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March 10, 2024

Future Clean Water and Wastewater Fund (FCWWF) of Infrastructure Canada
100-1000 Pacific Street
Vancouver, BC, V1W2X3

Dear Future Clean Water and Wastewater Fund (FCWWF) of Infrastructure Canada:

My name is Peter Parker and I am an engineer at Upsilon Tria currently working with the community of Van Anda to develop a water treatment system in hopes of addressing the community's current and future water needs. I am writing this letter on behalf of the community, with an Expression of Interest (EOI) for your organization to review, hoping that you will consider us for funding support. This project represents a significant step forward in securing a reliable water future for Van Anda, and your support would help make our vision a reality.

Our approach to Van Anda's water challenges has the community at the forefront, as we believe that collaboration with the community is the key to creating a successful solution. Through a thorough analysis and consultation process, our team has identified key insights into Van Anda's water challenges, highlighting both current concerns and anticipated future needs. Our recommendation for the community is to optimize the current decentralized water treatment system by renovating and repairing the current infrastructure in place to address these challenges. As outlined in our Expression of Interest (EOI), our proposed solution enhances both resiliency and efficiency while also promoting an environmentally sustainable and sound option. Additionally, we believe that this project may also be economically advantageous, primarily due to its potential to generate employment opportunities within the community as proven through our comprehensive Streamlined Life-Cycle Assessment (SLCA).

We firmly believe that investing in the improvement of Van Anda's water treatment system aligns with the objectives of the Future Clean Water and Wastewater Fund, and we are confident that our EOI encapsulates our deep commitment to Van Anda's water future. If given the opportunity, we would be eager to further discuss our proposal and provide additional details on our recommended solution. Thank you for considering our application, and we look forward to creating a brighter, water-secure future for the community of Van Anda.

Sincerely,

Peter Parker

Peter Parker, P. Eng.
Enclosures:

1. Expression of Interest (EOI)

Expression of Interest

Concerning Water Security in Van Anda, British Columbia

1. Problem Statement

Van Anda, a community of about 700 residents situated on Texada Island in the Northern Gulf of Georgia, has expressed an urgent need for improved water treatment infrastructure. This necessity arises from unpredictable weather patterns and the growing population. At present, the community primarily relies on Priest Lake to meet its water demands. Yet, its ability to adequately provide the population with safe, potable water has been hindered by environmental risks like floods and droughts in recent years. These factors have caused an increase in turbidity levels, raising concerns about potential contamination. Additionally, the current infrastructure is prone to leaks resulting in the loss of one-third of the total water supply before usage by residents.

While the community is exploring options for alternative water sources and treatment methods, there remains distress regarding groundwater pollution stemming from nearby mining activities conducted by the Lafarge Group. Nevertheless, the residents of Van Anda are keen to maintain their collaborative relationship with the organization, which has been an active member of the Van Anda Improvement District responsible for monitoring their water quality and engaging in consultation processes to address any arising issues.

Located on an island, Van Anda is dependent on sea transportation to connect with key centers on the mainland or Vancouver Island. As a small tight-knit community, it is integral to involve residents in the implementation of the water system, and there must be regular consultation with the community. Additional consideration needs to be taken, given the remote nature of the community, for individuals who might lack immediate access to electricity or modern amenities. Therefore, any proposed water system must be safe, climate-resilient and financially sustainable with minimal maintenance requirements to benefit the community.

2. Potential Solutions:

2.1 Option 1: Modified Existing Water Treatment Plant Supplied by Priest Lake (Semi-decentralized)

2.1.1: Description of Solution

This semi-decentralized solution focuses on optimizing the current centralized water treatment infrastructure in order to minimize the leakage and lost water in the current system, and ensuring the demand for consistent access to safe potable water is met. Further, it includes the option to ship in water in the case of depleted source water, which increases the resiliency of the solution.

Three components are considered in this solution. Firstly, improving the current system so that the water consistently meets safe water standards. Then, redesigning and optimizing the distribution system so that it is resilient to disturbances. As well as ensuring the health and protection of the water source through collaboration and communication between members within the Van Anda district. These three components work with and against each other, hence, it is integral that each is satisfied.

