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Faulder Water Upgrade

Presented to:

Regional District Okanagan-Similkameen

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Executive Summary

This report was written to generate a set of recommendations to the RDOS regarding the best steps forward in the Faulder water upgrade project. Our team has reviewed Faulder's current situation in addition to the technical memorandum from Associated Engineering and have applied various decision analysis to reach a conclusion.

Our approach is based on developing a core baseline model that encompasses the attributes of cost, ability to meet water quality standards, and ability to meet water quantity demands. These attributes comprise of the top concerns revolving the Faulder water upgrade project and are therefore at the core of our methodology.

Based on our methodology, we recommend the pipeline contingent upon Summerland approving the request. Otherwise, constructing a new well is the next best alternative.

Objective and Scope

The objective of this report is to (1) review the Faulder situation by examining primarily the Associated Engineering technical memorandum and (2) come up with a set of recommendations to the Regional District of Okanagan-Similkameen (RDOS) regarding the best steps forward (from the perspective of 2008).

The conducted analysis is mainly focused at re-evaluating existing alternatives with the perspective of taking into account various uncertainties related to each option. It is out of scope to come up with alternatives other that are presented in the Associated Engineering technical memorandum as it would be impossible to apply same models and methods that consultants used. It is also out of scope to take into account the availability of government grants as they are independent from the alternative chosen.

Baseline Model

Given the list of project alternatives provided by Associated Engineering, we have identified a number of "dominated" alternatives which are equal or worse along all dimensions compared to others. In response, we have developed a set of baseline criteria to set a standard for the chosen solution and to filter out inferior alternatives.

Baseline Requirements:

Water Quality

- Treated water quality must score at least "average" in conformance with IHA requirements
- Treated water quality must score at least "average" in risk of human consumption of non-potable water from system

Water Quantity

- Water quantity must score at least "average" in available source capacity to meet projected demands

Removal of Dominated Alternatives

- In accordance to our baseline criteria, we thereby eliminate the following alternatives from the Associated Engineering report:

Alternative number	Alternative name	Reason
1	Existing well - full ion exchange	Unable to meet quantity standard
2	Existing well - blended ion exchange	Unable to meet quantity standard
7	Existing well - point of entry treatment	Unable to meet quality standard
8	New well - point of entry treatment	Unable to meet quality standard
9	Trout Creek Ranney Well - point of entry treatment	Unable to meet quality standard

- We additionally filtered out alternative 4 (New Well, blended ion exchange treatment) as it was highly identical to alternative 3, but was dominated in accordance to baseline criteria.
- The option to do nothing is filtered out as it is also a dominated alternative (unable to meet quantity and quality standards).
- As a result, the remaining viable options for consideration are alternatives 3, 5 and 6.

Objectives and Weights

A swing weighting analysis for attributes was conducted to determine individual weights for each attribute. The swing weight process was conducted as follows:

We first identified the attributes for swing weighting analysis which are "cost", "quantity", and "quality". Next, we associated a matching criteria column from Associated Engineering's report to each attribute. The matches are as follows:

Attribute name	Associated Column Criteria
Cost_weight	Net Capital Cost
Cost2_weight	Total Annual Cost per Lot
Cost3_weight	Potential Additional Ongoing Costs
Quantity_weight	Capacity
Quality_weight	Treatment Conformance with IHA Requirements

Due to Associated Engineering's report having multiple columns associated with cost that we believe are important to include, we decided to create additional cost attributes (cost2_weight and cost3_weight) to pair them with.

Option	Associated with				
	Cost	Cost	Cost	Quantity	Quality
	Net Capital Cost	Total Annual Cost Per Lot	Potential Additional Ongoing Costs	Capacity	Treatment Conformance With IHA Requirements
3	$ 402,000.00	$ 670.00	Average	Good	Excellent
4	$ 369,000.00	$ 574.00	Average	Good	Good
5	$ 342,000.00	$ 633.00	Poor	Good	Excellent
6	$ 413,000.00	$ 743.00	Average	Good	Excellent

Next, we began the swing-weighting by developing six combinations. Combination 1 is the benchmark model and consists of the worst outcomes from each column criteria. Combinations from 2 to 6 each consist of a different "best" possible value, leaving other variables held constant at worst values.

