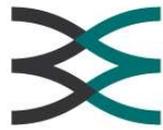


**Appendix 11f:
Kelda Sludge Markets
Decision Support Report**



business modelling
ASSOCIATES

Kelda Group Sludge Markets Decision Support Report

22nd August 2016

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business modelling
ASSOCIATES

Integrated Planning, Predictive
Modelling and Decision Support



1. Background

Business Modelling Associates (BMA) built an Opex sludge decision support tool (DST) for Yorkshire Water (YW) to provide a data-driven view of the most optimal operational approach for sludge management. The DST provides outputs at three levels of detail, daily, weekly and monthly. The SludgeOps DST is now embedded into business as usual with YW sludge operations to enable an ongoing view of the actions required to achieve the lowest Opex. Additionally, the tool can be used to review previous performance against the optimal plan.

The SludgeOps DST contains a comprehensive view of the asset base along with associated operational and financial data. The base data within the weekly model was last updated in 2014.

In light of the ongoing OFWAT Water2020 consultation and the likely introduction of a separate price control for sludge in 2020, the Kelda Group are seeking to understand whether there is potential for a market to exist for sludge in the Yorkshire region.

Kelda approached BMA to assist in understanding how OFWAT 2020 and the de-regulation of the sludge market may impact on YW / Kelda. It was agreed that the Sludge Ops model would be used as a base with which to modify and then run scenarios, to assist in understanding the possible impact.

The scope of this work is to utilise the existing sludge model to reflect the YW 2020 asset base and determine where a market may exist. The following aspects are included:

Model Inputs

- Addition of c. 25 sludge treatment facilities in regions outside Yorkshire.
- An additional circa. 260 additional export sites, provided by Kelda which are currently being services by neighbouring WASCs were added to the Sludge Ops model.
- The sludge volumes to be treated by YW export sites as it was represented on the Sludge Ops model was assumed to be sufficiently accurate and was used in this modelling exercise.
- The sludge volumes to be considered for the neighbouring WASCs was also captured into the mode.
- The logistics and processing costs currently in the sludge ops model was also assumed to be sufficiently accurate for this exercise.
- All the above data was provided by YW.

Model Outputs

The scenarios that have been run are summarised below:

- **Base Case**
Additional treatment and export sites were added into the base case. The same logistics cost basis used for YW was then applied to the other WASC networks, being careful not to allow inter-company trading in the Base Case.
- **YW Loss MKT**
Allows inter-company trading, only considers operational costs of logistics and sludge treatment and only allows other WASCs to “take” YW sludge for treatment at the lowest possible cost option. i.e. YW can lose volume to other companies, but this scenario did not allow YW to treat other WASC sludge. This scenario used like for like sludge processing costs.
- **Fair MKT Share**
Allows for other WASCs to treat YW sludge volume AND for YW to treat other WASCs sludge on a least cost (OPEX) basis considering logistics and treatment costs.
- **Individual Comp Discount**

Tests the impact on YW as a result of a recent assessment by OFWAT, in which individual WASCs were rated in terms of the cost efficiency to treat sludge. Based upon this assessment, the treatment costs of the other WASCs neighbouring YW were reduced accordingly thus testing the significance of the impact on YW

- **Other Comps 10% Less**
Tests the significance of the impact on YW of a flat 10% reduction in treatment costs for each neighbouring WASC when compared to YW's treatment costs.
- **No CVI Fair MKT Share & NO CVI Other Comps 10% Less than YW**
Both scenarios test the impact to YW of not having the Calder Valley Incinerator functioning. One scenario here evaluated the impact in the event of a like for like cost basis, and another scenario tested the impact in the event of a flat 10% reduction in neighbouring WASC treatment costs.

2. Model Assumptions

There are 3 main assumptions that were made in generating the outputs for this exercise:

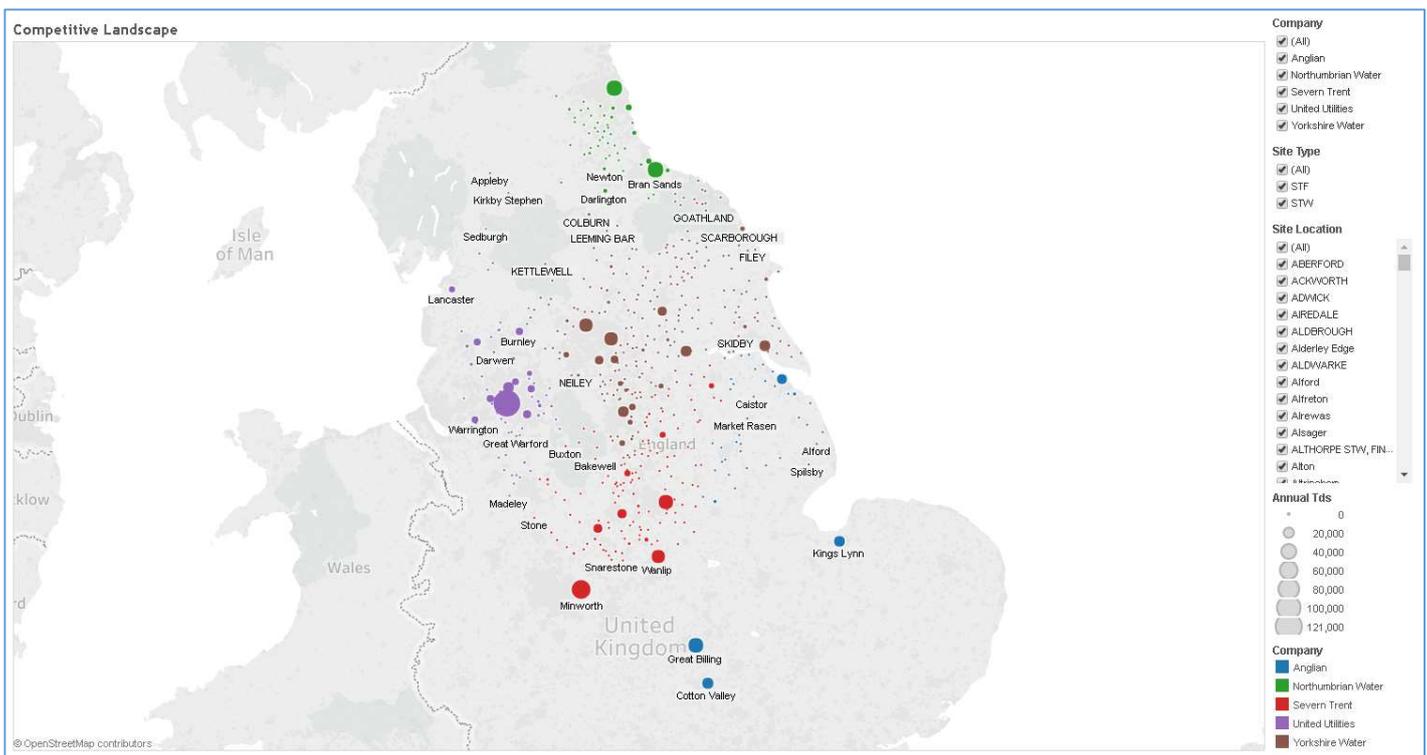
- For the logistics costs, the same cost basis that was applied to the YW sludge movements was applied to the other WASCs.
- For the processing costs, an analysis was performed on the YW Treatment Facilities, to determine a like for like treatment processing cost. These costs were then applied to the processing facilities for the neighbouring WASCs.
- For scenarios without Calder Valley Incinerator, it was assumed that the dewatering facilities at Calder Valley was still operational, should the model still select to use it. If the model selected to use this site, then the cake could be taken to the available sludge reception facilities identified on the 2020 asset base.

3. Project Outputs

- The outputs from the scenarios are available on a tableau web site for viewing and analysis.
- The following dashboards are available:
 - The Competitive Landscape
 - Logistics Maps
 - Loss Gains Dashboard
 - Capacity Utilisation Dashboard
 - Financial Summary
 - Financial Summary Map
 - Loss Gains Map
 - TDS by Company