Implementing the revised water system would lead to a decrease in water stress, an increase in local societal health and a possible increase in population (Appendix A). By improving the current system, it reduces the cost and waste caused by the shipments of water.

2.1.2: Environmental Impact

The Priest Lake area might face some disruptions as a result of upgrades to water treatment methods and changes in the distribution system potentially causing effects on the environment. Nevertheless implementing a reliable system that reduces leaks and frequent disturbances linked to repairs could result in an overall improved environmental state, in the long term.

2.1.3: Economic Viability and Sustainability

The upfront costs are those associated with implementing a new water treatment system, where similar systems were estimated at around $200 000. Further costs include operation and maintenance, costs associated with the new distribution system and minimal costs of the protection plan. Operation and maintenance would be locally sourced.

2.1.4: Social Sustainability

The suggested facility catering to the needs of the populace provides social advantages like utilizing resources from the area and involving the community in its redesign. By operating on a localized scale, residents can receive training and oversee the functioning of the center. Typically the preferred choice is to have access to drinking water through a system created by the community. Nevertheless, it's important to assess project expenses to guarantee benefits, for every member of the community.

2.1.5: Additional Considerations

The source water of Priest Lake is susceptible to environmental disturbances, as natural hazards can lead to increased turbidity or a generally diminished supply. Hence, there is a concern among the community that water insecurity may arise due to changing conditions. Having the option to ship in water at times when the source water is low or not able to meet standards will make the system.

Further concerns arise with the resiliency of the water shipment. As outlined in 2.2.5, water shipment is susceptible to supply chain and transportation problems. Further backup water options include well-water or rainwater collection.

2.2 Option 2: Periodic Shipments of Water to the Community (Centralized)

2.2.1: Description of Solution

This centralized solution involves the bulk shipment of treated, bottled water from a mainland water treatment plant to the island of Van Anda. The bottled water is then distributed directly to each household for consumption. Overall, this method offers a reliable and efficient means of addressing the demands for safe and potable water in the community while ensuring the well-being of the residents.

This method helps address worries about running out of water for locals depending solely on Priest Lake. The ample water resources from the mainland are less likely to be influenced by weather conditions or an increase in population. Nevertheless, it is crucial to consider the drawbacks concerning the environment, economy and community well-being, as outlined in Appendix A.

2.2.2: Environmental Impact

The production of plastic containers requires high energy consumption, intensifying greenhouse gas emissions and air pollution. These negative impacts are exacerbated by the transportation of bottled water from the mainland to Van Anda. Increased demand for bottled water also results in greater waste generation endangering marine creatures and ecosystems. Therefore, this option is impractical in the long run due to these adverse effects.

2.2.3: Economic Viability and Sustainability

Taking into account the costs associated with the manufacturing of containers, packaging and shipping of bottled water, and management of disposed containers, continuously relying on this method can exacerbate the financial burden on the stakeholders. This in turn results in reduced economic activity within the community, which affects local economic health.

2.2.4: Social Sustainability

While this option may introduce employment opportunities for the distribution process, it also reduces the community's reliance on locally available resources for satisfying their daily needs. Consequently, this may cause a decline in community engagement, which could have otherwise been maintained through water conservation efforts.

2.2.5: Additional Considerations

The bulk shipment of water is vulnerable to delays or cancellations of ferries, but is fairly resilient when subjected to unexpected weather, population growth or other climate-influenced disasters. The only major concern is its low sustainability and the associated long-term effects addressed above.

2.3 Option 3: Pipeline from Mainland

2.3.1: Description of Solution

Another option for a centralized solution consists of constructing a submarine pipeline from the Mainland to Van Anda which transports treated water to the community from a treatment plant located on the Mainland. This solution considers that the Mainland has reliable water treatment infrastructure which Van Anda can rely on while eliminating the usage of plastic bottles and the need for transportation via ferry between the two regions.

