

Ref 5.8E.1

Cwm Taf Water Supply Strategy Review Sept 2017 to April 2018

September 2018





SEWCUS NORTH WTW REVIEW

Merthyr WTW Business Case

Solution Assessments – Methodology and Progress

DCWW REF : B&V DOCUMENT : **122459-BVL-ZO-SS-RP-Z- 00001**

Dŵr Cymru Welsh Water

September 2017 to April 2018





SEWCUS North WTW Review

A review of the SEWCUS North WTW proposal was undertaken between September 2017 and April 2018. The purpose of the review was to scrutinise information collated during previous assessments and the potential solutions identified within a number of reports.

The review considered all assessments and investigations carried since the potential options for investment were first recognised and highlighted during the PR14 business planning period. The initial options identified during PR14 have been enhanced during PR19 to encompass a wider range of prospects for asset performance improvement and increased operational efficiency.

The proposed solutions were examined alongside a wide range of water quality parameters as well as customer expectations and customer affordability, all of which embrace the vision and forward planning identified in "Welsh Water 2050".

1. PR14 and PR19 timeline (2012 to 2016)

PR14 - Following the assessment of investment requirements at three water treatment works during 2011/2012 – Pontsticill, Llwynon and Cantref WTWs - a high level cost comparison was carried out to determine the viability of a single new works to replace the three existing treatment works. The comparison concluded a single new works was a viable proposition but the assessment would benefit greatly from a more detailed assessment of operating costs. This information was captured within the draft SEWCUS Review Document Rev11 Pont GAC report (Ref 1).

PR19 - During 2015 two further assessments were undertaken, 2015-15-05 DCWW Superworks Feasibility Study Report (Ref 2) and 2015-19-10 DCWW Feasibility Extension Report Final Issue (Ref 3) and Extended Study Cost summary v8.2 costing spreadsheet (Ref 4). Which considered solution options to build a new treatment works for three different scenarios to replace 3, 5 or 8 existing sites, or, to retain, maintain and enhance those existing sites. The 8 works scenario was removed from consideration because it was not cost beneficial.

The costs generated for the remaining two scenarios, 3 and 5 WTWs were then externally benchmarked and reviewed in 2016 within the Unit Cost Benchmarking - Merthyr Super-Works (September 16) report (Ref 5). The Cwm Taf Strategic Water Supply project had reached a stage where the remaining solution options were to build a new treatment works for two different scenarios to replace 3 or 5 existing sites, or, to retain, maintain and enhance those existing sites.

In July and August 2017 a further assessment was undertaken to review potential sites for a new WTW, including 24 hours storage. The findings within the Merthyr Land Purchase Study Report (Ref 6) indicated that Site 3, see Figure 1 below was the most suitable location for the new WTW.

1.1. Overview of the Black and Veatch Review

Following the site assessment for this this project a comprehensive review by Black and Veatch of the Cwm Taf Water Supply Strategy was undertaken to confirm the scope and cost for both scenarios, to construct a new WTW and to maintain the existing the 3 and 5 WTWs.

The Black and Veatch review has consisted of the following elements;



- Review the scope of the new WTW and the storage capacity of the Treated Water Tank
- Define the scope of the required raw and clean water pipelines
- Develop costs of the WTW, storage tank and pipelines
- Challenge the UCD cost models
- Confirm the most suitable location for the works
- Identify any potential risks and opportunities with regard to scope and cost (geology, planning, land ownership, terrain, cost models etc).
- Formulate high level outline designs to review hydraulic requirements
- Undertake geological assessments of existing WTW sites and a desktop assessment of proposed location and pipeline routes.
- Review the maintenance and enhancement requirements for the existing sites to maintain their operational status
- An additional review of the WTW production capacity was undertaken to capture the latest information from the Water Resources Management Plan
- Update and streamline the Extended Study Cost summary v8.2 costing spreadsheet (Ref 4) for the two scenarios being considered the new 3 and 5 works options or to maintain the existing sites.

The review has been undertaken in four phases between September 2017 and April 2018 which are summarised within Sections 2 to 5 below which contain updated versions of progress reports prepared by B&V during the review process. The phased approach ensured all stakeholders were party to the development of the review and agreed on the next phase of work.

The Extended Study Cost summary v8.2 costing spreadsheet (Ref 4) has been continually reviewed throughout the four stages of the review and the Merthyr Cost Summary Spreadsheet (Ref 7) has been created, see a summary of the structure in Annex D, to capture the costs associated with the Options and Scenarios for this project. A separate methodology, The Merthyr Cost Summary Methodology (Ref 8) provides an overview of the spreadsheet.

Phase 1 Review - Scope of the New Merthyr WTW, First Stage Review September 2017 to December 2017; reviewed and agreed a scope of work for the new and existing WTWs to allow costing.

Phase 2 Review - Scope of the New Merthyr WTW Second Stage Review December 2017 to January 2018; further detailed assessment of the new 5 WTW scenario against maintaining the existing sites identified that it was not cost beneficial to do.

Phase 3 review - Merthyr WTW Investigations – Stage 3 - February to 1st March 2018; agreement of the scope of the new WTW and optional processes.

Phase 4 review – Update the Merthyr WTW Cost Spreadsheet; March to April 2018; incorporate the Merthyr WTW benchmarking cost updates, review update and rationalisation of the Merthyr WTW Cost Spreadsheet to incorporate the final scope of work, benchmarked costs and the version 12 UCD costs for the new WTW and 3 existing sites.

Documented updates on progress were produced at the end of each phase identified above and circulated to stakeholders with any supplementary information. The updates provided are reproduced below.



The outcome of the review indicates a new Water Treatment works to replace 3 existing assets, Pontsticill, Llwynon and Carno WTW, to be the most cost beneficial solution.

