RAPID Gate Three
Strategic Resource Option – Hampshire Water Transfer and Water Recycling Project

Supporting Annex 8A: Solution Cost & Benefits

July 2024

Contents

8. Solution Cost & Benefits

8.1 Introduction

Following on from the Gate Two submission to RAPID, SW has undertaken additional work analysing the feasibility and viability of HWTWRP as part of the wider Water for Life Hampshire (WfLH) programme. This Annex sets out the cost estimate based upon the current design and analysis completed to date for both Preferred and Backup Tunnel Options (described in Chapter 2: Solution Design) describing the approach, assumptions and outcomes to determining solution costs.

In addition, this Annex demonstrates the selection of the solution as part of the WRMP and regional best value planning process, setting out the methodology and assessment that has taken place to determine HWTWRP as the Preferred Option. This includes a full summary of the best value scores for the solution consistent with that used in Water Resources South East (WRSE) investment models.

8.2 Solution Cost

As described in Chapter 2: Solution Design, the solution has evolved since Gate Two. The changes from Gate Two that have been considered for the cost estimates are as follows:

- The Water Recycling Plant (WRP) maximum capacity has increased from 15 Ml/d to 60 Ml/d;
- Two tunnel options are being developed for the transfer between the WRP and Havant Thicket Reservoir (HTR) (see Chapter 2: Solution Design);
- The High Lift Pumping Station (HLPS) is now located at the WRP site;
- The transfer capacity from HTR to Otterbourne WSW has increased from 75 Ml/d to 90 Ml/d, with the associated pipeline route and HLPS design being further developed;
- The length of tunnelling has increased from circa 1km to circa 6km; and
- The number of Intermediate Pumping Stations (IPS) has increased from 1 to 3.

A summary of the CAPEX for each of the HWTWRP options has been determined including risk and Optimism Bias (OB) (Table 8-1).

Table 8-1 - CAPEX costs for HWTWRP tunnel options including risk and OB

Options (CAPEX £m)	HWTWRP		Price Base (PB)
	Preferred Tunnel Option	Backup Tunnel Option	
Gate One	458		17/18
Gate Two	451		17/18
Gate Three	1040.91	1172.66	17/18
Gate Three	1227.95 (including 81.7 for PW)	1383.36	22/23 (PR24)

The costs relating to alignment works within Portsmouth Water's contracts for the Preferred Tunnel Option are £81.7m (22/23 PR24) and have been included within the CAPEX estimate.

8.3 Overall Costs of Construction and Operation

The overall CAPEX and OPEX, NPV and AIC values have been calculated in 2022/23 price base (Table 8-2). The whole-life cost estimates have been assessed over 80 years as consistent with the All Company Working Group (ACWG) guidance. This is consistent with the approach used to determine whole-life carbon costs (Chapter 5: Carbon) and has been separated into the following key periods:

- A four-year planning period prior to construction (2025-2028);
- A five-year construction period (2029 – 2033); and
- A 71-year operation period (2034– 2104).

The Net Present Value (NPV) and Average Incremental Cost (AIC) values for each of the two tunnel options (WRP to HTR) and the onward transfer to Otterbourne WSW (HTR to Otterbourne WSW) have been calculated using the maximum, average and minimum flows. These have been chosen represents the range of flows that are to be expected through the 80-year operating period of the HWTWRP.

Table 8-2 - HWTWRP CAPEX and OPEX Totals, NPV and AIC values (cost base PR24 2022/23)

Tunnel Option	Option component	Operating Regime	Flow (Ml/d)	CAPEX (£m)	OPEX (£m/year)	NPV (£m)	AIC (£/m^3)
Preferred	WRP to HTR Transfer	Min	10	599.6 (including 81.7 for PW)	5.51	646	1.48
		Average	30		8.25		
		Max	60		15.05	839	1.92
	HTR to Otterbourne WSW Transfer	Min	20	628.3	3.66	533	0.81
		Average	30		4.79		
		Max	90		11.21	685	1.05
Backup	WRP to HTR Transfer	Min	10	663.1	5.56	687	1.57
		Average	30		8.30		
		Max	60		15.10	880	2.01
	HTR to Otterbourne WSW Transfer	Min	20	720.2	3.82	601	0.92
		Average	30		4.96		
		Max	90		11.37	754	1.15

8.4 Detail of Capital Expenditure

The CAPEX breakdown for HWTWRP Preferred and Backup Tunnel Options have been determined and separated as consistent with that presented at Gate Two (Table 8-3).

Table 8-3 - Capital expenditure breakdown for both HWTWRP options as per cost item

Cost Item	HWTWRP Gate Two Estimate (£m) Base Q2 '21	HWTWRP WRMP Estimate (£m) Base Q2 '21	HWTWRP Preferred Tunnel Option Gate Three Estimate (£m) Base Dec '23	HWTWRP Backup Tunnel Option Gate Three Estimate (£m) Base Dec '23
Infra total	105.18	258.44	329.88	404.13
Non-infra total	51.80	106.77	190.01	190.01
Net direct costs (including uncertainty)	**156.98**	**365.21**	**519.89**	**594.13**
SW Contractor Indirect Costs	51.59	109.47	155.86	178.12
Contractor Total (Excluding Risk)	**208.57**	**474.68**	**675.76**	**772.26**
Additional Project Costs				
Land	8.13	127.03	21.16	21.16
DNO	4.05		4.28	4.28
Pilot Projects	9.72		Inc. in Client Costs	Inc. in Client Costs

Planning	5.76			
Public Consultation	0.90			
Legal	5.99			
Environmental	2.70		6.00	6.00
SW Client Indirects	25.92	52.14	148.55	148.55
CAPEX Subtotal	**271.74**	**653.85**	**855.75**	**952.25**
Risk (from developed risk register)	129.85	149.12	242.18	287.46
Optimism Bias	89.40	156.27	204.52	227.59
Option Project Costs (Subject to AACE Class 4 Accuracy Range)	**490.99**	**959.24**	**1,302.45**	**1,467.29**
Option Project Costs (Index Adjusted)	**451.29**	**943.89**	**1,227.95**	**1,383.36**
	Gate Two Price Base Q2 '21 adjusted to 17/18	**Gate Two Price Base Q2 '21 adjusted to Q3 '20**	**Gate Three Price Base Dec '23 with Indexation to align with PR24 Price Base 22/23 -5.7%**	

8.4.1 Preparation of the CAPEX Estimate

A summary of the process undertaken to prepare the CAPEX estimates for the HWTWRP tunnel options is as follows:

- Appraisal of the Preferred and Backup Tunnel Options by the estimating team with design leads to obtain understanding of scope and known constraints. Discipline specific design and estimating leads appointed to enable the collaborative production of estimates covering the infrastructure, non-infrastructure and tunnelling specific elements of scope;
- Production of scope documents aligned to SW's process drivers (by the design team), to enable the scope to be represented as a Cost Breakdown Structure (CBS) in order to be priced by the cost team;
- Estimating of direct costs for each Option from a combination of SW and Industry data supported by first principles estimating of the pipeline and tunnels elements;
- Estimates combined into comprehensive priced schedule of works;
- Estimates reviewed by design leads to ensure that the scope had been correctly interpreted;
- Risk registers collaboratively populated and costed with relevant SMEs;
- Contractor indirect cost allowances calculated from SW's percentage uplifts to align with PR24 allowances;
- Additional project costs reviewed with SMEs with external assistance from statutory undertakers Scottish and Southern Electricity and SW's Land Management and Environmental Consultants;
- Costs are based upon the updated allowance for land take and associated costs;
- Client costs calculated from SW's actual and forecast cost to align with PR24 allowances;
- OB calculation collaboratively populated with relevant SMEs in accordance with the ACWG 3 stage approach;
- Costs tested collectively to mitigate against gaps in known data or double counting between base cost, risk, and OB;
- In order for the estimates to align to the PR24 submission to Ofwat all costs have been indexed.
- Currently all costs are indexed to average 2022 / 23;
- The Gate Three cost and carbon estimate considers the net costs for the construction and management of the HWTWRP. These costs do not include for the potential lending fees, and interest incurred in terms of borrowing to finance the development and operation of the asset; and
- The price base is the average of 12 months of index, with a mid-point of end September. The factors for each year are April – March averages. Ofwat changed the basis of indexation in April 2020 to Consumer Prices Index Including Owner Occupiers' Housing Costs (CPIH). This provides an indexation from price base dates (December 2023) to PR24 dates 2022/23 of -5.7%. CAPEX costs and estimate structure provided to align with the production of OPEX, NPV and AIC summaries for each Option.

8.5 Detail of Operating Expenditure

Operating expenditure (OPEX) estimates have been prepared for both Preferred and Backup Tunnel Options in 2022/23 prices. OPEX estimates have been derived for the flow regimes and option components presented in Table 8-1. The calculations assume that first year of OPEX is assumed to occur in year 9, commencing in April 2034 and consistent with the "operational ready" date, following completion of commissioning (see Chapter 6: Programme and Planning for the latest project schedule).

The OPEX estimates cover operating staff, operational maintenance, chemical consumption and power consumption. Both tunnel options have similar OPEX as they have the same treatment and pumping components and only differ in the extent of pipelines and tunnels. Hence, both options have the same power and chemical consumption (the main OPEX components) but have a small difference in their operational maintenance costs.

As consistent with minimum, average and maximum flows listed. The average flows (Table 8-4) will occur during the period prior to commissioning of the SRO Thames to Southern Transfer (T2ST) project. However, once the T2ST project is commissioned it is envisaged that the WRP will normally operate at 60 Ml/d and the maximum expected transfer flow from HTR to Otterbourne will reduce to 80 Ml/d.

OPEX estimates have been divided in to fixed and variable costs. Fixed OPEX comprises operational maintenance and operating staff costs, whereas variable OPEX comprises power costs (for treatment and pumping) and chemicals used in treatment.

Fixed OPEX: Operational staff costs are based on expected staffing levels for the various assets and typical 'all-in' hourly unit costs for different types of staff. Annual operational maintenance costs are calculated as a percentage of initial CAPEX. These percentages are based on values used for estimates for similar types of assets on other SROs. Civil maintenance was calculated as 0.3% of the Infra and non-infra civil CAPEX whilst Mechanical and Electrical (M&E) maintenance was calculated as 1.5% of Infra and non-infra M&E costs.

Variable OPEX: Chemical and power OPEX estimates are both based on consumption quantities provided by SW's design teams for the above flow regimes. Unit costs for chemicals were taken from SW's OPEX tool where available or from industry data. SW has provided a power tariff forecast which shows power tariffs increasing from 13.6p/kWh in 2022/23 to 26p/kWh in 2025/26 and continuing at that level to AMP 9 (when the project is intended to become operational). This rate of increase in power costs from 2022/23 to 2025/26 (and to AMP 9) is greater than general inflation (based on CPIH). As power costs are a significant proportion of the total OPEX estimates, it was considered prudent to use the 26p/kWh value predicted from 2025/26 but deflated to 2022/23 prices. As there are forecasts (to 2027) for Consumer Price Index (CPI) but not CPIH SW have deflated the 2025/26 value to 2022/23 using CPI. SW consider that this is acceptable as CPIH and CPI share approximately 84% the same basket of goods and historically track very closely to each other. The resultant 2022/23 power tariff used in the analysis is 23.8p/kWh.

Table 8-4 - Summary of fixed and variable OPEX by option and flow regime

Tunnel Option	Component	Operating Regime	Flow (Ml/d)	Fixed OPEX (£m/year)	Variable OPEX		Total Component OPEX (£m/year)	Total Option OPEX (£m/year)
					£m/year	£/Ml		
Preferred	WRP and Transfer to HTR	Min	10	3.45	2.06	565	5.51	Minimum
		Average	30	3.45	4.80	438	8.25	9.17
		Max	60	3.45	11.60	530	15.05	Average
	Transfer from HTR to Otterbourne	Min	20	1.38	2.28	312	3.66	13.04
		Average	30	1.38	3.41	312	4.79	Maximum
		Max	90	1.38	9.83	299	11.21	26.26
Backup	WRP and Transfer to HTR	Min	10	3.50	2.06	565	5.56	Minimum
		Average	30	3.50	4.80	438	8.30	9.38
		Max	60	3.50	11.60	530	15.10	Average
	Transfer from HTR to Otterbourne	Min	20	1.54	2.28	312	3.82	13.25
		Average	30	1.54	3.41	312	4.96	Maximum

		Max	90	1.54	9.83	299	11.37	26.47

Table 8-5 - Comparison of previous gateway OPEX values for Maximum flows

Component	Operating Regime	Units	Gate One PB 17/18	Gate Two PB 17/18	Gate Three PB 17/18	Gate Three PB 22/23
WRP to HTR	Min	Ml/d	6	7.5	10	10
	Average	Ml/d		7.5	30	30
	Max	Ml/d	16	15	60	60
HTR to Otterbourne WSW	Min	Ml/d		7.5	20	20
	Average	Ml/d		7.5	30	30
	Max	Ml/d	61	75	90	90
Total Option OPEX		**£m/year**	**9.95**	**5.84**	**21.91**	**26.26**

It can be seen that there has been a significant rise in OPEX between Gate Two and Gate Three. The drivers for this increase can be attributed to:

- The increase in maximum flow for the WRP (15 Ml/d to 60 Ml/d) which will result in corresponding increase in power, chemicals and operational maintenance costs;
- The increase in maximum flow for the transfer to Otterbourne WSW (75 Ml/d to 90 Ml/d) which will result in an increase in power costs;
- Change in electricity tariff. The Gate Two power costs were based on 12p/kWh whereas a tariff of 23.8p/kWh has been used for Gate Three estimates. The higher tariff is based on current SW forecasts which indicate prices will rise to around 26p/kWh from 2025/26 and then stay at similar levels for the foreseeable future;
- Change in chemical quantities and unit costs. Design development for the WRP since Gate Two has resulted in the need for significant additional chemical dosing (including both the previously identified chemicals but also additional chemical types). Furthermore, chemical unit costs have increased significantly over the last few years, at a higher rate than CPIH; and
- The change in price date (CPIH has increased by 18% from 2017/18 to 2022/23).