2.3.2: Environmental Impact

While it is important to consider the potential impacts that a submarine pipeline has on the marine environment, it is worth noting that the long-term presence of the submarine pipeline generally is not expected to have significant adverse effects on a marine ecosystem. However, the extraction of raw materials and the energy usage during the construction of the pipeline may contribute a greater amount to total carbon emissions compared to other proposed solutions. In the Streamlined Life Cycle Assessment (SLCA), the pipeline scored poorly for energy usage and resources used in its raw material and production stages of its life (Appendix B).

2.3.3: Economic Viability and Sustainability

A large-scale project such as the construction of the submarine pipeline has the highest estimated upfront cost when compared to other proposed solutions. Generally, pipelines are estimated to cost approximately $5 million / km to construct, and the hefty upfront cost may not be viable for the stakeholders financially.

2.3.4: Social Sustainability

While the construction of the pipeline may require outsourcing skilled laborers, this large-scale project may offer employment opportunities for those in the community. Operating a system such as a pipeline and maintaining it requires operators on the Mainland's end, and thus such a system might not be self-sufficient in the context of the Van Anda community.

2.3.5: Additional Considerations

Submarine pipelines have the risk of being damaged due to ship anchors, corrosion, or tectonic activity. If not constructed with durable materials, an increase in pipeline maintenance may be required. This adds extra financial burden onto stakeholders long-term, and could potentially disrupt the marine environment and ecosystem surrounding the pipeline.

3. Final Design & Justification:

3.1: Identifying the Solution

A Streamlined Life Cycle Assessment (SLCA) was performed on each of the potential solutions (see Appendix B). This assessment is a qualitative method that gives insight into the long-term negative impacts of the project. The SLCA assigns scores to each life-cycle stage of the solution, from raw materials to end of life, in the categories of: resources used, waste generated, energy used, and public health, which then produces a summative score called the Environmentally Responsible Product Rating (R_{ERP}). A higher score means it is a more sustainable option.

The SLCA for Option 1 yielded the highest overall R_{ERP}, while Option 3 yielded the lowest. While the Option 3 pipeline was rated a "good" in most of the Disposal category, the fault of the solution was the sheer amount of material, waste and environmental disturbance that would be required in the early life-cycle stages. Conversely, Option 2: Bulk Water Shipment scored "fair" in the earlier life cycle stages, but lacked long-term sustainability, as shipping in bottled water would lead to a long-term problem of waste disposal.

Further evaluation of the options was done using a Weighted Decision Matrix (WDM), which quantitatively compared the results using weighted criteria. In consultation, the community members expressed that they needed a system that can adapt to disturbances, affordable up-front and low long-term maintenance costs, environmentally sustainable, has the ability to adapt to population growth, and is able to be operated and overseen by community members. The six key evaluation criteria are as follows: resilience, low upfront-costs, low long-term costs, minimal environmental impact, capacity and community involvement. Largest weights were given to resilience, cost and community involvement, as they were the areas of the highest concern.

The WDM determined that Option 1 was the most promising option for the community (Appendix C). We tested the sensitivity of this result and it held strong, which indicates it is the most appropriate solution.

3.2 Final Proposed Solution

3.2.1 Summary

We recommend that Van Anda modifies their current centralized water system that uses Priest Lake as a water source. Specifically, we propose a 4-step treatment system, a grid-distribution and an outline of the need for source water protection.

3.2.2 Water Treatment System

The water purification system needs to eliminate pathogens and potential hazards from the water source. It is essential to carry out filtration, primary disinfection and secondary disinfection. According to a study conducted by RESEAU WaterNET VAID in 2017, a suggested method for water treatment consists of Cartridge filtration disinfection, using UltraViolet light and secondary disinfection with Chlorine. These measures guarantee the safety of drinking water.

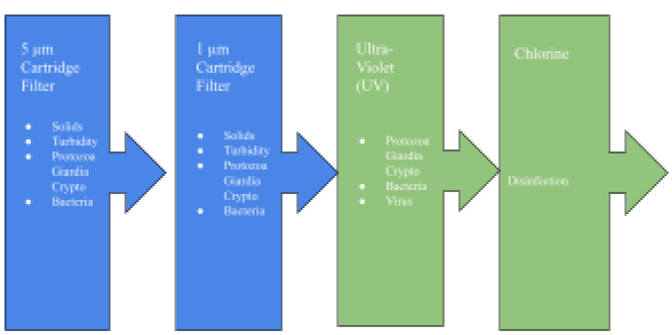

Fig. 1. Water Treatment Design Process

Out of the available centralized water treatment options for the water source, this one was the most cost-effective and had the highest score in qualitative analysis (Appendix D). The two cartridge filters remove the larger contaminants, while pathogens are removed by the UV. The chlorine is for secondary disinfection.