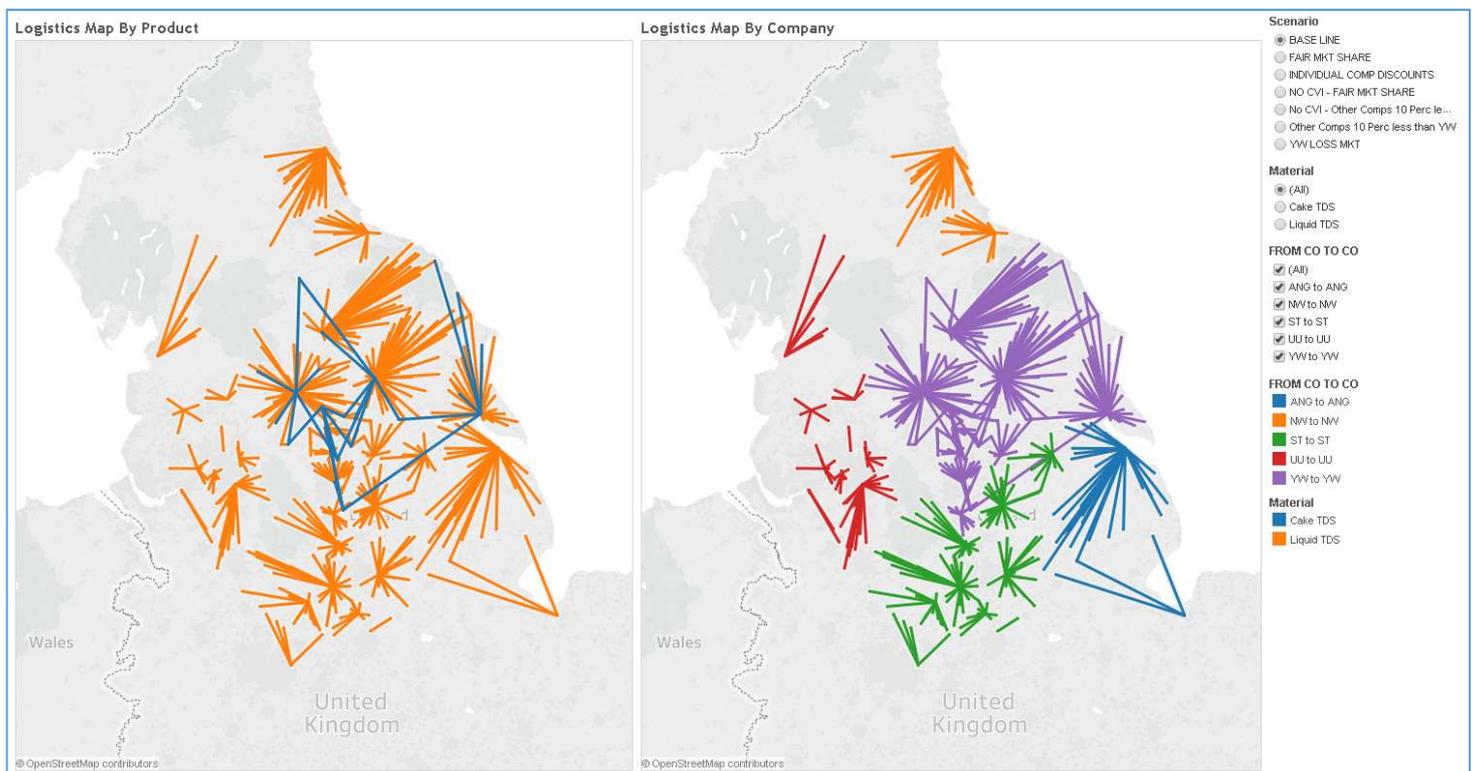
3.1. The Competitive Landscape

- The Competitive Landscape shows the distribution of STFs and STWs in a geospatial representation. This allows the user to view the YW and neighbouring sites by location, sludge volume and treatment capacity.
- The user is able to select Company (WASC), Site Type and Site Name with changing data as the selections are made.
- Selections are made by clearing or marking the various check boxes positioned on the right hand side of the screen. Any selection made in the selection criteria will result in a change on the items being displayed on the map.
- The purpose of the dashboard is for YW to ensure that the basic data used on this exercise is correct.



3.2. Logistics Maps

- The logistics maps show the allocation and re-allocation of STWs to STFs for each scenario that has been run.
- The map on the left shows the allocation of STW to STF by product type; Liquid Sludge or Sludge Cake
- The map on the right shows the allocation of STW to STF by “cross border” or intercompany trading type.
- This map allows the user to select to view which STWs are more efficiently serviced by which WASC based on each scenario.
- By selecting or clearing the checkboxes on the right, various scenarios, materials (Products) and STW to STF allocations can be viewed.



3.3. Loss Gains Dashboard

- This dashboard shows a table of results for each scenario showing in detail which STF services which STW and the annual amount of TDS that is serviced.
- The STW and STF allocations for each of the scenarios, cannot be shown in detail in the previously discussed logistics maps, so this dashboard has been created to allow the user to analyse the detail as well as download the table data for further analysis.
- The table on the left side of the screen is controlled by the filter selection options in the middle of the screen. Any selections in these filter boxes will affect the table data.
- The map shows the STW sites that are allocated or serviced by a company in a particular scenario. The user will be able to identify STWs that are serviced by companies and also those that have been allocated to different WASCs, when compared to the Base Case.

Loss / Gains Table - Values in the table are TDS per Annum

From Com...	To Comp...	From Location	To Location	Material	Scenario	
Anglian	Anglian	ALFORD/STW	PYEWIPE/STF	Liquid TDS	BASE LINE	93
					FAIR MKT SHARE	93
					INDIVIDUAL COMP DISC...	93
					NO CVI - FAIR MKT SHAR...	93
					No CVI - Other Comps 10 ...	93
					Other Comps 10 Perc less ...	93
					YW LOSS MKT	93
BARTON-UPON-HUM...		PYEWIPE/STF		Liquid TDS	BASE LINE	303
					NO CVI - FAIR MKT SHAR...	5
					YW LOSS MKT	303
BASSINGHAM/STW		PYEWIPE/STF		Liquid TDS	BASE LINE	55
					YW LOSS MKT	55
BRIGG/STW		PYEWIPE/STF		Liquid TDS	BASE LINE	187
					YW LOSS MKT	187
BROUGHTON/STW		PYEWIPE/STF		Liquid TDS	BASE LINE	138
					YW LOSS MKT	138
CAISTOR/STW		PYEWIPE/STF		Liquid TDS	BASE LINE	99
					FAIR MKT SHARE	99
					INDIVIDUAL COMP DISC...	99
					NO CVI - FAIR MKT SHAR...	99
					No CVI - Other Comps 10 ...	99
					Other Comps 10 Perc less ...	99
					YW LOSS MKT	99
CLEETHORPES/STW		PYEWIPE/STF		Liquid TDS	BASE LINE	1,459
					FAIR MKT SHARE	1,459
					INDIVIDUAL COMP DISC...	1,459
					NO CVI - FAIR MKT SHAR...	1,459
					No CVI - Other Comps 10 ...	1,459
					Other Comps 10 Perc less ...	1,459
					YW LOSS MKT	1,459
CRANWELL/STW		KINGS LYNN/STF		Liquid TDS	BASE LINE	74
					YW LOSS MKT	88
DUNHOLME/STW		PYEWIPE/STF		Liquid TDS	BASE LINE	14
					YW LOSS MKT	149
GRANTHAM/STW		KINGS LYNN/STF		Liquid TDS	BASE LINE	1,467
					YW LOSS MKT	1,467

From Company

 (All)
 Anglian
 Northumbrian Water
 Severn Trent
 United Utilities

To Company

 (All)
 Anglian
 Northumbrian Water
 Severn Trent
 United Utilities

From Location

 (All)
 ABERFORD/STW
 ACKWORTH/STW
 ADWICK/NO 2 STW
 AIREDALE/STW
 ALDERBOURGH/STW
 ALFORD/STW
 ALREVAS/STW
 ALSAGER/STW
 ALTHORPE STW, FINAL EFFLUE...
 ALTON/STW
 ALTRINCHAM/STW

To Location

 (All)
 ALDWARKE/STF
 ALFRETON/STF
 BEVERLEY/STF
 BLACKBURN MEADOWS/STF
 BLACKBURN/STF
 BRADFORD ESHOLT/NO 2 STF
 BRAN SANDS/STF
 BURY/STF
 CALDER VALLE/STF
 CALDER VALLEY/STF
 CASTLEFORD/STF
 CLAYMILLS/STF
 DAYHULL/STF