Where some revised cost assumptions have resulted in cost reductions (e.g. lower staffing level assumptions for the WRP) these reductions have been relatively insignificant compared to the increasing costs listed above.

8.6 Estimating Uncertainty, Risk and Optimism Bias

Following the development of the base cost (direct costs), consideration must still be given to the remaining uncertainty contained within both the pricing assumptions (e.g., assumed unit rates) and the design assumptions (e.g., assumed ground conditions).

In order to account for these risks, all assumptions made during the design and estimating process are interrogated in formal risk workshops to determine the level of variance associated with the risk. Discussion of the assumptions between the HWTWRP design, estimating and risk team within the workshop enables each assumption to be assigned, as appropriate, to one of estimating uncertainty, risk or OB to ensures that all these elements that need be considered within the cost estimate are fully integrated and considered to avoid either cost duplication or cost gaps. These elements are considered within the cost estimate as follows:

- Estimating Uncertainty: a percentage ranges around the component costs and productivity rates of the defined project scope which account for variance inherent in the input values;
- Risk: Discrete and specific event that has the potential to impact (positive or negative) on the achievement of the defined and agreed scope; and
- OB: A percentage uplift applied to those elements of the Project Delivery that are not sufficiently defined or understood to enable an agreed scope to be defined and therefore discrete, specific risks to be applied. This approach is ensured through the adjustment of the OB percentage utilising the information contained within the quantified risk register.

8.6.1 Estimating Uncertainty

Completion of the base cost estimates are generated through a summarisation of individual costs to an associated cost component as demonstrated in Table 8-3. Where assumptions for each cost component are identified to require an estimating uncertainty, uncertainty ranges are applied. The range applied represents either a positive or

negative percentage impact on the summarised cost. These percentages are selected by an agreement of level of confidence in the likelihood of the level of change to component cost for each option assessed. These estimating uncertainty values enable a Net Direct Cost to be generated. Where an assumption is agreed to be expressed using estimating uncertainty, they are included within the cost estimation, and then removed from the subsequent risk or optimism bias assessments to prevent duplication.

8.6.2 Risk

Where assumptions are considered to be a specific risk (threat or opportunity) to the agreed design and scope, they are captured on a quantified risk register by current probability of occurrence and range of cost impacts, estimated and agreed by the design, estimating and risk team. This process is conducted for both infrastructure and the non-infrastructure elements for each tunnel option. This ensures that a comprehensive list of discrete risks is identified and allows a fully quantified risk register to be developed based on the assumptions made during the design process.

In order to estimate the probability for each risk, the probability is assessed in a quantitative manner on a scale of 1% to 99% using group consensus during the facilitated cost risk workshop, with final approval granted by the Project Manager. This approach is in accordance with the wider Risk Management Process as contained within the SW internal Risk Management Handbook, aligning with best practice.

When estimating the range of cost impacts for each identified risk, minimum, most likely and maximum cost impacts are considered. However, it should be noted that given the level of uncertainty that remains within the tunnel options, only the minimum and the maximum costs for the current project maturity. The risks to cost identified for HWTWRP Preferred Tunnel Option (Table 8-6) and Backup Tunnel Option (Table 8-7), the risk score and potential cost impact have been determined.

Table 8-6 - Preferred Tunnel Option Risk to Cost

Asset and Risk ID	Risk	Score	Cost Impact (£m)	
			Min	Max
WRP Site - 11	There is a risk that the current pricing percentages utilised (34%) are insufficient based on the current market data (50% - 60%), leading to an increase in uplift for indirect costs.	25	75.17	90.20
HLPS to Otterbourne WSW pipeline - 30	Risk percentage uplift (41%) associated with undefined risk and uncertainty for the WRP to Otterbourne WSW Tunnelled section (WRP to Portsdown Hill Road).	25	29.70	59.39
WRP Site - 10	Owing to a number of global factors including shipping costs, import tariffs, pandemics, and other supply/demand volatility, projections are indicating significant increases in costs associated with Steel and Timber. Therefore, there is a risk that the costs associated with these items are significantly higher than assumed within the cost estimate rates, leading to an increase in the cost of the Non-Infrastructure element of the cost estimate (cost increases around pipe materials previously accounted for).	23	4.77 7.25	19.09 29.02
HLPS to Otterbourne WSW pipeline - 31	Risk percentage uplift (41%) associated with undefined risk and uncertainty for the WRP to Otterbourne WSW Tunnelled section (East of the Highbridge Road to the west side of the railway).	23	6.49 9.54	12.98 19.07
WRP Site - 7	Additional Construction Preliminary activities (schedule delay) due to weather, archaeology, ecology, Unexploded Ordnance (UXO), protesters, etc.	23	4.25 6.46	9.50 14.44
Preferred Tunnel - 23	Risk percentage uplift (41%) associated with undefined risk and uncertainty for the WRP and Risk (including settlement/heave of the A27 crossing and bridge damage for underground pipework across Mill Lane in the vicinity of the railway bridge) of pipe-jacking from WRP Site to Bedhampton Springs.	25	5.20	10.40
HLPS to Otterbourne WSW pipeline - 35	Risk that the cost of pipe materials, including bedding and surround increases significantly owing to shortages in supply from multiple pipe route schemes taking place.	8	3.30 4.85	9.90 14.55
HLPS to Otterbourne WSW pipeline - 40	Risk associated with the construction of the BPT and Pumping Stations as part of the Option.	13	6.81 10.35	6.81 10.35
WRP Site - 5	There is a risk that compensatory habitats are required in relation to the WRP. Mitigation approaches are under consideration and will be included as part of the Stage 2 Habitats Risk Assessment (HRA).	18	5.00 7.60	30.00 45.60

WRP Site - 6	Risk that additional environmental adjustments are required when reinstating. Includes for environmental net gain and habitat mitigation.	17	1.75 2.66	5.75 8.74