3.2.3 Distribution

To reduce the severity of leakage in the distribution infrastructure, we propose to implement more redundancy into the piping networks. Having a grid-like system, or multiple pathways across the community will ensure more resiliency for the community members since if a problem occurs, it will be able to be managed.

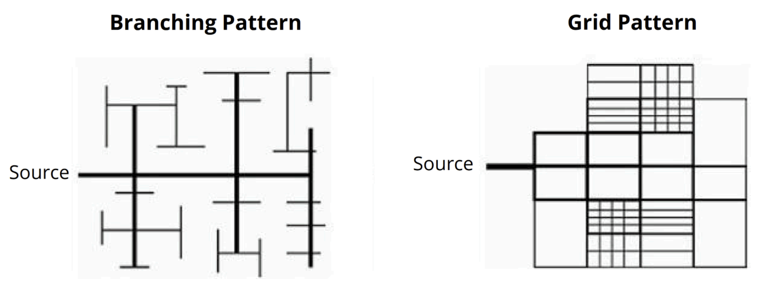

Fig. 2. Grid vs. Branching Distribution (Source: UBC APSC101)

3.2.4 Source Water Protection

Priest Lake is susceptible to environmental and anthropogenic disturbances, which can consequently affect the quality of the water brought into the treatment system. Cooperation with the mining industry due to their proximity is essential. The water source needs to be protected by constant monitoring of the system. Any risks that arise, must be mitigated or removed in a timely manner.

4. Engagement, Learning and Synthesis Strategies

When creating a major change to a community's infrastructure, it is essential that the community is involved throughout the process. As part of the project, we have created an engagement plan which aims to keep the community involved throughout the implementation of our design (see Appendix E).

The activities before the project aim to allow the community to express their concerns with it before it starts. It also allows the engineering team to address any uncertainty with the project, and implement ideas from the community. During construction, community workshops and site visits create transparency with the project. Community members are able to see exactly what is being done to their water treatment system, and learn how it will work once it is finished. After completion, the community will be able to tour the plant, learn how it is operated, and have another opportunity to ask questions and raise concerns directly with the engineering team.

To track success, periodic surveys will be conducted by both the town's council, as well as the engineering team. The surveys will ask the community members both about the water quality, as well as engagement with the project. The engineering team will also revisit the community after six months for a feedback session. The resources used during the engagement plan include renting space for the events and paid-time for the organizers. These resources are justified because the plan will allow the community to engage with the project and will allow them to give the engineers ideas specific to them.

5. Appendix

Appendix A: Causal Loop Diagrams (CLD's)