Combination	Description	Net Capital Cost	Total Annual Cost Per Lot	Potential Additional Ongoing Costs	Capacity	Treatment Conformance With IHA Requirements	Rank	Rating	Weight
Combination 1	Benchmark, worst in all	413000	743	Poor	Good	Good	6	0	0
Combination 2	Best Net Capital Cost	**342000**	743	Poor	Good	Good	2	80	0.2857
Combination 3	Best Total Annual Cost per Lot	413000	**574**	Poor	Good	Good	1	100	0.3571
Combination 4	Best Potential Additional Ongoing Costs	413000	743	**Average**	Good	Good	3	60	0.2143
Combination 5	Best Capacity	413000	743	Poor	**Good**	Good	6	0	0
Combination 6	Best Water Treatment Conformance with IHA	413000	743	Poor	Good	**Excellent**	4	40	0.1429
							TOTAL	280	

Following, we assigned ranks to each alternative based on what we believe makes the greatest business sense to the project. The following table explains our logic in how we assigned ranks to the combinations:

Combination	**Rank**	**Reasoning**
1 - Benchmark	6	The benchmark is the the dominated combination. As such, it is the lowest ranked combination
2 - Best Net Capital Cost	2	We weighed this combination second because it is a large fixed upfront cost to initiate an alternative. If the net capital cost is too high, the government will not have sufficient funds to carry the upfront cost
3 - Best Total Annual Cost per Lot	1	We strongly weighed "total annual cost per lot" due to the fact that it is a continuing variable cost into the future. Over the long-term, the accumulated cost will be greater than the net capital cost.
4 - Potential Additional Ongoing Costs	3	We weighed this combination third because it accounts for potential cost risks in the future. While it is uncertain, it is still an important cost variable to account for.

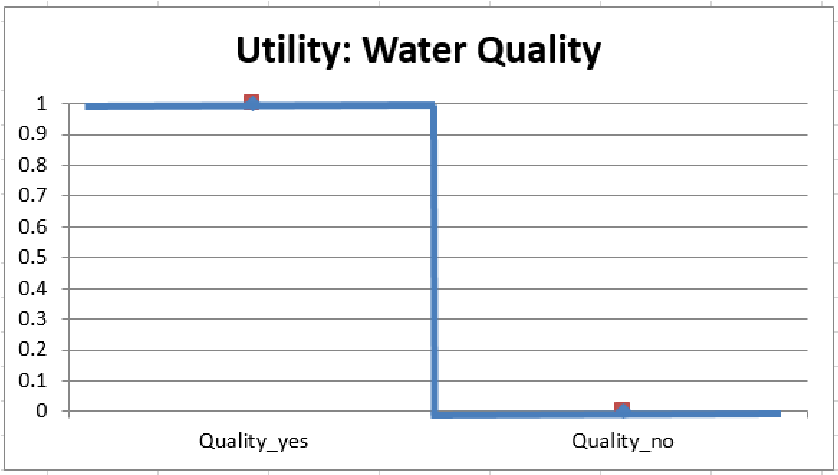
5 - Best Capacity	6	This combination is ranked sixth as opposed to fifth because it is an exact match of the benchmark model. This occurrence is due to the remaining viable alternatives 3, 4, 5, and 6 all sharing the same score of “good” under capacity. Capacity is therefore not weighed strongly as there is no concern for a chosen alternative to have lacking water quantity.
6 - Best Water Treatment Conformance with IHA	4	This combination is ranked fourth because the remaining viable alternatives 3, 4, 5, and 6 already conform with IHA standards. As such, there is no concern for a chosen alternative to have unsafe water quality.

Our final weights for the attributes are as follows:

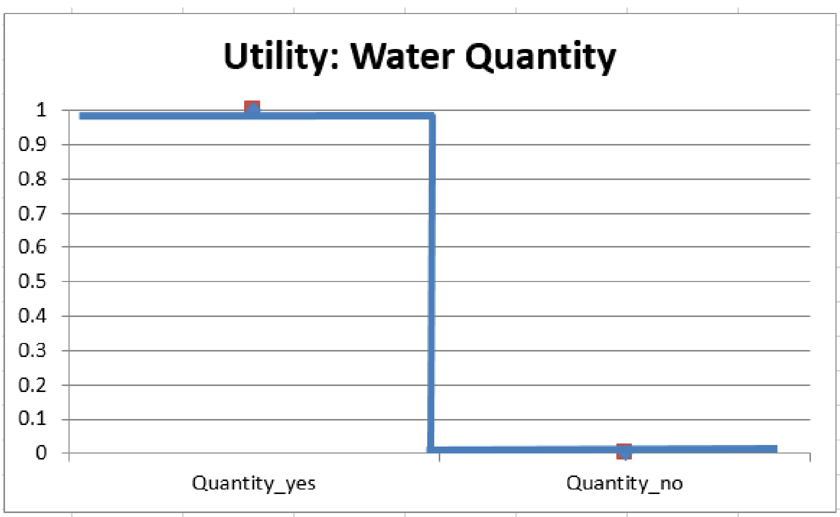
Attribute	Weight
Cost_weight	0.286
Cost2_weight	0.357
Cost3_weight	0.214
Quanity_weight	0.000
Quality_weight	0.143
Total	**1.000**

Utility Maps

The water quality utility map reflects that the water is safe up to 0.02mg/L at which point the utility immediately drops from 1 to 0 as it becomes unsafe.

