|--|--|
| Site selection – Cut-fill balance | The site selection process considered a number of factors including whole life carbon emissions. A key driver for both cost and carbon were identifying a site where a cut-fill balance could be achieved thus reducing the need for import and disposal of surplus materials. The best performing site was one of the lowest whole life carbon options of those considered. | Not applicable |
| Transport of materials – Opportunity for rail transport of materials | Transport of construction materials can contribute significant emissions but also have implications on road congestion and air quality. The scheme has allowed for costs to develop and utilise rail transport for construction materials, which has the potential to then be integrated and utilised for public transport post construction. | Product and material suppliers |
| Renewables | The scheme has made allowances for significant land and floating solar array infrastructure to generate renewable power | District Network Operators and other power users to maximise value of renewables in the region |

6.2 Capital Carbon Mitigation Opportunities

Carbon mitigation opportunities have been identified during gate one and gate two for 'build clever' and 'build efficiently' stages in the carbon reduction hierarchy, these range in potential impact and feasibility with some being relatively easy to implement, and others requiring further work to understand their feasibility. The following areas shown in Table 6.2 will continue to be explored as part of the carbon mitigation strategy for SLR:

Table 6.2: Carbon mitigations opportunities as scheme evolves

| Scheme area | Mitigation measures | Supply chain engagement requirements |
|--------------------------------------|---|---|
| Low carbon construction plant | The earthworks element of the reservoir construction is the largest hotspot area of the scheme. A significant proportion of this is driven by the fuel used in the construction plant to carry out the earthworks. The current assessment has been undertaken assuming conventional plant using diesel fuel. However, there are significant savings possible through further exploration of use of alternative fuels, such as Hydrogenated Vegetable Oil (HVO), hydrogen or electric for smaller scale excavations. These alternative fuels would also have an improved impact on air quality during the construction programme compared to conventional diesel fuel. | Equipment manufacturers HVO suppliers Hydrogen suppliers Other asset owners: Highways England, Defra, EA Other water companies delivering similar schemes |

| | | |
|--|--|---|
| Low carbon construction materials | There are significant emissions associated within the embodied carbon of construction materials used. Particularly for substantial civil structures for the WTWs and also temporary and permanent road structures. The opportunity to work with the supply chain to identify low carbon alternatives for concrete, steel, pipelines, and other construction materials can have a significant impact on the scheme. There is also opportunity to engage with the supply chain to help support them to decarbonise the products and materials they supply. | Contractors Concrete suppliers Structural steel suppliers Road and temporary road product/material suppliers |
| Efficient construction approaches | The use of efficient construction approaches that improve fuel and resource efficiency during delivery of the scheme will be explored in more detail as the scheme design detail develops. This includes consideration of automation and opportunities to minimise waste generated through construction. | Contractors |
| Transport of materials – Opportunity for transport of materials | Transport of construction materials can contribute significant emissions but also have implications on road congestion and air quality. There is an opportunity for the scheme to develop water and utilise water transport for construction materials, which materials has the potential to then be integrated and utilised for navigation post construction. | Product and material suppliers |
| Multi-sector (system) opportunities | The SLR scheme has further opportunities to integrate with the wider region and potentially support multi-system benefits, including supporting regional decarbonisation efforts. These opportunities continue to be explored with relevant stakeholders across the region. | Regional stakeholders |
| Maximise land-use disciplines benefits | As the scheme progresses there will be greater detail built into maximising the value generated within and beyond the scheme footprint. This will focus on maximising overall value, incorporating water quality, flood defence, biodiversity and carbon sequestration benefits to help offset residual emissions associated with the scheme. | Various technical and regional stakeholders |

As Table 6.2 shows there is significant need for a collaborative approach with a range of regional stakeholders and the supply chain to maximise the decarbonisation opportunities presented above. This engagement will form an important part of the scheme development going forward from the next design stages and through to delivery.

Overall, the scheme at its current stage of design has looked to minimise carbon impacts whilst maximising water supply and wider environmental benefits within the region. However, there are still significant opportunities available to further mitigate the whole life emissions associated with the scheme.

As Table 6.2 shows there is significant need for a collaborative approach with a range of regional stakeholders and the supply chain to maximise the decarbonisation opportunities presented above. The nature of this engagement needs to be planned further taking into account potential barriers of meaningful and detailed engagement with the supply chain until an established procurement process is in place. This may also mean that some of this engagement activity will need to be managed by a future Competitively Appointed Provider (CAP), and consideration will need to be made on how the appointment of a CAP and associated contracts can effectively integrate carbon mitigation requirements.

As the scheme progresses to gate three and beyond, it is expected more mitigation measures will be embedded into the scheme design and costing and a detailed offsetting plan to cover the remaining residual emissions will be developed. The scheme carbon assessments will continue to be updated as the design evolves.