There is potential for incorporating 2 further assets, Nantybwch and Carno at a later date if improved network connectivity can be developed, or, combining these two at Nantybwch alone.



2. Phase 1 Review - Scope of the New SEWCUS North WTW, September 2017 to December 2017

The following elements of the new water treatment works scope and storage volumes were identified for re-evaluation:

- a. Would there be a need for a separate manganese precipitation stage or could manganese removal be achieved within the Taste & Odour (GAC) removal stage?
- b. Was Ultra Violet treatment required given the upstream treatment?
- c. What was the definition of "24 hour storage" for the Treated Water Storage Tank?

For the purposes of this update, a treatment works throughput of 225 Ml/d was used as the base design figure, cost sensitivity was assessed for higher and lower flows.

Water Resources Planning Team confirmed figures for historical demand (since 1973). The figures in Table 1 below represent a summary of those historical figures which include an uplift of 14% to represent the theoretical maximum deployable output from the current assets, these are the values used in the WRMP.

	Pontsticill	Llwynon	Cantref	Nantybwch	Carno	TOTAL MI/d	
Min	35.0	11.0	0.0	0.0	2.3	84.7	
5 th %ile	40.0	11.0	0.0	0.0	2.3	103.5	
Mean	79.2	44.1	3.3	9.8	2.6	138.9	
95 th %ile	85.0	55.0	21.0	25.0	5.0	167.5	
Max	85.0	55.0	21.0	25.0	5.0	175.7	

Beyond these figures the production cannot be deployed due to network constraints.

Table 1 – Demand Figures for the existing WTW with a 14% uplift for growth

Providing a treatment works with 225 MI/d output would significantly benefit the network once improvement work has been made to deployment (network storage, pumping and main sizes).

When resilience benefits, maintenance enabling and optimisation of the cost of water, by utilising gravity sources is considered by further assessment, it may be possible to increase or decrease the 225MI/d figure prior to final design. For the purposes of this exercise 225MI/d has been selected and appears to be a reasonable basis upon which to have undertaken the assessments.

A treated water storage tank volume of 160 Megalitres has been selected which approximates to 24 hour storage at the 95% deployable output from the 5 WTWs. This also equates to 26 hours at average demand from 3 works (126MI/d for past 12 months) and approximately 24 hours average demand of the 5 works.

The decision on whether to replace 3, 5 or 8 works has at this stage confirmed the elimination of the 8-works option, due to increased cost with no discernible benefit.

The scope for the WTW has provisionally removed the manganese removal stage but will be reviewed with DCWW process scientists.

The remaining items within the treatment process scope have been assessed to establish whether the cost model for each assembly, as available from DCWW's Unit Cost Database (UCD), would reflected the scope of work envisaged for such a large works – for example COMAH regulations that might apply to the chlorine storage plant, or increased number of process streams.

For the network scope it was considered that a number of elements had not been included in the earlier assessments, but would be required:



- a. A raw water pumping station to transfer Llwynon raw water complete with infrastructure and new power supply to the pumping station site.
- b. Raw Water and Treated Water tie-ins to existing trunk mains
- c. Raw water by-passes for existing treatment works
- d. River Crossings
- e. Village supply pipework, pumping stations and infrastructure.

At this stage NO changes to the suggested network SRV storage has been included in any scope or cost.

a) Site Location

Twelve locations were investigated in previous assessments. Initially, Site Option 2 was suggested as the preferred location, see Figure 1 below. Site Option 3 was subsequently chosen, primarily because of the land availability to accommodate the 225 Ml/d treatment works and 160Ml treated water storage tank.



Figure 1 – Satellite View of Site Three

This location of Site 3 is adjacent to the Pont Sarn valve complex (northernmost point) and close to the Llwydcoed SRV feed (adjacent to site 2). Low level trunk mains from Pontsticill WTW feed the Pont Sarn valve complex and pass through Site 3, this location therefore promotes best use of existing assets (trunk mains).

This surface geology for this location indicates glacial till (boulder clay) overlying limestone (in one area to the south A465 end). A full survey will determine the thickness of the glacial till.

Glacial till will provide a good foundation material and is fairly straightforward to excavate.

The geological risk will amount to the orientation of the works within the land confines and profile together with the underlying limestone. Avoiding the location of structures straddling limestone and glacial till will limit differential settlement across the works.

The area around the proposed WTW location, where network / trunk mains would be routed, is also glacial till with areas of limestone. A risk assessment has been carried out to determine the likelihood of encountering limestone, the UCD costs for trunk mains have been confirmed as acceptable for dealing with "average" ground conditions which might include rock.



The topography of the WTW site is such that it will assist in accommodating the hydraulic profile of the works. The site has a gentle slope of some 10 metres fall, from the south-east corner to the north-west. The site is slightly higher than Site Option 2 shown above the original location adjacent to the quarry entrance which will entail more raw water pumping but this can be partly recovered by having less delivery head on treated water pumps.

A hydraulic profile was prepared to confirm compatibility with land profile.

There are environmental hurdles to overcome but this is the most advantageous location for the development of all those considered. One such hurdle in selecting this location (but also a benefit) is that the 24" and 18" from Pont Sarn /Pontsticill WTW pass through the site.

Overall, this site offers the best opportunity for the development of a new works.

b) <u>Cost</u>

Whilst the treatment stages in the overall process train have been reduced, as mentioned above, those elements which remain have been reassessed to determine whether the UCD cost models would generate a budget which would allow specific scopes of work, design features (resilience/robustness) or more arduous specifications to be accommodated.

In addition, previous and recent external benchmarking exercises have been reconsidered to determine whether the UCD will provide sufficient budget overall (planning, feasibility, environmental requirements etc). Where changes were considered applicable the amendments have been incorporated and are identified in Part 1 of Annex A, at the end of this document.