Table 8-7 - Backup Tunnel Option Risk to Cost

Asset	Risk	Score	Cost Impact (£m)	
			Min	Max
WRP Site – 11a	There is a risk that the current percentages utilised (34%) are insufficient based on the current market data (50% - 60%), leading to an increase in uplift for indirect costs.	25	84.41	101.29
HLPS to Otterbourne WSW pipeline - 30	Risk percentage uplift (41%) associated with undefined risk and uncertainty for the WRP to Otterbourne WSW Tunnelled section (WRP to Portsdown Hill Road).	25	29.70	59.39
Backup Tunnel - 14	Risk percentage uplift (41%) associated with undefined risk and uncertainty for the WRP to HTR Tunnelled section.	25	25.17	50.34
WRP Site - 10	Owing to a number of global factors including shipping costs, import tariffs, the coronavirus pandemic, and other supply/demand volatility, projections are indicating significant increases in costs associated with Steel and Timber. Therefore, there is a risk that the costs associated with these items are significantly higher than assumed within the cost estimate rates, leading to an increase in the cost of the Non-Infrastructure element of the cost estimate (cost increases around pipe materials previously accounted for).	23	4.77 7.25	19.09 29.02
HLPS to Otterbourne WSW pipeline - 31	Risk percentage uplift (41%) associated with undefined risk and uncertainty for the WRP to Otterbourne WSW Tunnelled section (East of the Highbridge Road to the west side of the railway).	23	6.49 9.54	12.98 19.07
WRP Site - 7	Additional Construction Preliminary activities (schedule delay) due to weather, archaeology, ecology, Unexploded Ordnance (UXO), protesters, etc.	23	4.25 6.46	9.50 14.44
HLPS to Otterbourne WSW pipeline - 35	Risk that the cost of pipe materials, including bedding and surround increases significantly owing to shortages in supply from multiple pipe route schemes taking place.	8	3.30 4.85	9.90 14.55
HLPS to Otterbourne WSW pipeline - 40	Risk associated with the construction of the BPT and Pumping Stations as part of the Option.	13	6.81 10.35	6.81 10.35
WRP Site - 5	There is a risk that compensatory habitats are required in relation to the WRP. Mitigation approaches are under consideration and will be included as part of the Stage 2 HRA.	18	5.00 7.60	30.0 45.60
WRP Site - 6	Risk that additional environmental adjustments are required when reinstating. Includes for environmental net gain and habitat mitigation.	17	1.75 2.66	5.75 8.74

The cost range are estimated using group consensus during a facilitated workshop, with final approval granted by the Project Manager. All costs are aligned with those values used in the base cost build up.

The risk to cost impacts are captured initially as direct costs only within the risk register. Indirect uplifts are then applied to the cost impacts (shown in red) to reflect the application of indirect cost percentages to ensure that the modelled risk value presented within the estimate is aligns with other capital costs (which themselves have been uplifted by indirect costs).

The cost risk inputs are then modelled using Monte Carlo simulation in accordance with the ACWG methodology. This enables a range of risk output values to be calculated, as consistent with the project schedule risk approach (see Annex 6: Programme and Planning). The P50 value being selected for inclusion within the cost estimate.

The P50 risk values for the Preferred and Backup Tunnel Options have been determined (Table 8-8), along with the risk percentage when compared to the base cost. The Gate Two base cost and risk values are included for comparison where available.

Table 8-8 - P50 risk values for both HWTWRP options

HWTWRP Tunnel Option	Gate Two Base Cost £m (Q2 '21 PB)	Gate Two P50 Percentage	Gate Three Base Cost £m (Dec '23 PB)	Gate Three P50 Value £m	Gate Three P50 Percentage
Preferred	272	48%	827	242	29%
Backup	272	48%	907	287	32%

The use of a quantified risk approach, resulting from a maturing design, has enabled a more realistic view of the cost risk profile at Gate Two and Gate Three and in this instance has resulted in a decreasing risk profile as more information is obtained through the design process.

Significant changes to the quantified risks since Gate Two are summarised as follows:

Table 8-9 Significant risk changes since Gate Two

Decreased Risk	Increased Risk
Land value for WRP site since the land purchase is imminent	Disposal of contaminated land
Budd's Farm WTW Turbidity issues requiring further pre-treatment	Extent of capping requiring remediation
Risk associated with the construction of the BPT and Pumping Stations	Owing to a number of global factors, projections are indicating significant increases in costs associated with Steel and Timber
Construction techniques changed to pipe jack technique and shortened for the WRP to BHS length	Risk around the uplift, percentages utilised (34%) that may increase to (50% - 60%) based on the current market data to allow for indirect costs, is increased by the increase in direct costs.
Extent of work to known services	Pipe materials including bedding and surround costs due to shortages
Risk associated with the WRP to Otterbourne Tunnelled section from the East of the Highbridge Road to the west side of the railway.	

In order to further reduce the risk value throughout the next stages of the project lifecycle, focus will be on information gathering and mitigation in order to manage these risks to an acceptable level.

8.6.3 Optimism Bias

The OB has been calculated following the guidance as set out in the HM Treasury Green Book Supplementary Guidance: Optimism Bias[1], ensuring the updated guidance from the ACWG was incorporated. This has ensured that the appropriate Project Type (Non-Standard Civil) has been applied and that the appropriate adjustments have been made to the OB percentages throughout the assessment. This process was again followed to update the Gate Two templates to develop the Gate Three OB allowance, maintaining traceability to the work undertaken for the previous gates.

This generated a Risk Adjusted OB percentage, and this percentage value was then applied to the estimate, excluding the previously calculated total risk value, in order to provide an overall Option Project Cost, subject to Association for the Advancement of Cost Engineering (AACE) range and Indexation adjustments.

Table 8-10 - Adjusted OB used for option forecast

HWTWRP Tunnel Option	Risk Adjusted Percentage	Value (£m)
Gate Two	32.9%	89.4 (Estimate Base Q2 '21)
Preferred	23.9%	197.65 (Estimate Base December 2023)
Backup	23.9%	216.79 (Estimate Base December 2023)

Similar to the risk value and percentage, the OB percentage has reduced from the positions at Gates One and Two, though the project value has increased and therefore the risk exposure value has increased since the previous gates. This is owing to a shift of value from OB into the quantified risk register.

[1] HM Treasure Green Book 2022

Table 8-11 - Optimism Bias changes since Gate Two

Improvements to confidence	Reduction in confidence
Contracting strategy has been developed since the last review.	Information Management is still not adequate for the size and scope of the project, with the exception of the use of MOATA and ProjectWise.
Innovation: The pilot has shown that water quality of recycled water is better than spring water.	No clarification of funding availability for Gate Three, Gate Four, or beyond Gate Four, and there is no investor in place.
Business case has been developed and improved.	Site characteristics
Stakeholder management: • Site selection has been completed and the land is in the final stages of purchase. • Landowners have been identified in readiness for engagement.	The moderately long lead time gives opportunity for economic environment to change during the project.
The project management team has grown and has improved expertise and experience.	