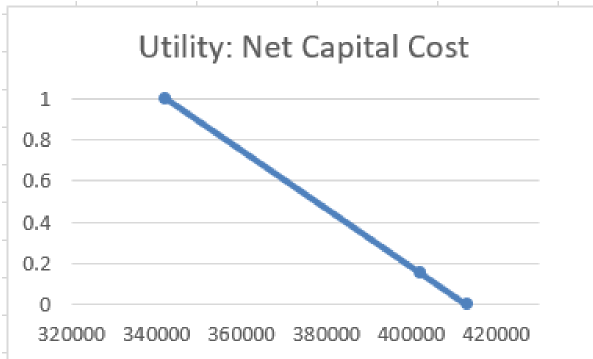


The water quantity utility map is similar in that it is sustainable up to a particular volume at which point the utility immediately drops from 1 to 0 as it becomes unsustainable.



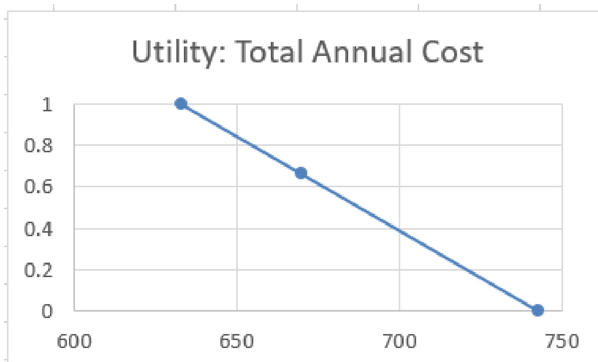
The net capital cost utility map includes the new well, pipeline, and Ranney well options. Pipeline ($342000) was assigned a utility of 1 as its low cost is the most preferable, while Ranney well ($413000) was assigned a utility of 0, as it was the least preferable. The utility for the new well ($402000) was derived by assuming a linear utility: we assigned its utility relative to the cost of Ranney well and the pipeline.

Net capital cost	Utility
402000	0.15493
342000	1
413000	0



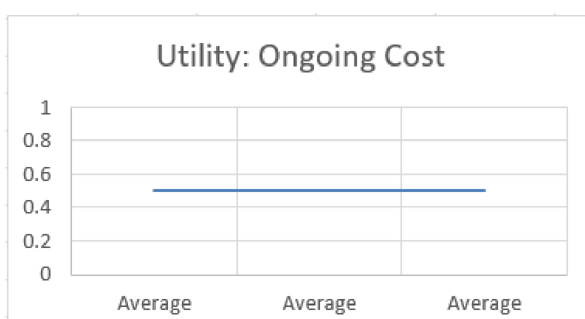
The total annual cost utility map includes the new well, pipeline, and Ranney well options. Pipeline ($633) was assigned a utility of 1 as its low cost is the most preferable, while Ranney well ($743) was assigned a utility of 0 as its high cost is the least preferable. The utility for the new well ($670) was derived by assuming a linear utility: we assigned its utility relative to the cost of Ranney well and the pipeline.

Total annual cost	Utility
670	0.66364
633	1
743	0



The ongoing cost utility map is constant at 0.5 as all alternatives were given a score of Average.

Ongoing cost	Utility
Average	0.5
Average	0.5
Average	0.5



Multi-Attribute Utility Theory Matrix

To conduct the multi-attribute utility theory, we began by referencing the attribute weights obtained from the swing weight analysis.

Weights	0.29	0.36	0.21	0.00	0.14	1.0
Alternative	**Cost (net capital cost)**	**Cost2 (total annual cost per lot)**	**Cost3 (potential additional ongoing cost)**	**Water Quantity**	**Water Quality**	**Total**
New well	60	120	90	200	250	115.00
Pipeline	78	120	0	200	250	100.86
Ranney	57	120	90	200	250	114.14

Each alternative was scored against the attributes and the score values were directly drawn from “Table 3 - Long Term System Options Rating” in the technical memorandum by Associated Engineering. A total weighted score was then assigned to each alternative. These scores represent the total weighted utility offered by each alternative.