In recognition of the potential scope and specification requirements adjustments have been made to the assemblies for the three works option resulting in the following outcome:

c) <u>Cost to build at present day cost, no abandonment of existing works and no land purchase</u> <u>costs</u>

i.	225 MI/d with 160 MI/d sto	prage and network connections for 3 works
		0400

<u>Total</u>	£176m
Network	<u>£37m</u>
WIW	£138m

Land purchase previously estimated as £1.5m, abandonment estimated as £3m for three works. These costs have not been included in this section because they precede, or follow, the construction of the new works.

Note – at this stage SDT / Alliance partners were examining UCD costs for pipelines and B&V were uplifting scope for network/trunk mains to that required.

The additional infrastructure required to transfer raw and treated water from Nantybwch to Merthyr increase the network costs of the scheme:

ii. 225 MI/d with 160 MI/d storage and network connections for 5 works

Total	£211m
Network	£73m
WTW	£140m

The network cost uplift of £36m comprises:

Raw Water Main – Nantybwch to Merthyr (10km)

£17m

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Treated Water Mains –Merthyr to Nantybwch to Carno (10km) Pumping stations and network connections





3. Phase 2 Review - Scope of the New SEWCUS North WTW, December 2017 to January 2018

Please see Phase 1 above for additional information on scope and UCD adjustments.

a) Scope and Cost

Revisions to the scope of work for the treatment works together with adjustments to, and a full review of, the network / trunk mains connections has resulted in the "cost to build" figures set out in Table 2 below.

	3 Works Option	5 Works Option
Treatment Works	£138.8m	£138.8m
Network Connections	£32.5m	£60.9m
Land (Estimate)	£1.5m	£1.5m
Total Capex – Current Cost	£172.8m	£201.2m

Table 2 – WTW and Pipeline Cost to build for 3 and 5 new WTW

These figures represent the costs for design, construction and commissioning of a treatment works with a throughput of 225MI/d, together with raw and treated water connections and a treated water storage of 160MI at the treatment works. These design figures have been selected to provide the best opportunity for proceeding with a 3-works option, with the ability to extend to 5 works in the future, if required.

Consideration has been given to the figures being used by Water Resources Team in WRMP predictions. The flow of 225MI/d represents a robust throughput which would suffice for either a 3-works or 5-works scenario.

The final cost outcome is relative to the increased cost for raw and treated water network mains to incorporate the additional two works – Nantybwch and Carno. Currently, the additional network requirements for the 5 works project increases that option by £28.4m.

The costs have been generated using UCD, with adjustments based on benchmarking information for similar work, as indicated in the December 6th status update.

The cost difference between a treatment works with 225MI/d and 264MI/d is £10m. A cost reduction of 10pprox.. £7m would be generated if the works throughput were reduced to 200MI/d.

The abstraction licence limit is 242MI/d. The deployable output figure being used in WRMP is 175.7MI/d and represents the maximum flow that can be supplied before the network becomes a bottleneck.

The 160Ml onsite storage capacity is sufficient to support the 95%-ile daily flow used in WRMP (actually 167.5 Ml/d). This storage volume will therefore provide a 24 hour storage capacity for 95% of the time. It is also equivalent to 70% of the network service reservoirs volumes supplied directly by the 3 main works, which in themselves provide an average 28 hour storage.

It is recommended that 4 network service reservoirs are enhanced to provide, approximately, an additional 20MI storage. At this point each service reservoir will provide 24 hours storage in addition to the 24 hour storage at the new works; a combined 48 hour storage. The details of how the existing SRVs may be enhanced has not been included in this exercise, neither has any cost. The impact on WRMP deployable output as a result of the overall asset enhancements has not yet been submitted for assessment.

b) <u>Land</u>



Site Option 3 (Pont Sarn) has been selected to accommodate the new works. Comments on the suitability of this area were made in the previous status update. Having visited the location we feel that the terrain and topography is well suited to accommodating the new works. Geology appears acceptable with some limestone and glacial fill. No allowance has been made for encountering rock.

Land for the "Cefn Coed Pumping station (raw water from Llwynon) appears to present a problem. The area is surrounded by burial grounds and is located in a valley (potential rock). The solution is likely to be to locate the raw water pumping station to the north or south. This may incur an increase in cost through working in difficult terrain or rock. Alternative locations are being investigated.

c) <u>Programme</u>

A high level outline programme has been produced for the scheme which indicates an overall project duration of 6.5 years.

The initial preparatory work covering outline design, environmental studies, archaeology and planning application preparation are likely to take 1.5 years. An assumed start date of 1st January 2019 would indicate a start on site(s) date in early 2021, one year into AMP7. The programme assumes no commitment to Gateway 3 until planning permission is granted.

An initial design team of process engineers, project engineers, environmental specialist, planning specialist, land agents and stakeholder liaison specialists is envisaged to undertake the initial concept development and progress the scheme through to planning submission.

It is suggested that separate teams undertake the treatment works and network designs with an overall coordinating "principal" (possibly independent) to ensure harmonisation and compatibility of design and progress. This approach will allow advancement of the two main elements of the scheme simultaneously, in an organised manner.

Following the planning submission, separate teams are again proposed for the treatment works and network designs. These two elements can be progressed more quickly if separated. As for the initial concept a principal is suggested to provide leadership.

The work will require 30 to 50km of trunk mains, depending on 3 or 5 works options. A period of 2 years has been allowed for this work.

Hereford trunk mains is anticipated to have an installation programme of 14 months.