Scenario

 BASE LINE
 FAIR MKT SHARE
 INDIVIDUAL COMP DISCOUNTS
 NO CVI - FAIR MKT SHARE
 NO CVI - Other Comps 10 Perc less than...
 Other Comps 10 Perc less than YW
 YW LOSS MKT

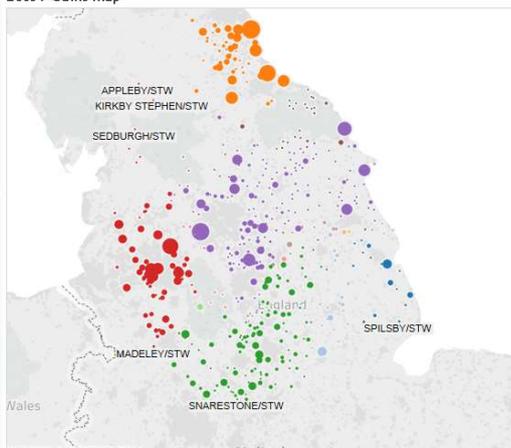
From Co To Co

 (All)
 ANG to ANG
 ANG to ST
 ANG to YW
 NW to NW
 ST to ST
 ST to UU
 ST to YW
 UU to UU
 YW to ANG
 YW to NW
 YW to ST
 YW to UU

From Co To Co

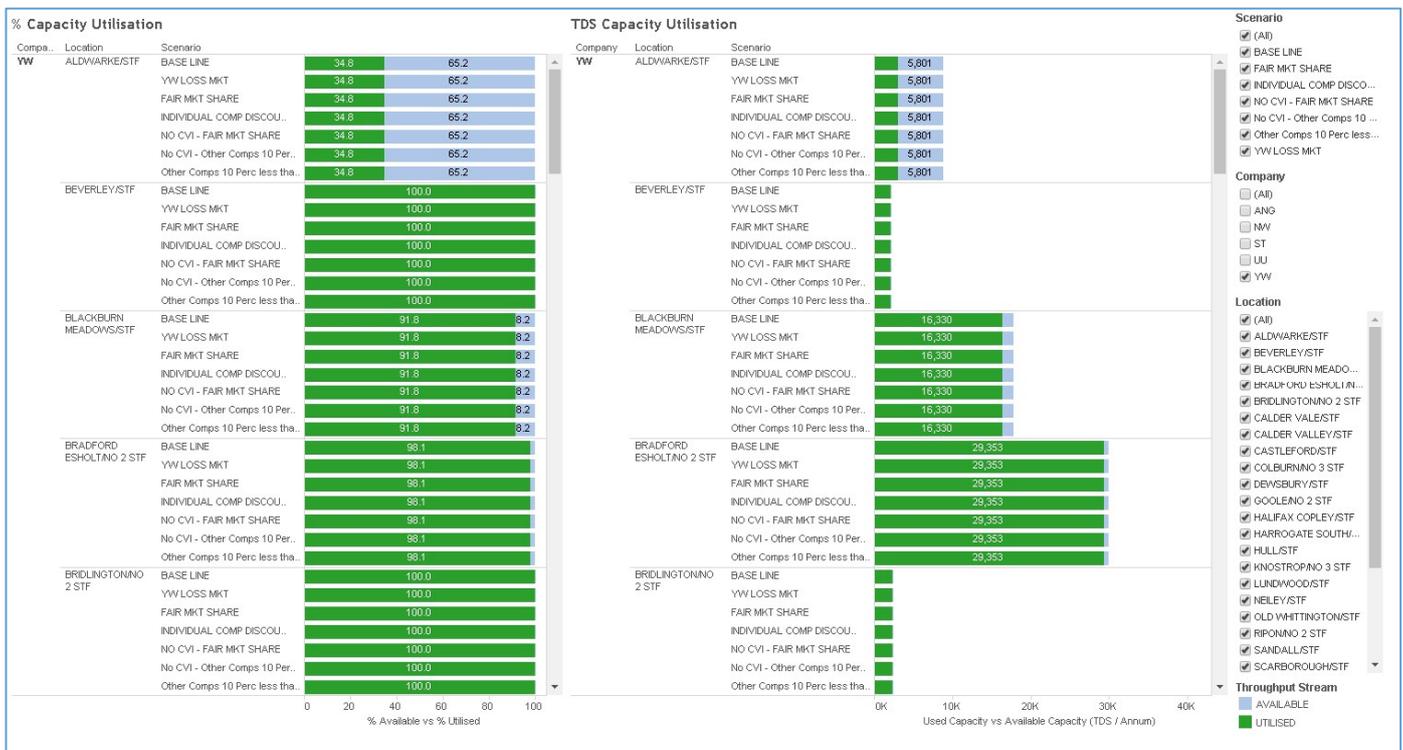
 ANG to ANG
 ANG to ST
 ANG to YW
 NW to NW
 ST to ST
 ST to UU
 ST to YW
 UU to UU
 YW to ANG
 YW to NW
 YW to ST
 YW to UU