Whilst the Green Book recommends applying OB to CAPEX, OPEX and benefits, the Supplementary Green Book Guidance does not provide recommended upper and lower bound adjustment factors for OPEX as there is insufficient data to do so. In the absence of this information, the Supplementary Green Book Guidance recommends using sensitivity analysis to test the materiality of OPEX assumptions for investment decisions. Hence, the OPEX values presented in this report do not include OB.

8.7 Net Present Value (NPV) and Average Incremental Cost (AIC)

NPV and AIC values presented in Table 8-2 have been estimated using the costs described above (including CAPEX, OPEX, risk, OB), capital maintenance/replacement costs (see below) and the ACWG AIC template (revision G). An 80-year appraisal period has been used which is aligned with ACWG guidance (4 years for planning and development, 5 years for design and construction and 71 years of operation). Key numerical assumptions, including Weighted Average Cost of Capital (WACC) and discount rates, etc., are described in Section 8.8.

Separate NPV and AIC values have been prepared for each of the tunnel options as each component has different minimum and maximum flows.

Capital maintenance (lifecycle costs): The process undertaken to prepare the Capital Maintenance estimates for the options is as follows:

- CAPEX estimates (in 2022/23 prices) have been split by asset type and each asset type has been assigned an asset life from 4 to 100 years, using values recommended in the ACWG Cost Consistency Methodology[2]; and
- This allocation has then been used to allocate future capital maintenance/renewal costs for each asset type over the 71-year operation duration used in the NPV and AIC analysis. Capital maintenance/renewals cycles have been taken as starting in year 9 (first operating year).

8.8 Assumptions and Exclusions

The design which underpins these estimates remains at an early level of maturity, the estimate is deemed to be of AACE Class 4 accuracy (+30% / -5%). While the design work has reached 30% complete significant uncertainties remain regarding project specification and external factors such as market conditions and material pricing. It is proposed that Stage 3 later this year undertakes a process to engage with the market for key material supply packages and consider more detailed estimating of key packages (tunnelling for example) to improve the estimate classification and accuracy range.

8.8.1 Basis of Estimates

Material prices are based on December 2023 rates adjusted to PR24 22/23 utilising CPIH data and while current price volitivity is included within risk allowances no allowance has been made for future fluctuations in supply costs.

All costs are exclusive of Value Added Tax.

[2] Cost Consistency Methodology: Technical Note and Methodology, ACWG February 2022

8.8.2 Construction General

- An allowance has been included for piling, specifically for all the proposed buildings and selected process plant base slabs;
- No allowance has been made for any ground stabilisation works;
- No allowance has been made for meeting any planning or environmental costs unless advised within the estimate and risk / OB sums;
- No allowance has been made for dealing with any impact that the proposed works may have on any existing or proposed assets plant or foundations;
- The SW provided costs such as the allowances for land purchase, DNO, Public Consultations etc are taken at face value and included within the relevant estimates;
- No allowance has been made for environmental mitigations that may be required based on the outcomes of the Environmental Statement and Supporting Assessments including the Habitat Regulations Assessment unless stated within the estimate and risk / OB sums.
- No information is available as to the current ground conditions of the proposed plant;
- Process plant and pipework sizing has not yet been finalised. Allowance has been made within the risk register for limited fluctuations in sizing;
- Quantum for Bulk Earthworks Allowances for dealing with Cut / Fill / Disposal have been provided by the designers and adopted by estimating.
- All works are assumed to be carried out during normal day time working hours;
- It is assumed that the working area is not impacted in any way by hazardous working conditions with the exception of the marine works;
- It is assumed that there are no restrictions to access;
- For any materials which may be sourced from abroad, no allowance has been made for any fluctuation to these rates for exchange rate or tariff obligations;
- No additional allowance has been made for any restrictions placed on the works due to adverse weather conditions other than the factors included within the risk register for prolongation as a result of bad weather;
- As the projects are currently at concept stage no quantities have yet been finalised thus all quantities assumed in the preparation of costs are indicative;
- No allowance has been made for 3rd party works such as utility upgrades or diversions and connections unless specifically stated otherwise; and
- Specialist Dewatering is excluded from the base cost. An allowance has been included within the risk values.

8.8.3 Open Cut Pipework

- Standard working hours are assumed as 50 hr week (apart from critical TM phases and continuous micro tunnelling);
- All crossings assumed to be 1200 diameter sleeve installed by micro tunnel;
- All crossings assumed to be single pipe;
- All crossings assumed to have 9 m diameter launch shafts x 9 m deep to formation;
- All crossings assumed to have 4.5 m diameter reception shafts x 9 m deep to formation – All shafts to be backfilled with imported aggregate;
- 150 mm bed and haunch in fields 30% of arisings to tip replaced with imported granular material;
- Reinstatement of open cut pipework to pre-commencement conditions within field easement;
- 150 mm bed in roads 100% of arisings to tip replaced with imported granular material;
- 25 m easement in fields;
- Stock fencing both sides of easement livestock crossing point every 300m and footpath crossing every 500m;
- Land drain crossing in fields every 20m clay stank in fields every 25m;
- Allowance has been made for a bend every 167m of route; and
- No thrust blocks required - use of anchor gaskets assumed.

8.8.4 OPEX, NPV and AIC Assumptions

Cost of water

- Water supplied from HTR has been assessed to have a zero OPEX impact.

Staff costs

- WRP assumed to require 6 operators and 2 managers, 8hr/day, 365 days a year;
- Transfer infrastructure assumed to require 1 operator, 8hr/day, 365 days a year;
- Hourly rates for various grades of operational staff taken from SW OPEX calculating tool.

Chemical costs

- Chemical volumes supplied by SW design teams for the water recycling plant;
- Costs for chemicals taken from SW OPEX tool where available and provided by Mott MacDonald where unavailable. Where chemical costs were only available for concentrations other than those specified, the price was pro-rated accordingly.

Power

- Power quantities for treatment and transfer assets provided by SW's design teams;
- An 'all in' average electricity price of 23.8p/kWh based on SW forecasts for 2025/26 onwards (26p/kWh) deflated to 2022/23

Operational maintenance

- Civil maintenance is calculated as 0.3% of the Infra and non-infra civil costs per year;
- M&E maintenance is calculated as 1.5% of Infra and non-infra M&E costs per year.

These percentages are lower than those used at Gate Two (0.5% and 2.5%, respectively) and are considered to give a more realistic indication of likely operational maintenance expenditure given the change in option scopes and scales since Gate Two.