Court Farm WTW GAC & service reservoir the initial project programme indicated 1 year for preliminary works up to target cost and receipt of planning approval. Construction took place over 2 years. This was on an existing DCWW site with no off-site trunk mains.

If the project is to be issued for competitive tendering then representatives of the concept engineering team from each work element will be required to assist in the preparation of tender document.

The programme does not allow for any tender preparation or tendering period.

d) Cost benchmarking.

As identified in the October and earlier December Status updates a number of cost models have been benchmarked. Benchmarking took place during the previous reporting (2015) and more recently with BV costs on our Scottish Water framework.

Trunk mains have been re-scoped and passed to STC team for review.



BV are awaiting costs for typical trunk main laying work from our colleagues in the Anglian Water area.

Certainty on cost will improve when increased benchmarking information is available, see NPC costs in Table 3 below for the new and existing WTW.

e) <u>NPC Costs – for reference</u>

	New 3 Works Option	New 5 Works Option	Keep 3 works	Keep 5 works	
Capex	£185.0m	£214.7m	£207.0m	£261.0	
Opex	£90.9	£98.8.0	£104.4m	£129.2	
Totex	£275.9	£313.5m	£311.4m	£390.2m	

Table 3 – NPC Costs for the new and existing WTW options

The existing works options **do not include a provision for increased treated water storage**. A cost for GAC treatment has been included although as discussed previously no land is available to build such a treatment stage at each existing asset. To provide GAC at the existing sites an off-site location would be required, inevitably this would likely conclude the land at Site 3 being the most suitable, which is part way to completing the new works.

The previous assumption of rebuilding each existing works in 25 years time has been amended as this also is physically not possible at the existing sites. Instead, major refurbishment has been included (which equates to 50% of the previous allowance) and is more in line with the maintenance allowance for the new works options after 25 years.

f) Opportunities & Threats.

 \uparrow A reduction in treatment works design capacity to reduce costs.

 \uparrow Possibility of "fine tuning" trunk mains usage to optimise asset re-use and facilitate commissioning.

 \uparrow Removal of a re-lift pumping station at the new WTW, pending detailed hydraulic / topographic assessment. (£1.4m).

 \uparrow Opportunity to undertake a full assessment of at-risk service reservoirs within the supply zone and plan for future demand, or improve use of resource(s).

↑ Retention of Nantybwch as 'Heads of the Valleys' treatment source but with a possibility that Nantybwch and Carno may be integrated at some future date (if 3-works option selected initially).

↑ Land available for expansion and creating a major "hub" to reinforce the "mothership" concept.

 \uparrow Design the new asset to cater for potential expansion.

 \downarrow A National Grid High pressure gas pipeline is routed through Cefn Coed via Pen Sarn, near to the valve complex. (Dowlais to Dyffryn Clydach).

 \downarrow Full utilities / environmental desktop search required.

 \downarrow Existing mains in proposed plot – establish location to produce layout.

 \downarrow Ground Investigation / Topographic survey should proceed to minimise risk and surprises.

 \downarrow Duration for obtaining Planning Permission. Any special conditions imposed.

 \downarrow Land Purchase duration.

↓ Location of Cefn Coed PS and pipeline routes from Cefn Coed to Site 3 (Graveyard), terrain, rock.

 \downarrow Pipeline routes in general.

 \downarrow UCD costs for pipework.



 \downarrow Changeover from Raw to Treated Water through existing trunk mains – commissioning activities / planning feedback into design stage.

g) <u>Construction Options</u>

Treatment and storage risks may be mitigated by constructing the GAC, contact tanks, treated water storage and associated chemical dosing in advance of the Flocculation, DAF and RGF.

The cost commitment for this approach would show a reduction of approximately £40m on the cost of constructing the treatment works. In this approach the network costs may well be increased as the scope will involve extending treated water mains to the new works which would not necessarily satisfy raw water conveyance at a later date – again – commissioning activities feeding into design. In terms of time, it is envisaged this approach would still take over 5 years to achieve.

h) Nantybwch & Carno replacement costs (incorporation in 5-works option)

Capex (Cost to Build)	
Network Mains	£28m
Pumping Station	<u>£0.675m</u>
	£28.675m
Орех	
Pumping	£513,000 per annum
Energy Recovery (approx.)	<u>£310,000</u> per annum
Net	£213,000 cost

Average output 6,062 MI/annum from both works (2014/2015 marginal cost calculation).

Marginal cost increase +£25/MI (allowing for energy recovery and more efficient treatment works). Therefore, in the enlarged new works, the additional pumping costs would have the effect of increasing marginal cost from £86/MI to £111/MI for Nantybwch/Carno treated water.

The 10-year and 20-year capital maintenance costs for Nantybwch and Carno have been estimated within Table 4 below*:

Capital Maintenance costs	Nantybwch	Carno
10 Year	£3m	£4.6m
20 year	£9.3m	£1m
Total	£12.3m	£5.6m
Table 4 10 and 20 us	an Nantukuush and Cama M	

Table 4 – 10 and 20 year Nantybwch and Carno WTW maintenance costs

From the above and the following charts the addition of Carno and Nantybwwch to the 3-works option (to form the 5-works option) does not appear to provide cost benefit. The main reason for this being return pumping costs.

The following charts have inflated the potential Capex investment at Nantybwch and Carno (£35million) simply to demonstrate the level of investment that could be employed without seeing the abandonment out-turn as a beneficial option.