Loss / Gains Map



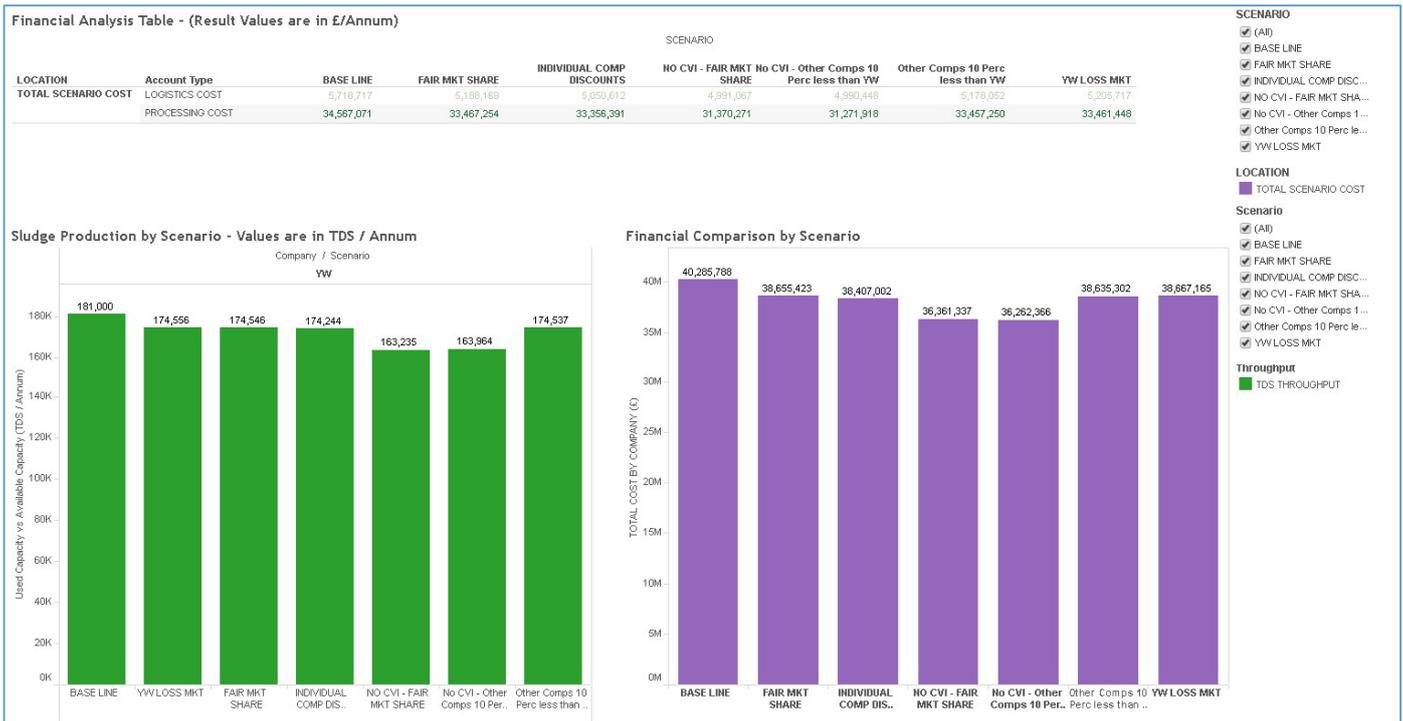
3.4. Capacity Utilisation Dashboard

- This dashboard shows two outputs, the % utilisation and the actual volume (TDS) treated by each treatment facility. In addition available capacity in % as well as volumetric terms is also shown.
- As per previous dashboards, the user can interact with the dashboard by selecting or de-selecting the filters on the right of the screen. Both graphs will then change as a result of the users selection.
- The user can now analyse how throughputs at the various sites have changed as a result of the scenario changes.