NPV and AIC calculations assumptions

- All NPV and AIC estimates are based on operation commencing in Year 9 (from April 2034). Both fixed OPEX and the unit variable OPEX rate (£/Ml) are assumed to remain the same both before and after the T2ST enters operation, which is assumed to occur in 2040;
- WACC assumed to be 2.92%. Discount rates are as per the HM Treasury Green Book;
- Land, planning and development costs are split over the first 4 years, and construction costs are split 20:30:25:15:10 over years 5-9. The construction duration has been increased from the 4 years used at Gate Two, to 5 years, in line with the increase in project scope;
- Client On costs have been spread over the development and construction costs. Over the construction period it's been assume at 20% of the development period. This estimate will be reviewed once the commercial requirements of the contract are known and could significantly increase. Assumed to be included in risk of on-cost increases;
- For the Preferred Tunnel Option, the contribution to the alignment works delivered by PW's has been spread over years 2,3 and 4 in the NPV model;
- Capital maintenance (lifecycle costs) is based on asset lifetimes provided in the ACWG guidance; and
- NPV and AIC estimates have been produced using the ACWG AIC template (Revision G).

8.9 Environmental and Water Quality Mitigations

As described within Chapter 4: Environmental, SW has committed to contribute to and enhance the natural environment by providing meaningful net gains for biodiversity. Landscape design proposals will seek to deliver the best outcomes for biodiversity and achieve the greatest proportion of the project-level Biodiversity Net Gain (BNG) commitment as practicably feasible. Biodiversity and environmental net gain are part of the principles for design and have underpinned the maturity of the HWTWRP since the Gate Two Submission. An Outline Environmental Masterplan showing potential zones for biodiversity and environmental enhancement will be presented as part of the Statutory Consultation.

A mitigation hierarchy approach is applied throughout the development process. In the first instance, avoidance is considered to ensure that losses are minimised, particularly in relation to protected habitats and species, and habitats of very high value and distinctiveness.

The Environmental Impact Assessment and the Outline Environmental Masterplan are still in development and will be updated following Statutory Consultation and further engagement with landowners and third parties. At this stage, the impacts on Biodiversity and Environmental Net Gain and associated costs for any enhancement measures that may be required, are not fully known. Given this, a cost allowance of £6m has been included at this stage which has been calculated on the basis of purchasing Statutory Biodiversity Units at a rate of £42k per

Biodiversity Unit. This is an estimate cost based on a high-level calculation of the potential biodiversity loss and may vary during the further assessment work required as part of the Environmental Statement.

This cost estimate takes the worst-case approach in terms of approach to offsetting biodiversity impacts; however SW will adhere to the mitigation hierarchy whereby impacts to biodiversity are avoided or minimised, and on-site areas of biodiversity are retained and enhanced wherever possible.

Where BNG cannot be delivered on-site, the net gain requirement shall be delivered off-site (offsetting). Where offsetting is required, the focus will be on identifying any Local Nature Recovery Strategies, Biodiversity Opportunity Areas (BOAs) and partnering with existing organisations including wildlife groups and local councils to ensure needs of the local area are met in accordance with any local strategies in place at the time.

At this stage there is no expectation for any Compensatory Habitat to be required, but as environmental assessments are not yet complete at this stage, the cost of mitigation measures and wider environmental enhancements and additional net gain is not known in terms of scale and cost.

8.10 Cost Methodology

The estimates have been prepared in line with relevant guidance requirements and methodologies.

The approach to calculating the NPV and AIC values has followed ACWG guidance to ensure consistency in the calculation of NPVs and AICs across all SROs. This includes process aligned with HM Treasury Green Book. As recommended by the ACWG, the NPV and AIC values have been estimated over an 80-year period (comprising 4 years for planning and development, 5 years for construction and 71 years for operation).

The OB assessment approach was aligned to the HM Treasury Green Book Supplementary Guidance: Optimism Bias and the latest guidance from the ACWG to enable consistency of OB assessments across all SROs Therefore, whilst the OB assessment process undertaken at Gate Two was initially used, the recent process has ensured that all subsequent guidance has been appropriately incorporated prior to the values being submitted as part of the Gate Three submission. Estimates have been developed in line with WRSE guidance where appropriate.

8.11 Cross-comparison of Updated Solution Costs as Tested in Regional or National Modelling

The updated solution costs based on the developed scope for Gate Three have increased against the more recent estimates used in SW's upcoming revised draft WRMP (Table 8-3). The key scope changes are the reduction in tunnelling for the HWTWRP Preferred Tunnel Option, however, this is countered by the material cost increases and the increase in tunnelling along the pipe transfer route, notably under the river Itchen and main railway.

8.12 Scalability Tipping Points

The current design does not allow for any scalability assessments due to the WRP capacity of 60 Ml/d and is consistent with the availability of Final Effluent from Budds Farm WTW during a drought event.

8.13 Cost Uncertainty and Volatility

Solution owners can reflect on costs uncertainty and volatility given changing input prices such as energy and can discuss these in checkpoints in the run up to Gate Three submission. Section 8.6 has set out the approach taken to applying uncertainty and assessing the risk to cost for each tunnel option.

8.14 Best Value and Solution Benefits

As described in Chapter 8: Solution Costs and Benefits, the HWTWRP has been assessed against the Best Value Metrics determined and agreed by the WRSE and member companies[3]. The Best Value Plan considers a range of financial and non-financial metrics that provide a broader account of value that the regional plan would provide. The options presented are assessed against the following key criteria:

- Meeting the supply/demand balance for both public water supply and the future needs of other sectors;
- Meeting Leakage reduction targets set out by the WRPG;
- Considering reductions in water use in line with the WRPG;
- Accounting for customer priorities and preferences;
- Strategic Environmental Assessment (SEA) criteria;
- Increasing Natural Capital (NC) in line with the Governments 25-year Environment Plan;

[3] WRSE Developing our 'Best Value' multi-sector regional resilience plan February 2021

- Reducing abstraction from sensitive water sources in line with environmental destination plans;
- Improving biodiversity in line with the WRPG;
- Achieving net zero carbon emissions by 2030;
- Drought resilience requirements set out by the National Infrastructure Strategy;
- Resilience reliability;
- Resilience adaptability;
- Resilience evolvability;
- Programme cost; and
- Inter-generational equity.

The unconstrained option list identified as part of the SW's WRMP development were assessed against these metrics to enable determination of the best value and preferred options list. The HWTWRP is an integral option that contributes to the broader benefits that would be provided by HTR however has been assessed as part of the best value plan for both WRP and the transfer to HTR, and the transfer from HTR to Otterbourne WSW (Table 8-12). Where the solution has been identified to not provide a benefit, the score for the given metric is excluded.