Whole Life Cost Calculations

1.Excluding Tax Relief

NPV Summaries (ex	cludin	g residual v	values & ta	ax savir
NPV 20 Years	£	32,704	£	14,556
NPV 40 Years	£	34,201	£	16,269
NPV 60 Years	£	34,946	£	17,911

Total costs over 60 years

£	-
£	35,000
£	-
£	-
ex	kcluded
£	35,000
	£ £ £ £

2. Including Tax Relief

NPV Summaries (including tax savings & residual value NPV 20 Years £ 26,881 £ 11,933 NPV 40 Years £ 13,326 £ 27,323 NPV 60 Years 27,760 £ 14,618 £ Total costs over 60 years Abandon Retain Capex £ 29,675 £ Replacement Cycles £ 200 £ 35,000 **Operational Costs** £ 12,780 £ Income £ £ Tax Allowances 12,292 6,739 -£ -£ £ 30,363 £ 28,261







4. Phase 3 review - Merthyr WTW Investigations, February to 1st March 2018

At a review meeting in late January the scope of the WTW and pipelines for the new works was reviewed and the request to add de-alkalisation and indicate a separate cost for reinstating the manganese removal stage was included. A review of the pipeline schedule with the operational team was also requested. As well as a review of the costs with the Welsh Water cost team, Mott MacDonald and Alliance benchmarking.

a) Scope and Cost

When including De-alkalisation for chemical preparation and Manganese removal filters the revised costs are set out in Table 5 below.

Cost to build

(Efficiency Removed)

	3 Works Option		5 Works Option		Maintain 3	+ GAC	Mai	intain 5 + GAC
WTW	£	167,256,044	£	167,256,044	£ 266,94	17,697	£	343,289,228
Dedicated manganese	f	17 529 9//	f	17 529 9//				
removal stage	L	17,323,344	Т	17,525,544				
Dealkalisation Plant*	£	628,490	£	628,490				
Network Mains**	£	39,974,208	£	71,662,983				
Land Purchase	£	1,000,000	£	1,000,000				
Total	£	226,388,686	£	258,077,461	£ 266,94	17,697	£	343,289,228
Previous Cost without the £203m		£23	84m					
additional processes (a		(£167m+£35m) (£167m+£67m)		67m+£67m)				

* cost model used - Lime dosing plant for 20MI/d

Table 5 Cost to build values including Mn removal stage and dealkalisation plant

<u>Whole Life Cost Comparison</u> <u>40 years</u> Efficiency Removed from Capex

	3 Works Option		5 Works Option		Maintain 3 + GAC		Maintain 5 + GAC	
hole Life Cost comparison 40 years	£	227,626,941	£	249,706,249	£	249,349,808	£	314,501,324
Efficiency Removed from Capex	£	90,798,014	£	98,798,720	£	104,430,536	£	129,191,636
Decommission	£	3,284,153	£	3,284,153*				
Land Purchase	£	1,000,000	£	1,000,000				
Total	£	322,709,108	£	352,789,122	£	353,780,345	£	443,692,960

(* Addendum Note – decommissioning 5-works option should be £5m actual cost, £5.31m NPC cost)

Table 6 – Whole life cost comparison efficiencies removed

b) Network Mains

During a productive meeting with DCWW Operations on 23rd Feb the proposal to replace the Taff Trunk mains with duplicate 1200 main from the proposed Merthyr WTW to the Mormon Church area of Merthyr Tydfil was discussed. The proposal was viewed extremely favourably by operations as it offers the following benefits:



- Allows the use the existing 32" Taff main as a 'run to waste' pipe directly to river with greater flow than that adjacent to the proposed works.
- Delivers treated flow to the Llwynon and Cantref mains without the need for separate treated water mains for these flows.
- Replaces an aged section of the Taff Trunk.
- Increases the capacity of the upper section of the Taff Trunk main, reducing the potential need for supplementing the system from other parts of the SEWCUS network.
- May assist in eliminating the need for pumping from the Superworks (see * below).
- Raises the possibility of the 37" Taff main being re-lined and used as feed man for Llwynon raw water flows (a 0.5km section would still need relaying due to the need to accommodate A465 proposals).

A schematic pdf has been developed showing the proposed trunk mains connections and the sequence in which they will be used to allow the new works to be commissioned. An overview of the proposed pipelines associated with the project can be seen in Annex C.

* The possibility exists for the main low level flow from the works to be conveyed by gravity. Further modelling would be recommended to confirm the potential.

If the above is feasible it also generates the potential benefit of being able to deliver more flow down the Taff Trunk mains due to being able to work on the basis of a lower hydraulic gradient. The commissioning procedure was also discussed and accepted as a suitable procedure, at this stage. See separate document. Operations view was that sufficient treated water supplies could be maintained in following this sequencing – now modified to switch Pontsticill high lift over before the low lift.

B&V have reviewed the potential for aligning some of the trunk main laying element of the project with the A465 Trunk Road widening scheme. Unfortunately, the present proposals do not provide any synergies.

c) <u>Risk to cost.</u>

The risk to the costs on the WTW have been minimised as far as possible. Manganese Removal and De-alkalisation costs have been included within this review.

Confirmation of the "factors" used in the latest STC was expected in early April from Cost Team to verify – see Part 2 - Annex A. (These "factors" have subsequently been agreed with minor revision in April 2018, the adjustments are indicated in Annex A)

The risk to the pipeline costs depends on the likelihood of encountering rock during the dig and whether the UCD model used in the costing exercise contains an element of allowance which would cater for encountering rock.

Of the pipeline routes considered to be most at risk, these have been examined in a desk-top study. The proportion of pipeline route which might contain rock is approximately 30%. This is only an approximation based on desktop assessments of geological information for the area. The type of rock which might be encountered is not fully established. Removal ease could vary.

The risk to cost relates to approximately 2400m of 1200mm pipe, currently equivalent to £6 million within the overall cost.

At present, for the three works option there is one dual pipeline trench (3000m of 1200mm diameter). At present there is no model for dual pipes in a single trench. The full allowance for 6000m of 1200mm diameter pipe is £15million. A dual-pipe trench would obviously reduce this cost. There is also the opportunity for other, shorter lengths of pipe to be run in common trenches to reduce cost.