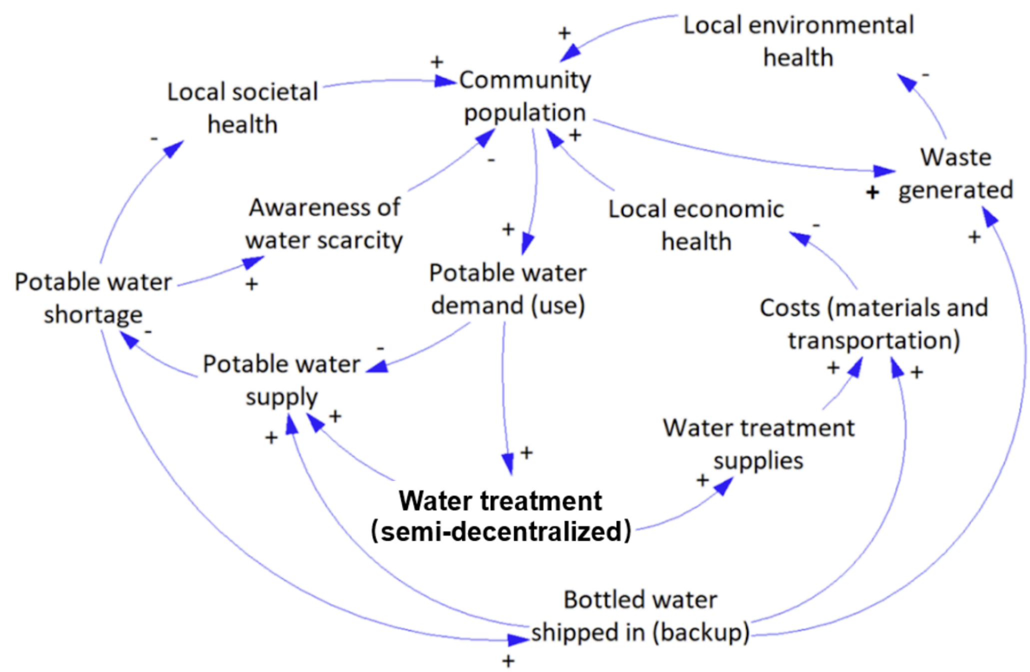

Fig. 3. Qualitative Analysis of the Impacts of Option 1.

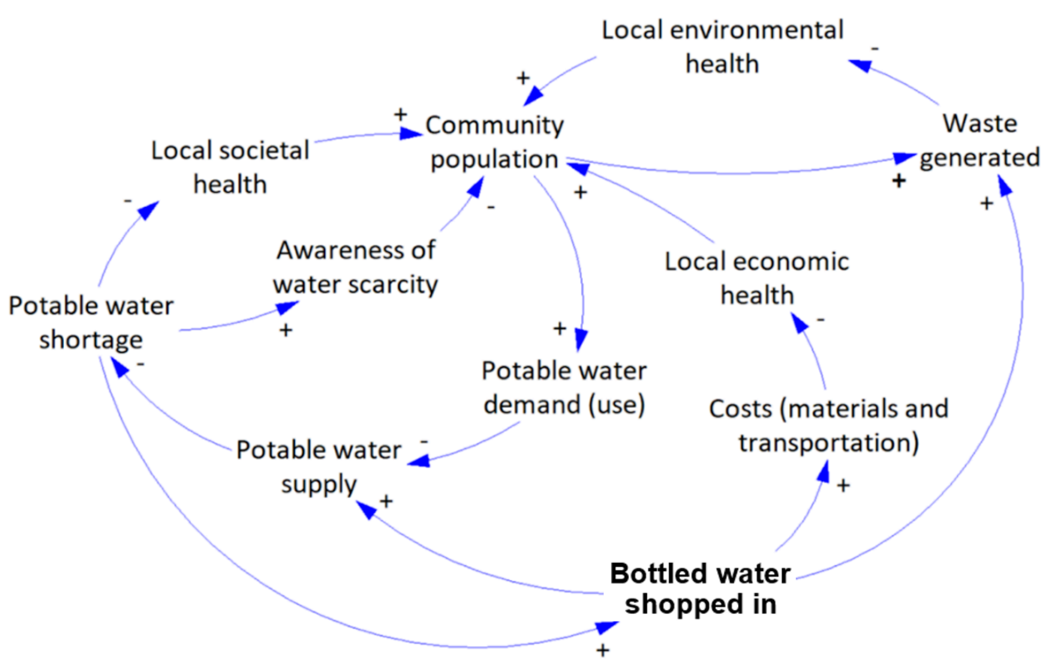

Fig. 4. Qualitative Analysis of the Impacts of Option 2.