Decision Tree Analysis

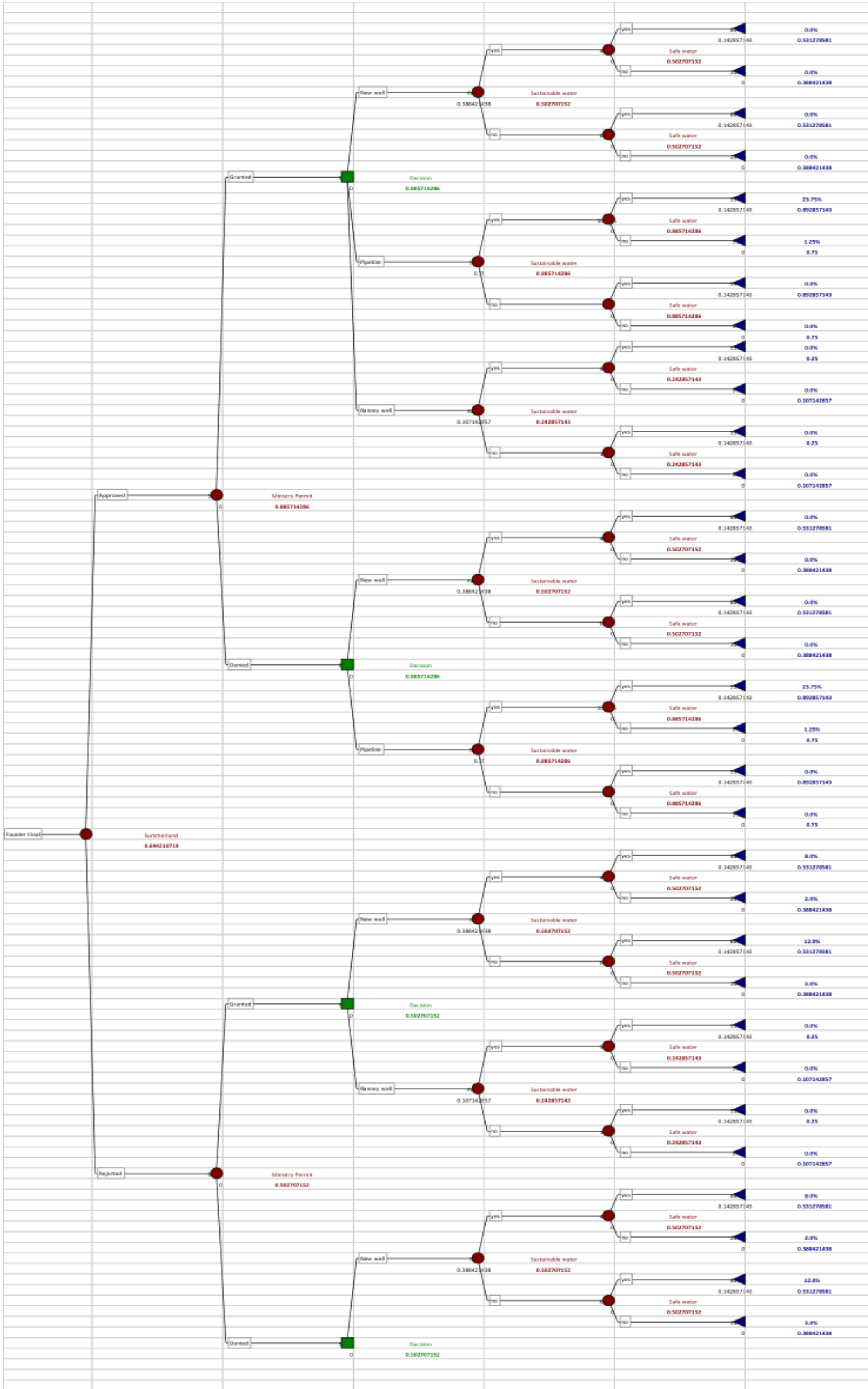
The following is the list of uncertainty reduction strategies that is reflected by the final decision tree:

- Discuss with the District of Summerland if they approve our alternative to purchase treated water from them
- Get an approval from the Ministry of Environment for extracting water from Trout Creek

Two levels of event nodes have been moved to the root of the final tree. They represent uncertainty reduction strategies that are described above. All the necessary information that is possible to be gathered beforehand is going to be collected prior to selection of an alternative. Given the results from the collected information, non-viable alternatives are pruned from the decision tree.

The decision tree analysis revealed that only the District of Summerland's decision influences our recommendation. The recommended alternatives remain unchanged regardless of the Ministry of Environment's decision.

The following is the final version of the decision tree (please refer to the Excel sheet for more details):


Faulder Final
Summerland
Approved
Rejected
Ministry Permit
Granted
Denied
Decision
New well
Pipeline
Sustainable water
Safe water
yes
no

Recommendation

As described in the Decision Tree Analysis section, the recommendation is dependent on the information collected after completing uncertainty reduction strategies. The following is the list of assumptions that affect our recommendation:

- Assume that time is not a vital issue and that the information about aquifer levels, Summerland, and the Ministry of Environment are made known to us at the same time before making a decision. That is, we do not make a decision based on partial information;
- Assume that the chance events are all independent and do not affect each other;
- Assume that combinations of alternatives are out of scope
- Assume that utility for cost is linear, and utility for quality/quantity is stepwise.

The only decision that influences our recommendation is the approval process result of the District of Summerland. If their decision is to approve the pipeline, then the best course of action is to build the pipeline. Otherwise, building a new well is the next best alternative.