5. Phase 4 review - Merthyr WTW Investigations, March 2018 – April 2018

The review of the pipeline and Water Treatment capital costs has continued and an update regarding costs was delivered at the Stakeholder meeting on 10th April. The benchmarking exercise undertaken by the DCWW Unit Cost Database (UCD) team highlighted that the capital costs for pipelines were within the acceptable range and that two items on the water treatment works needed to be updated, the GAC cost model and to increase the multiplier used for buildings. The summary of the benchmarking exercise can be seen within the Merthyr WTW Cost Methodology Review (Ref10). The costs for the new sites, pipelines and GAC for the existing sites have been developed using the UCD and version 12 of the Solution Target Price template.

Within the Merthyr Cost Summary Spreadsheet an update of the NPC calculations has been made using an updated cost of capital 2.4% moving from the original value of 3.6%. The capital costs have also been updated costs following the cost benchmarking assessment.

At the stakeholder meeting the scope of the WTW was agreed to include a three streamed WTW with the processes below, a schematic of the WTW can be seen in Annex B. The pipelines associated with the raw and clean water for the new WTW were also

The capacity of the WTW has been reviewed and a separate capacity review document has been generated, New Merthyr WTWs sizing Final v1 (Ref 9), which summarise the main issues. At the stakeholder review meeting on 10th April it was agreed that the new WTW should have a capacity of 225Ml/d. The reasons for this are list in the bullets below;

- Resilience benefit both current and future to support other WTWs across SEWCUS as well as Felindre in future,
- Maintenance enabling for the new works and other across SEWCUS
- In order to meet and recover from maximum demand periods
- Optimisation of costs by using gravity water sources when they are available
- They meet future Welsh Water Strategy
- Water Treatment capacity that can meet the additional demand of Nantybwch and Carno in future

The upgrade of the Taff Trunk Mains work that is part of the pipelines assessment for the new WTW treated and raw water connections will increase the cost of the project by £4.25m in AMP7 but will avoid the cost of upgrading the pipelines in the future which will cost £15.3m when the work is undertaken. A summary of the costs and benefits of this scope of work can be seen in Table 9 below.

Compatibility between the Opex costs between a new works and retaining existing works has been thoroughly reviewed and overhauled within the Merthyr WTW Cost Summary spreadsheet. This resulted in a more realistic sequence of Opex changes throughout the whole life of each option.

The updated values for the two 3 treatment works options have been updated and the revised costs to build the new WTW and maintain the existing sites and the NPC values for these can be seen in below. Indicating that the whole life cost of the new 3 works option is more cost beneficial than maintaining the existing sites.



Cost to build WTW Improvements

No Efficiencies

	New 3 Works Option	Maintain 3 + GAC
WTW	£205,921,954	£159,380,607
Network Mains	£41,937,053	N/A
Total*	£247,859,008	£159,380,607

* AMP7, 8 and 9 costs including decommissioning costs in AMP 9 Table 7 – Cost to build improvements

NPC 40 year costs, no efficiencies

	3 Works Option 27Ml storage only	Maintain 3 + GAC
Whole Life Cost comparison 40 years Capex	£228,840,397	£239,987,913
Whole Life Cost comparison 40 years Opex	£96,363,042	£127,013,022
40 year NPC Totex	£325,203,439	£367,000,935

Table 8 – 40 Year NPC costs



5.8E.1 - Cwm Taf Water Supply Strategy Review Sept 2017 to April 2018							
Pipeline	Additional Work	Length of	Cost of	Benefit	Value of benefit		
		Main	pipeline/scheme				
Dual Taff trunk replacement	85% of total length, 15% to be done as part of the A470 diversion. Shutdown and disruption will be taking place in the area.	2 x 2.7km of 1200 diameter main.	£15.3 million	Improved reliability. Long term requirement to replace existing Taff Mains. Saving laying separate Llwynon and Cantref treated mains. Existing Taff Trunk pipes can be used as Run to Waste main to a major water course.	Lower cost to reline second raw water pipeline than relay. Saving on new run to waste pipeline to a large water course to enable significant volumes of water to run to waste (30 Ml/d and over). Taff Trunk replacement will be required in future and new Cantref and Llwynon pipelines will be potentially abandoned at that time. There is also forecast to be an improve flow to regards Tongwylais, with flow possible in excess of 150Ml/d. -£0.85m (run to waste saving) -£2.3m diversion contribution		
No need for Llwynon distribution main.	New main saved.	3km metres of 1050 diameter main	£5.36m	New main no longer required.	-£5.36m		
No need for a new Cantref distribution main.	New main saved.	2km metres of 700 diameter main	£2.54m	New main no longer required.	-£2.54m		
Abandonment of existing Llwynon trunk mains 1.5km.	Cut and cap the mains.	1.5 km	£0.1m	Benefit of abandonment of sections of aged pipeline.	Additional cost £0.1m Benefit will prevent 5 burst main repairs at least over the next 20 years in future at £25k each. Saving £0.13m for repairs		

Table 9 – Summary of the Additional work and benefits associated with replacing a section of the Taff Trunk Mains as part of the new WTW connections

References

- Ref 1 draft SEWCUS Review Document Rev11 Pont GAC report
- Ref 2 2015-15-05 DCWW Superworks Feasibility Study Report
- Ref 3 2015-19-10 DCWW Feasibility Extension Report Final Issue
- Ref 4 Extended Study Cost summary v8.2 costing spreadsheet
- Ref 5 Unit Cost Benchmarking Merthyr Super-Works (September 16) report
- Ref 6 Merthyr Land Purchase Study Report
- Ref 7 Merthyr Cost Summary Spreadsheet
- Ref 8 The Merthyr Cost Summary Methodology
- Ref 9 New Merthyr WTWs sizing Final v1
- Ref 10 Merthyr WTW Cost Methodology Review