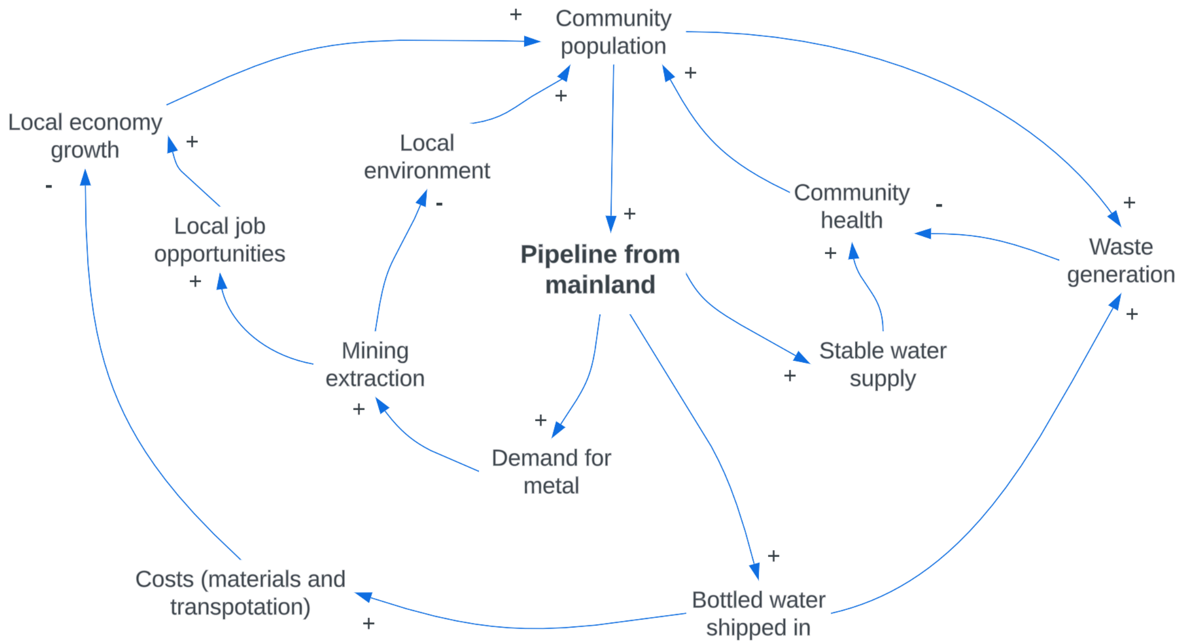

Fig. 5. Qualitative Analysis of the Impacts of Option 3.

Appendix B: Streamlined Life Cycle Assessments (SLCA's)

Table 1: Option 1: SLCA

Option 1 – Water Treatment from Priest Lake (semi-decentralized)					
	Material	**Production**	**Distribution**	**Disposal**	**Total**
Resources used	2	2	2	3	
Energy usage	1	2	3	2	
Waste generation	2	3	3	2	
Public health	3	3	4	3	
Total	**8**	**10**	**12**	**10**	**40**

Table 2: Option 2: SLCA

Option 2 – Supply of bottled water (centralized)					
	Material	**Production**	**Distribution**	**Disposal**	**Total**
Resources used	2	1	1	2	
Energy usage	1	1	2	2	
Waste generation	2	1	3	1	
Public health	2	2	3	3	
Total	**7**	**5**	**9**	**8**	**29**

Table 3: Option 3: SLCA

Option 3 – Pipeline					
	Material	**Production**	**Distribution**	**Disposal**	**Total**
Resources used	1	1	2	3	
Energy usage	1	1	2	2	
Waste generation	1	2	3	2	
Public health	2	2	3	3	
Total	**5**	**6**	**10**	**10**	**31**

Appendix C: Weighted Decision Matrix (WDM)

Table 4: Weighted Decision Matrix - Raw Scores and Criteria

Criteria	**Criteria Explanation**	**Weighting**	**Option 1**	**Option 2**	**Option 3**	**WDM Assumptions**
Resilience	The ability of the solution to adapt to disturbances	0.2	5	2	8	This considers the source, treatment and distribution of the water.
Low upfront costs	Upfront costs are those needed to initially implement solution	0.2	5	8	0	Upfront costs encompass the building of the structure and acquisition of materials. Assuming there are no unforeseen expenses.
Low long-term costs	Long-term costs are those needed to maintain solution	0.2	7	3	8	Long-term cost assumes that infrastructure is built properly and requires minimal maintenance .
Minimal environmental impacts	Measures the environmental sustainability of the solution	0.15	8	0	6	Takes into account the environmental impacts through the usage of energy, production of waste, and potential disruptions in the ecosystem at all stages of the life-cycle of the system.
Capacity	The ability of the system to adapt to changes in population	0.1	6	3	9	Capacity refers to the proposed solution's ability to adapt to an increased demand of potable water by the population. Assuming that the population growth will not deviate far from projected population trends.
Community Involvement	Involvement by community members in implementation and in operation	0.15	8	3	4	Community involvement is defined as how appropriate the technology is for the context of the region and how well the community is able to engage with it. If it is likely to frustrate or cause political tension, it is unlikely to foster community engagement.