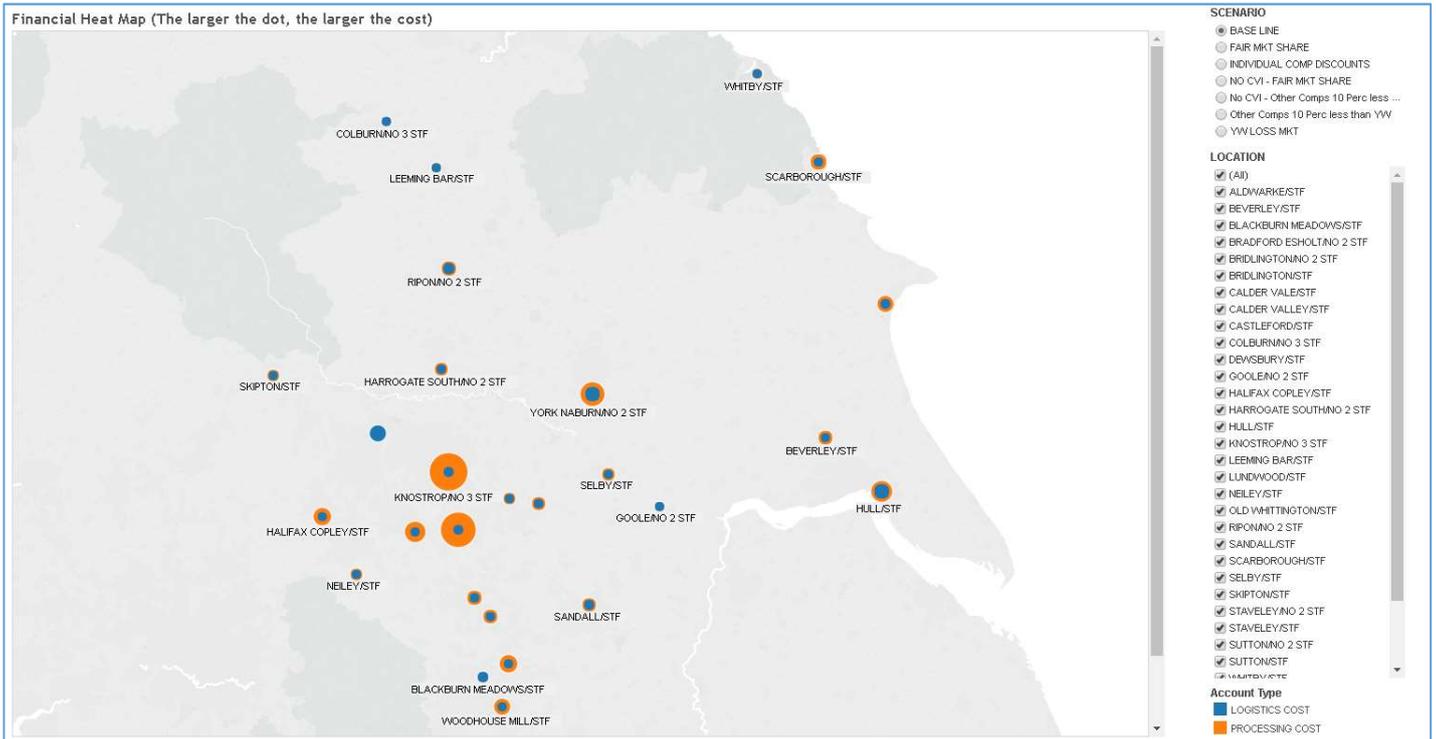
3.5. Financial Summary

- The financial summary dashboard, provides an overview of the processing and logistics costs that have been included in the model for each scenario.
- The results are available in tabular and graphical form.
- Also included on the dashboard is an indication of the annual sludge volume to be treated by YW in each of the scenarios.



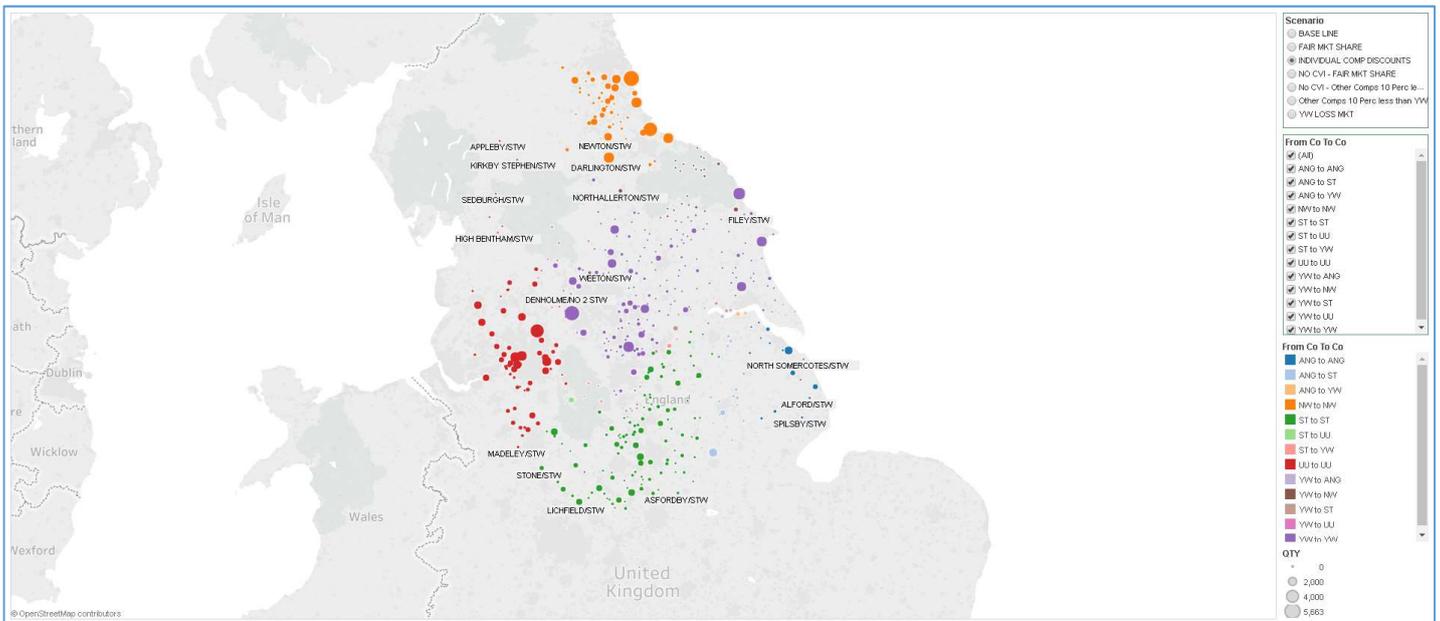
3.6. Financial Summary Map

- The map shows the processing and logistics costs that are incurred at a treatment facility level in a geospatial format.
- The map only shows YW treatment and logistics costs and not any other WASC costs.