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Annex A – STP Cost Changes

Part 1 – Phase 1 Review - Cost changes – three works Option 225 Ml/d throughput

- a. Inlet works doubled to allow for 3 (or 4) raw water inlet connections and control equipment (+ £1.3m net)
- b. Lime dosing doubled to allow for higher specification of storage and possible use of Lime water, also to align with benchmarking (+£0.7m net)
- c. Flocculation Tanks doubled to allow for accommodating additional cells to suit increased number of DAF lanes (£+0.3m net)
- d. DAF Plant +20% to allow for up to 20 DAF lanes. (£1.6m net)
- e. RGF +20% to allow for multiple streams matching the number of DAF cells and align with benchmarking. (+£1.5m net)
- f. Chlorine Dosing Doubled to allow for possible compliance with COMAH regulations and benchmarking (+£0.45m net)
- g. Treated Water Storage tank Doubled to align cost with that of benchmarking (+ £10m net)
- h. Sludge thickener Three thickeners instead of 1 model uses a single total volume. (+£0.3m net).
- i. Dirty Washwater recovery doubled as two tanks likely. The single cost model unlikely to cover specific requirements at this works (+ £0.5m net)
- j. Buildings +50% benchmarking indicated UCD to be low. Not in BBNP but likely to be subjected to planning aesthetics (+ ~£1.5m net)
- k. Other elements not previously included +£1.7m
- I. Network requirements +£11.6m

Total additions for specification, scope and benchmarking (three works) £30.5 m net, £50m Total.

Total Reductions for scope – Mn (- £5m) filters and UV (- £0.6m) = -**£5.6m net**, -**£9.4m Total**.



Part 2 – Phase 3 Review - STP Worksheet - UCD Cost Model challenge - with outcomes indicated

Commentary on adjustments made to "NR" to cater for scope envisaged for 225 MI/d WTW, 160 ML Treated Water Storage Tank and associated ancillary plant.

Identification numbers below refer to "Item" numbers on STC worksheet entitled "Merthyr 3 Works with Mn and de-alk.xlsm"

1.001 - Inlet Works (Adjustment agreed by Cost Team April 2018)

The cost model upper range limit is 60MI/d.

Scope of the model includes all items for the inlet works – pipework, valves, flowmeters, surge vessel, flow balancing chamber.

The reason for entering "2" in NR field relates to the need to cater for three inlet pipes, one from each raw water source. In effect we will have three separate inlet connections, each with individual control & isolating valves and flowmeters connecting to what is envisaged to be three reception tanks in a common structure, flowing into a common balance/mixing tank. There will be separate water quality instruments for each inlet pipeline and the blended water.

The pipeline sizes for each inlet will be will be circa 700mm, 1050mm and 1200mm. There is also the need to consider a fourth inlet pipe, from Nantybwch.

Whilst there could be an argument for allowing for three separate structures corresponding to the individual flow from each source, there will be some efficiency of scale.

There is no "flash mixing" system identified in the Inlet Works Model. Whilst these tend to be included in the chemical dosing model the requirements for mixing in this instance will require significant bespoke mixing arrangements.

The need for individual pipelines, mixing arrangements, separate valves, instruments and sectionalised tank has influenced the move to increase the NR to "2".

<u>1.004 – Chemical Dosing – Lime (Adjustment agreed by Cost Team April 2018)</u>

Cost model upper range limit is 35 Ml/d.

The margin for error on this model could be significant.

Example - There are media articles report a "lime water" plant at Severn Trent's Frankley WTW, built by MWH in 2014/15, for £14million. Frankly throughput circa 300 to 400 MI/d.

The UCD model for 225Ml/d produces a budget of less than £1 million. The full scope of work at Frankley WTW is not known but media articles suggest it was the main element. Refurbishment of an existing building was part-included rather than a new building. Lime silos are outside.

Not included is Merthyr scope is a dealkalisation plant (included within the Frankley scope), we do not have a UCD model for such but it is likely to be required.

By increasing NR to "2" we achieve a budget of approx. £3m for lime and de-alkalisation. This could well be light when compared to other references.

<u>1.006 – Flocculation Tanks (Adjustment agreed by Cost Team April 2018)</u>

Cost model upper range limit is 100MI/d.



The suggestion for the DAF design for Merthyr is for multiple streams. This would allow part of the works to be shut-down for maintenance, or to adjust number of lanes to match the required inflow. Up to 20 lanes have been suggested but this is more likely to be 12 or 16. Felindre uses 8.

In a normal DAF plant, the floc tank would be upstream of and part of the DAF lane. If this were the case then additional dividing walls would be required. Multiple streams will require extra inlet /outlet valves, flocculation paddles, cabling, weirs and dosing points.

More likely in this case we will see 6 or 8 floc lanes which will probably feed 12 or 16 DAF cells. There could however be equal numbers of both.

Without knowing the eventual number of DAF lanes, the model has been adjusted to allow for a reasonable number of floc lanes, to match the anticipated number of DAF lanes.

The NR figure has been increased to "2" to cater for the additional tank and for the increased number of flocculation paddles, flocculator paddle drives, support structure, access walkways, MCC and cabling.

<u>1.007 – DAF Plant (Adjustment agreed by Cost Team April 2018)</u>

Cost model upper range limit is 100MI/d.

As per the information above, the DAF plant is likely to have multiple lanes to allow flexibility in operation, more lanes than would normally be expected.