Table 5: Weighted Decision Matrix - Weighted Scores

	Criteria	**Option 1**	**Option 2**	**Option 3**
Calculated Scores (table automatically copies criteria and calculates values)	Resilience	1	0.4	1.6
	Low upfront costs	1	1.6	0
	Low long-term costs	1.4	0.6	1.6
	Minimal environmental Impacts	1.2	0	0.9
	Capacity	0.6	0.3	0.9
	Community Involvement	1.2	0.45	0.6
TOTAL		**6.4**	**3.35**	**5.6**

Appendix D: RESEAU-WaterNET

Table 6 : Options investigated by RESEAU WaterNET VAID 2017

Option	Description
A	Cartridge Filtration + Ion Exchange + Ultraviolet (UV) + Chlorination
B	Cartridge Filtration + Ultraviolet (UV) + Chlorination
C	Bank Filtration + Ultraviolet (UV) + Chlorination

Table 7: Qualitative Metric Criteria (source: RESEAU WaterNET VAID 2017)

Qualitative Metrics	**Low (1)**	**High (5)**
Treatment Efficiency	Poor	Good
Reliability/Robustness	Poor	Good
Proven Technology	Uncommon	Common
Mechanical Complexity	Very Complex	Least Complex
Operator Requirement	Lots of attention required	Low level of attention required
Operations and Maintenance	Major increase in operations time	No significant change to current operations time
Waste Management	Wastes generated during the treatment	No waste generated during the treatment
Constructability	Complex construction sequencing, difficult	No construction sequencing
Regulatory Acceptance	Highly likely to experience regulatory challenges	regulatory challenges Unlikely to cause regulatory challenges
Community Acceptance	Undesirable	Most Acceptable

Table 8: Qualitative Assessment (source: RESEAU WaterNET VAID 2017)

Qualitative Metrics	Option A	Option B	Option C
Treatment Efficiency	5	3	3
Reliability/Robustness	5	5	2
Proven Technology	5	3	2
Mechanical Complexity	2	3	4
Operator Requirement	2	2	3
Operations and Maintenance	2	3	4
Waste Management	1	2	3
Constructability	3	3	1
Regulatory Acceptance	5	2	2
Community Acceptance	3	3	3
Total	**33**	**29**	**27**

Table 9: Quantitative Metrics (source: RESEAU WaterNET VAID 2017)

Quantitative Metrics	Low (1)	High (5)
Capital Costs	Highest	Lowest
O&M Costs	Highest	Lowest

Table 10: Quantitative Assessment (source: RESEAU WaterNET VAID 2017)

Quantitative Metrics	Option A	Option B	Option C
Capital Cost	2	4	3
O&M Cost	2	3	4
Total	4	7	7

Appendix E: Engagement Plan

Table 11: Summary of engagement plan

Activity	Time	Organized by	Details
Q&A Session	Before the project	Engineering team, town council	Community members are able to ask questions to the engineering team regarding the project, and the town council is also able to answer questions regarding logistics of the project before it begins
Door-to-door outreach	Before the project	Engineering team	The engineering team will go door to door to get individual opinions on the project
Community workshops	During the project	Engineering team, town council	While working on the project, the engineering team can connect with the community using workshops, where the community can connect with the engineers
Site visits	During the project	Engineering team	While under construction, the community can visit the site to learn about the system and understand how their water will be treated
Surveys	After the project	Engineering team	The community can give feedback about the system to the engineering team and town council
Feedback session	After the project	Engineering team, system employees	After gathering feedback, the engineering team returns to the island to discuss the system and allow the community to share their ideas on ways to improve or change it