Table 8-12 - The HWTWRP Best Value metric scores

Component	Best Value Planning Metric	Unit	Score
WRP to HTR Transfer (60 Ml/d)	Biodiversity Net Gain	BNG Unit	-122.7
	Natural Capital	£/year	-54.86
	NC: Air Pollutant Removal	£/year	0
	NC: Carbon Storage	£/year	-33.37
	NC: Food Production	£/year	0
	NC: Natural Hazard Management	£/year	-21.49
	NC: Water Purification	Score (-1 to 1)	-1
	SEA Benefit Effect	Score (0 to 99)	9
	SEA Benefit: Air	Score (0 to 16)	0
	SEA Benefit: Biodiversity Flora and Fauna	Score (0 to 16)	0
	SEA Benefit: Carbon	Score (0 to 16)	0
	SEA Benefit: Climatic Factors	Score (0 to 16)	1
	SEA Benefit: Flood Risk	Score (0 to 16)	0
	SEA Benefit: Historic Environment	Score (0 to 16)	0
	SEA Benefit: Landscape	Score (0 to 16)	0
	SEA Benefit: Material Assets	Score (0 to 16)	0
	SEA Benefit: Minimise Waste	Score (0 to 16)	0
	SEA Benefit: Population and Human Health	Score (0 to 16)	0
	SEA Benefit: Soil	Score (0 to 16)	0
	SEA Benefit: Tourism and Recreation	Score (0 to 16)	0
	SEA Benefit: Water Resource	Score (0 to 16)	0
	SEA Benefit: Water Supplies	Score (0 to 16)	8
	SEA Negative Effect	Score (-99 to 0)	-54
	SEA Negative: Air	Score (-16 to 0)	-2
	SEA Negative: Biodiversity Flora and Fauna	Score (-16 to 0)	-12
	SEA Negative: Carbon	Score (-16 to 0)	-1
	SEA Negative: Climatic Factors	Score (-16 to 0)	0
	SEA Negative: Flood Risk	Score (-16 to 0)	-8
	SEA Negative: Historic Environment	Score (-16 to 0)	-2
	SEA Negative: Landscape	Score (-16 to 0)	-5
	SEA Negative: Material Assets	Score (-16 to 0)	-4
	SEA Negative: Minimise Waste	Score (-16 to 0)	-1

	SEA Negative: Population and Human Health	Score (-16 to 0)	-5
	SEA Negative: Soil	Score (-16 to 0)	-4
	SEA Negative: Tourism and Recreation	Score (-16 to 0)	-5
	SEA Negative: Water Resource	Score (-16 to 0)	-5
	SEA Negative: Water Supplies	Score (-16 to 0)	0
HTR to Otterbourne WSW Transfer (90 Ml/d)	Biodiversity Net Gain	BNG Unit	-180.8
	Natural Capital	£/year	-468.84
	NC: Carbon Storage	£/year	-295.85
	NC: Food Production	£/year	0
	NC: Natural Hazard Management	£/year	-172.99
	NC: Water Purification	Score (-1 to 1)	-1
	SEA Benefit Effect	Score (0 to 99)	8
	SEA Benefit: Air	Score (0 to 16)	0
	SEA Benefit: Biodiversity Flora and Fauna	Score (0 to 16)	0
	SEA Benefit: Carbon	Score (0 to 16)	0
	SEA Benefit: Climatic Factors	Score (0 to 16)	0
	SEA Benefit: Flood Risk	Score (0 to 16)	0
	SEA Benefit: Historic Environment	Score (0 to 16)	0
	SEA Benefit: Landscape	Score (0 to 16)	0
HTR to Otterbourne WSW Transfer (90 Ml/d)	SEA Benefit: Material Assets	Score (0 to 16)	0
	SEA Benefit: Minimise Waste	Score (0 to 16)	0
	SEA Benefit: Population and Human Health	Score (0 to 16)	0
	SEA Benefit: Soil	Score (0 to 16)	0
	SEA Benefit: Tourism and Recreation	Score (0 to 16)	0
	SEA Benefit: Water Resource	Score (0 to 16)	0
	SEA Benefit: Water Supplies	Score (0 to 16)	8
	SEA Negative Effect	Score (-99 to 0)	-28
	SEA Negative: Air	Score (-16 to 0)	-4
	SEA Negative: Biodiversity Flora and Fauna	Score (-16 to 0)	-4
	SEA Negative: Carbon	Score (-16 to 0)	-2
	SEA Negative: Climatic Factors	Score (-16 to 0)	0
	SEA Negative: Flood Risk	Score (-16 to 0)	-1
	SEA Negative: Historic Environment	Score (-16 to 0)	-1
	SEA Negative: Landscape	Score (-16 to 0)	-1
	SEA Negative: Material Assets	Score (-16 to 0)	-4
	SEA Negative: Minimise Waste	Score (-16 to 0)	-1
	SEA Negative: Population and Human Health	Score (-16 to 0)	-1
	SEA Negative: Soil	Score (-16 to 0)	-1
	SEA Negative: Tourism and Recreation	Score (-16 to 0)	-4
	SEA Negative: Water Resource	Score (-16 to 0)	-4
	SEA Negative: Water Supplies	Score (-16 to 0)	0

8.15 Changes in RAPID costs from Gate Two to Gate Three

As detailed in Annex 8C: Interim Update (shared with RAPID in May 2023), SW had identified errors in the Gate Two submission regarding the Gate Three expenditure identified at the time.

During the Gate Three window, a series of changes were made resulting in a difference from that published at Gate Two to the values included in this submission. Below is a description of these changes, highlighting where in this submission further details can be found. All costs are in 17/18 prices.

8.15.1 May 2023 Interim Update - Scope Changes and Gate Three Guidance Updates

The Gate Two submission (including Gate Three forecast) was submitted prior to RAPID Gate Three guidance being made available to the industry in August 2022. On receipt the guidance provided clear direction that some activities forecast in Gate Four, should be 'reprofiled' into Gate Three, and that there was an expectation for further 'new' activities not previously identified or forecasted.

Once the guidance was received, a full activity review was completed to analyse impacts to HWTWRP schedule and cost (Figure 8-1). As described in Section 5 of Annex 8C: Interim Update, this was a collaborative analysis conducted in workshops with Portsmouth Water. The reprofiled activities generated an increase of £7.8m. Similarly, the 'new' activities produced an additional increase of £5.1m. In total, assimilating the Gate Three guidance resulted in an increase of £12.87m over and above the Gate Three forecast presented at Gate Two. When added to the corrected estimate from Gate Two, resulted in a forecast of £45.52m, as reported to RAPID in December 2022.

The change in scope for the SRO from that described at Gate Two to Gate Three are detailed in Chapter 2: Solution Design, as relates to maintaining alignment with WRSE Regional plans and the upcoming revised draft WRMP24 together with the identification of the Preferred Tunnel Option.

In February 2023, the works on the WRP changes were completed, identifying a further £5.08m increase to carry out Gate Three activities which also increased the Gate Three window by 5 months to March 2024. These are further detailed, as understood at the time, in the Annex 8C: Interim update where they had first been identified and shared with RAPID in May 2023.