The uplift to a "1.2" is to cater for the additional dividing walls, inlet penstocks, sludge scrapers/drives, fabricated weirs, saturator pipework, saturated water nozzles, headers & manifolds, flow control, instrumentation/sampling in each DAF lane, walkways and cabling.

1.008 – RGF and Secondary Manganese Filters (Adjustment agreed by Cost Team April 2018)

Cost model upper range limit is 100MI/d.

Similar to the DAF plant which will likely have more lanes than normal, the two filter plants would be designed to match the DAF lanes arrangement, not necessarily in equal numbers but there could be more. This is a third-level assumption following on from Floc and DAF. The 1.2 factor is a general uplift to accommodate any upstream design criteria. A factor of 2.4 is used in line 1.08, 1.2 for the RGF and 1.2 for the Mn removal.

<u>1.009 – Pressure Filters All types (Used for GAC Treatment Stage)</u> (*Adjustment Not agreed by Cost* <u>Team</u>)

Cost model upper range limit is 100MI/d.

This model has been utilised for the GAC plant. The reason for this is that the GAC plant model produces costs which out-turn less than that of an RGF. The likelihood is that a GAC plant will actually cost more than a RGF, this is because of the depth of the cells, GAC material cost and service water requirements. If not

Example - Frankley WTW (Severn Trent) has a 3000m² GAC plant for 220MI/d which was reported in the press in 2007 as £31.5 million. The use of the Pressure Filter UCD model results in an out-turn cost of approx. £22m. Using the GAC model would have produce an out-turn of £8million.

Cost team recommended use of a x "3" factor against the "GAC Contactors model, this has been applied to the STC sheet.



<u>1.010 – GAC Contactor (Cost Team requested reinstatement of this cost model)</u>

This model was reinstated and a factor of x "3" was applied as recommended by Cost Team

<u>1.012 – Chlorine Dosing</u> (*Adjustment agreed by Cost Team April 2018*)

Cost model upper range limit is 75Ml/d.

This model identifies "Chlorine Chemical Dosing". The scope suggests liquid form - sodium hypochlorite. This is suitable to an extent for this size works but the likelihood is that this works will have on-site hypochlorite electrocatalytic (OSEC) in preference to importation and bulk storage.

Felindre has bulk chlorine <u>gas</u> storage of a quantity that defines Felindre as a Control of Major Accident Hazards (COMAH) Regulations 2015 site.

DCWW are unlikely to want to have that imposition in the future so a form of OSEC may be provide an alternative. It is not been investigated whether the OSEC plant will have any specific regulations but it is likely. Allowance must be made for this.

There will be many unknowns when this section of the plant enters design phase.

Example - Purton WTW – 165MI/d (A BV Project) completed in 2011 had a contract value of £3m.

With the "2" for NR the budget here would be approx. £1.8million.

There will be a need to dose at intermediate and final locations within the process. Not known if the model would allow for two sets of dosing equipment and pipelines.

This model might need more input to ensure the budget generated is adequate

1.015 - Storage (Adjustment agreed by Cost Team April 2018)

Cost model upper range limit is 75Ml.

Scope requires 160Ml.

Example - Talybont 11 Ml - £4.2m, extrapolated using 6/10ths rule gives £37.5m

Example - BV benchmark from Scottish Framework indicates £20m cost to build (BV in house pricing model) against UCD of £12.1m.

Example - The benchmarking costs from WRc and SW were £15m and £38m.

A "2" has been used to cater for the above. This produces a net cost to build of $\pm 24m$, equivalent to a TCTC of $\pm 42m$.

1.016 / 1.017 – Washwater Recovery (Adjustment agreed by Cost Team April 2018)

There are two elements in the UCD selection for washwater recovery, storage and thickener. Both models exclude interconnecting pumping plant, interconnecting pipework, chemical dosing.

These two elements were used to formulate the cost for the entire wastewater recovery plant.

Example - The BV in-house model for a similar size works produced a cost to build cost of £876k. The thickener tanks and picket fence mechanisms were over £500k.

The "3" used in the STC sheet produces a cost to build cost of £546k. It is possible that this is light in comparison.

The wastewater plant is an area which can be underestimated.



At present there no allowance for GAC rinse tanks, Supernatant Return Holding Tanks, supernatant return pumps or sludge holding tanks. These have been added as extra items in lines 1.33 to 1.36.

There is no polyelectrolyte dosing system associated with the wastewater which is another shortfall area.

Clean backwash tanks are assumed to be constructed as an integral part of the 160ML storage. However this may not be the case and separate tanks may be required.

<u>1.020 to 1.024 inc – Buildings</u>. (Adjustment_Not Agreed by Cost Team)

Example - The building costs were consistently much lower than benchmarking costs from WRc, SW and MM.

Example - BV in-house costs for a traditional water treatment works building were twice the cost of the UCD model. BV in-house costs are based on x2 rates.

As a result of the unknowns in the fabric and aesthetics of the buildings the "1.5" increases the cost allowance to be more in line with benchmarking.

Cost Team recommended use of a x "2" or x "1.5" factor, based on the external benchmark evidence.

1.026 & 1.027 - Surge Vessel and Valves (Both adjustments agreed by Cost Team April 2018)

"3" used because there will likely be 3 separate systems. Unlikely that the resulting £39k will provide sufficient budget for 3 surge suppression systems.

"12" has been used against valves to inflate the cost to that which would provide for compressors, controls, instrumentation and interconnecting pipework.



Annex B – New Merthyr WTW 3 Stream Schematic





Annex C – New Merthyr Works Raw Water and Treated Water Pipelines





Annex D – Overview of the Cost Summary Spreadsheet

Refer to "Merthyr WTW Cost Summary Spreadsheet Methodology" for details of the spreadsheet methodology.