3.7. Loss Gains Map

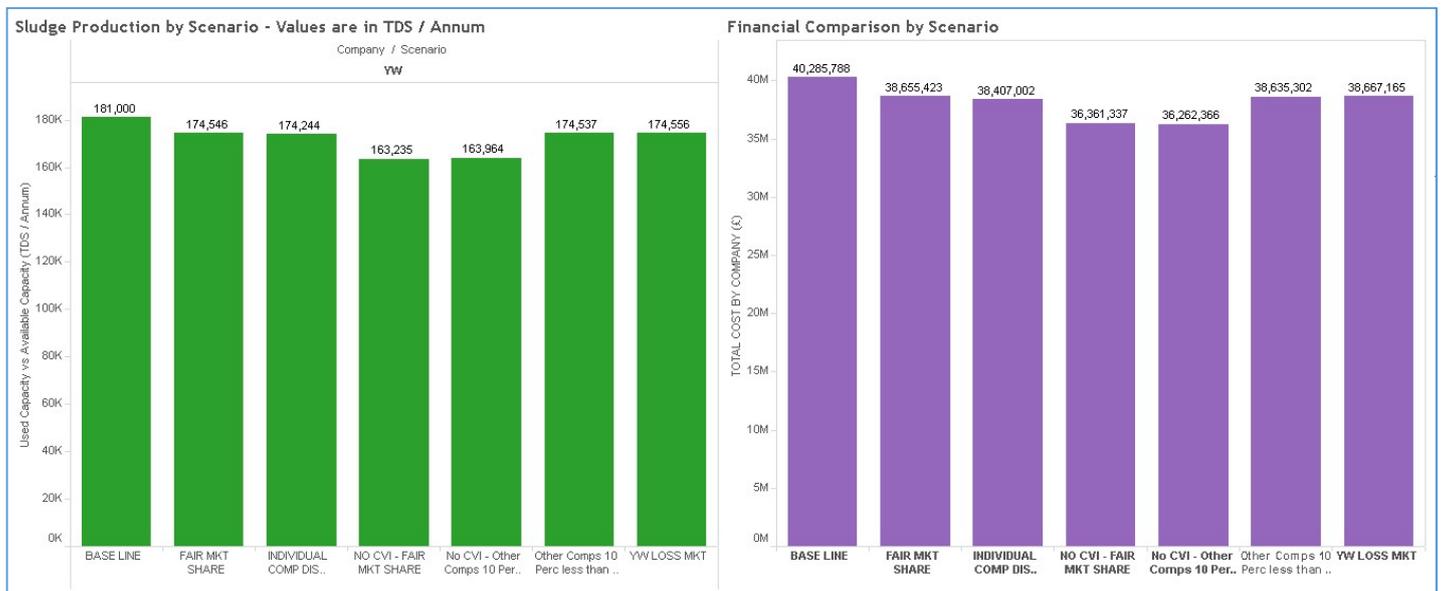
- This dashboard is a larger version of the Loss Gains Dashboard Map, allowing the user to analyse which STWs have been allocated to which companies for each scenario.



4. Discussion

The graphic below, an excerpt from the Financial summary dashboard, shows in all scenarios that there is a loss of sludge production volume when compared to the Base Case. Similarly, in the bar graph showing the total costs by scenario, it can be seen that there is a corresponding reduction in total costs for YW.

In essence, it can be seen that the scenario results can be classified into 2 distinct groups when comparing to the base case. The two scenarios that exclude Calder Valley Incinerator (CVI) are in one group and seem to have the greatest negative volume impact on the organisation while the 4 scenarios that include CVI, are in a second group, and are all comparable in terms of volume and cost.

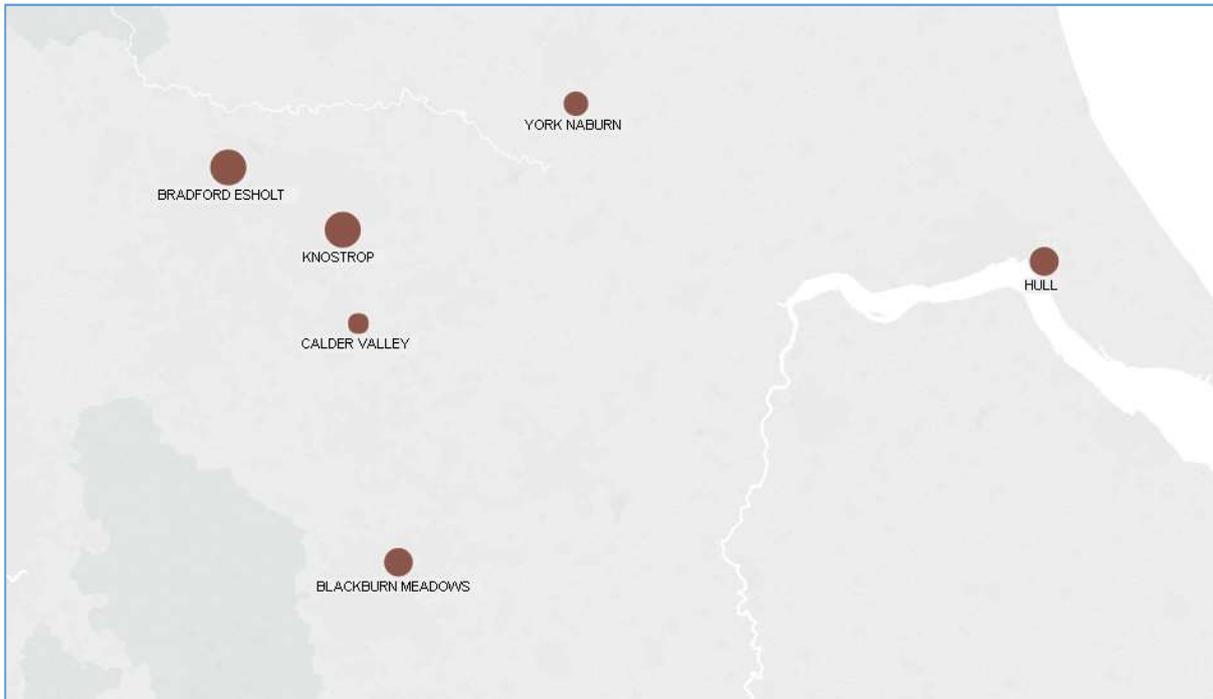


Graphic - Financial comparison by Scenario & Volume comparison by Scenario

Scenarios that exclude CVI, result in a larger sludge volume reduction, this has been driven by a combination of high treatment costs at Knostrop and high utilisation levels at Blackburn Meadows and Bradford Esholt. In addition handling costs in the form of dewatering at CVI, sludge cake logistics and re-wetting and then handling at the sludge cake reception facilities has also driven this volume reduction.