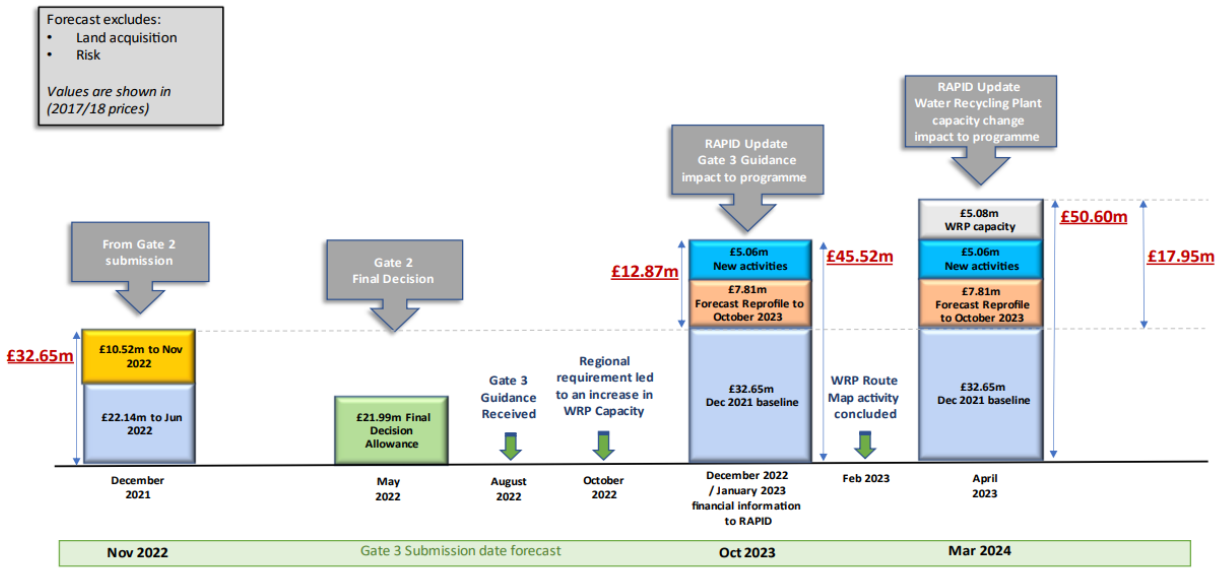

Figure 8-1 - Expenditure Timeline from Gate Two to Interim Update (December 2021 to May 2023)

8.15.2 Summary Position as of May 2023 (Annex 8C: Interim Update)

- Early Gate Three expenditure (£3.21m) as reported in Annex 6, Table 14, of the Gate Two submission[4];
- Gate Three expenditure since the Gate Two submission (£27.64m);
- Newly identified expenditure (£17.95m) resulting from Gate Three guidance, Alignment activities and WRP activities;

[4] HWTWRP RAPID Gate 2 Submission Annex 6: Efficiency of Expenditure

- Inclusive of Option B.5 costs (£1.8m);
- Total of £50.6m.

Please note that the initial Gate Three guidance required a breakdown to under £250k granularity, this has been superseded by more recent guidance (v3) which requires a breakdown to under £500k.

8.15.3 May 2023 to (end) March 2024

- The costs for Option B.5 (the Backup Tunnel Option suspended during Gate Three to prevent inefficient spend – detailed in Annex 8C: Interim Update) are removed from the HWTWRP Gate Three forecasts - reduction of £1.8m;
    - These Gate Three costs are requested separately (together with Desalination Gate Three costs) from the HWTWRP submission in the Gate Three cover letter;
- In July 2023, the HWTWRP team carried out a deep dive on forecasted costs and shared this with RAPID as part of the Gate Three financial review which resulted in a decrease of projected costs to £45.94m;
- October 2023 – identification of early Gate Four activities and removal of activities and associated costs into Gate Four forecasts – reduction of £4.34m from Gate Three and addition of the same to Gate Four forecasts;
- Total of £41.6m.

In March 2024 RAPID confirmed a revised Gate Three allowance of £40.6m (Figure 8-2).

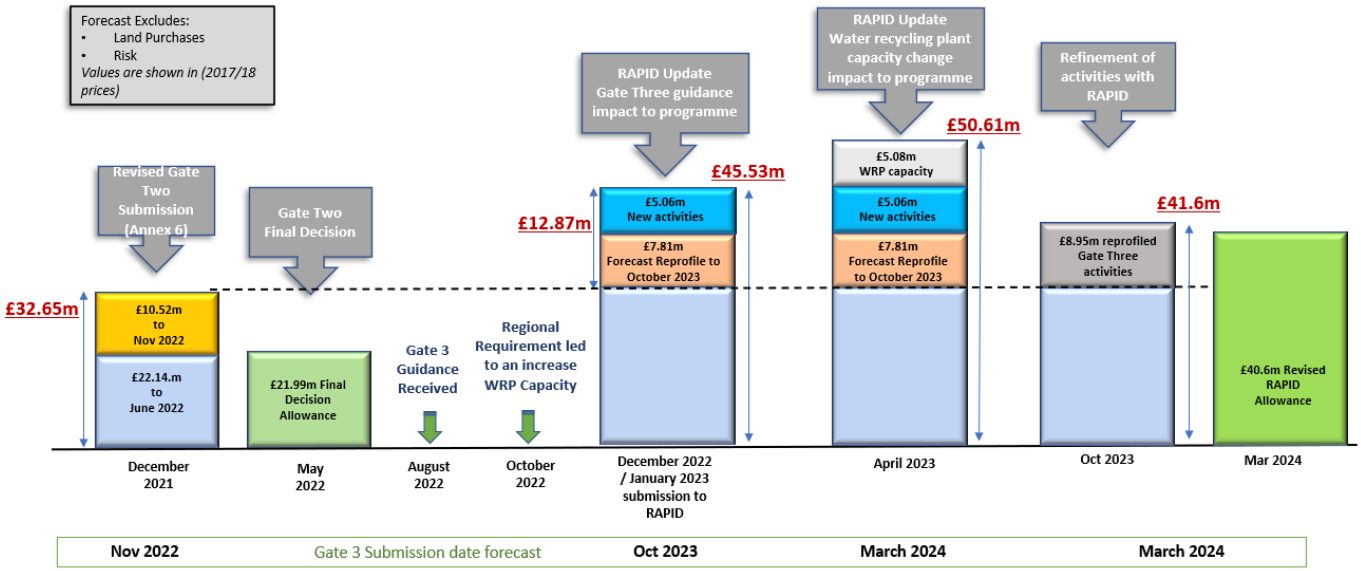

Figure 8-2 - Expenditure from Gate Two to Gate Three (December 2021 to March 2024)