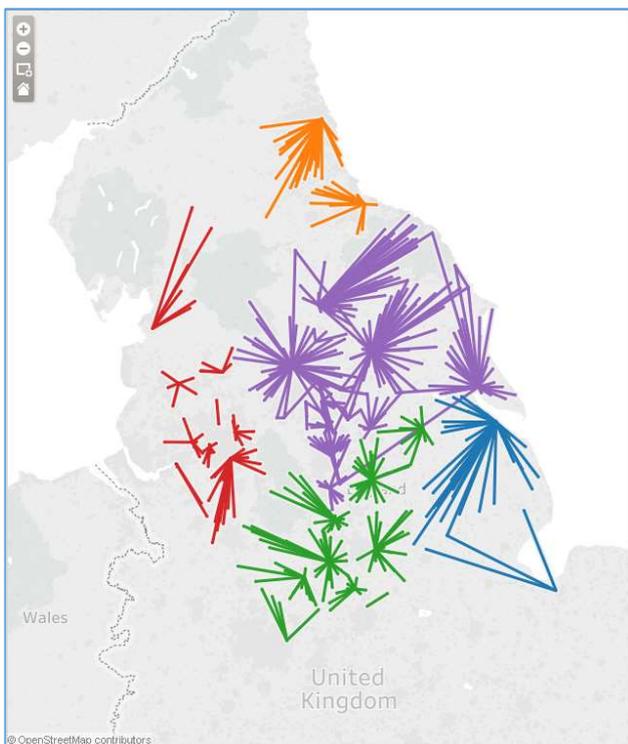
The model has, as an alternative, chosen to re-allocate the STW volumes to other WASCs as this reduces the overall system cost, by eliminating over stressed assets, the double handling and resulting higher treatment costs.

The graphic below shows the sludge cake reception facilities in the model that CVI cake can now be sent to for treatment. An alternative to this will be for the model to re-allocate sludge volumes to neighbouring WASCs to reduce overall costs.

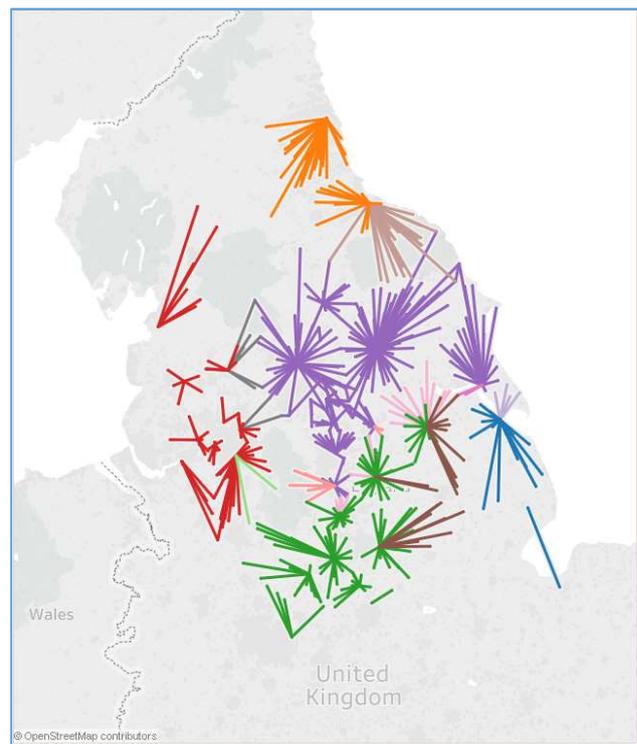


Graphic – Indication of Sludge Cake Reception Facilities

The second group of scenarios, which includes CVI, as a treatment facility and which merely differ in terms of treatment costs, seems to indicate very little difference in overall volume or cost. This seems to indicate that sludge logistics has a significant difference in the resulting mix of how STWs will need to be serviced to truly reduce Totex.



Graphic – Base Case Logistics allocation



Graphic – Fair Market Share Logistics Allocation

In the two graphics above, with base case on the left and a Fair Market Share scenario on the right, it can be seen that a significant number of STW in the North East of Yorkshire have been re-allocated to Northumbrian Water. This is based mainly on the cost of logistics to service the STWs in that region and the fact that Northumbrian Water has a facility that is well positioned to service this volume.

In a similar manner, there are sites on the southern Yorkshire border that are re-allocated to Severn Trent, as well as Anglian Water, with other sites that are re-allocated from Severn Trent Water to Yorkshire Water.

In some studies that BMA has conducted, it has been shown that the benefits of thickening and / or dewatering should not be underestimated and could play a significant role in YW retaining some of the volume indicated as being lost by the scenarios. This is especially significant where long logistics distances are regularly travelled.

5. Recommendations.

It is essential that an accurate picture be portrayed when performing studies such as this. BMA recommends that these scenarios be incorporated in a model that fully considers the Totex impact to the business of each scenario.

Some considerations that BMA would suggest including in a Totex model would be the ability of the model to consider thickening and dewatering options to reduce logistics costs as well as considering the capital and operational requirements of treatment over time, so that the total costs for YW / Kelda can be minimised, subject to requirements.

BMA will be producing a strategic Totex model for sludge to support PR19 and PR24 investment. We recommend that the outcomes from this project are considered in conjunction with the wider totex project to provide outcomes that are optimised for investment, commercial and operational strategies.