2020 Corporate Strategic Asset Management Plan

Appendix I
CVRD Vulnerable Infrastructure and Risk Assessments

CVRD Infrastructure Vulnerable to Climate Change Impacts

Table 1.0 – Asset Systems Located in Flood Plains

Asset System	Location	Flood Plain	Risk Assessment Complete
Water Systems	Honeymoon Bay Water	Cowichan Lake	Yes
	Mesachie Lake Water	Cowichan Lake	Yes
	Shawnigan Lake North Water	Shawnigan Lake	Yes
	Youbou Water	Cowichan Lake	Yes
Sewer Systems	Cowichan Bay Sewer	Cowichan & Koksilah Rivers	Yes
	Eagle Heights Sewer	Cowichan & Koksilah Rivers	Yes
	Mesachie Lake Sewer	Cowichan Lake	Yes
Recreation Centres	Island Savings Centre	Cowichan & Koksilah Rivers	No
Parks and Trails	Arbutus Parks and Trails	Cowichan Lake	No
	Bald Mountain Parks and Trails	Cowichan Lake	No
	Bear Lake Parks and Trails	Cowichan Lake	No
	Bell Irving Beach Access	Shawnigan Lake	No
	Boys Road Pullout	Cowichan & Koksilah Rivers	No
	Bright Angel Parks and Trails	Cowichan & Koksilah Rivers	No
	Busy Place Creek Parks and Trails	Cowichan & Koksilah Rivers	No
	Cannery Trail	Cowichan & Koksilah Rivers	No
	Central Parks and Trails (Honeymoon Bay)	Cowichan Lake	No
	Chaster Road Trail	Cowichan & Koksilah Rivers	No
	Cowichan Bay Boat Launch	Cowichan & Koksilah Rivers	No
	Cowichan Bay Marine Gateway	Cowichan & Koksilah Rivers	No
	Cowichan Valley Trail	Chemainus River & Cowichan Lake	No
	Hecate Parks and Trails	Cowichan & Koksilah Rivers	No
	Lakeview Parks and Trails	Cowichan Lake	No
	Lily Beach Parks and Trails	Cowichan Lake	No
	Maple Grove Parks and Trails	Cowichan & Koksilah Rivers	No
	Maplewood Parks and Trails	Cowichan & Koksilah Rivers	No

	Marble Bay Parks and Trails	Cowichan Lake	No
	Marble Bay Roadside Trail	Cowichan Lake	No
	Masons Beach Parks and Trails	Shawnigan Lake	No
	Mays Road Beach Access	Shawnigan Lake	No
	Memory Island Parks and Trails	Shawnigan Lake	No
	Mile 77 Parks and Trails	Cowichan Lake	No
	Miller Road Rest Area	Cowichan & Koksilah Rivers	No
	Nantree Parks and Trails	Cowichan Lake	No
	Old Mill Parks and Trails	Shawnigan Lake	No
	Price Parks and Trails	Cowichan Lake	No
	Recreation Road Boat Launch	Shawnigan Lake	No
	Robert Service Memorial	Cowichan & Koksilah Rivers	No
	Sandy Pool Regional Parks and Trails	Cowichan River	No
	Shawnigan Wharf Parks and Trails	Shawnigan Lake	No
	Stoker Parks and Trails	Cowichan Lake	No
	Swordfern Parks and Trails	Cowichan Lake	No
	West Shawnigan Lake Provincial Parks and Trails	Shawnigan Lake	No
	William Rivers Parks and Trails	Shawnigan Lake	No
	Worthington Parks and Trails	Shawnigan Lake	No
	Youbou Little League Parks and Trails	Cowichan Lake	No

Table 2.0 – Asset Systems Located within Sea Level Rise Projections

Asset System	Location	Risk Assessment Complete
Parks and Trails	Clearwater Road Beach Access	No
	Osborne Bay Regional Parks and Trails	No
	Manley Creek Parks and Trails	No
	Stoney Hill Regional Parks and Trails	No

	Cowichan Valley Trail	No

Table 3.0 – Asset Systems Located within Extreme Wildfire Hazard Rating Area

Asset System	Location	Risk Assessment Complete
Ornamental Street Lighting	Arbutus Mountain Estates Lighting System Establishment	No
	Mill Springs Street Lighting System Service Establishment	No
Parks and Trails	Glenora Trails Head Park	No
	Ruxton Island Park 1	No
	Cowichan Valley Trail (CRD Connector)	No
	Spectacle Lake Regional Park	No
	Chemainus River Park	No
	Quarry Nature Park	No
	Bald Mountain Park	No
	Marble Bay Park	No
	Stoker Park	No
	Marble Bay Roadside Trail	No
	Glenora Riverside Park	No
	Stebbings Road Park	No
	Old Baldy Mountain Park	No
	Belvedere Trail	No
	Sandy Pool Regional Park	No
	Hollings Creek Park	No
	Cobble Hill Mountain Regional Recreation Area	No
	Silvermine Trail	No
	Cowichan Valley Trail	No
	Kinsol Trestle	No
Public Safety - Communications	Bald Mountain	No
	Mt Wood	No

	Woodley Range	No
	Harris Creek (Ch. 9)	No
	Mt. Brenton (CVARS)	No
	Mt. Hayes (FortisBC LNG)	No
	Heather Mountain	No
	Towincut Mountain	No
	Harris Creek BC, Gordon River Log Camp	No
	Roberston River BC	No
	BC Hydro (Cowichan Lake)	No
	Edinburgh ARS BC	No
Sewer System	Arbutus Mountain Estates Sewer	Yes
	Mill Springs Sewer	Yes
	Bald Mountain Sewer	Yes
Water System	Youbou Water	Yes
	Honeymoon Bay Water	Yes
	Mesachie Lake Water	Yes
	Shawnigan Lake North Water	Yes
	Bald Mountain Water	Yes
	Saltair Water	Yes
	Honeymoon Bay Water	Yes

The case studies were conducted using a four-step process developed in the previous high-level screening assessment[5]:

1. Identify Exposure
2. Vulnerability Assessment
3. Risk Assessment
4. Risk Management

The first three steps resulted in identification of the highest vulnerabilities and risks and Levels of Service implications for each system as well as a scoring system for prioritizing risks and risk management actions. The risk management step included identification of potential mitigating actions and alignment of the actions with the condition assessment 10-year capital and O&M plan for each system.

Summary reports for each system detailing risks, risk management action and alignment with the condition assessment 10-year capital and O&M plan can be found in the appendices.

Risk Threshold

The CVRD water Management Division has established a risk thresholds specific to this risk assessment process. Figure 1 summarizes the risk matrix. This matrix is used to prioritize risks and establish the follow up required to effectively manage the risks.

Risk Matrix					
	1	**2**	**3**	**4**	**5**
1	1	2	3	4	5
2	2	4	6	8	10
3	3	6	9	12	15
4	4	8	12	16	20
5	5	10	15	20	25

1 to 4	Low Risk - No immediate or short-term actions required. Continue to monitor and re-evaluate annually or as new data is acquired.
5 to 9	Medium Risk - Action may be required within 2-5 years. Continue to monitor and re-evaluate annually or as new data is acquired.
10 to 16	High Risk - Action may be required within 1-2 years. Continue to monitor and re-evaluate annually or as new data is acquired
20 to 25	Immediate Action Required. Follow up to ensure resources have been secured.
5	Medium risk rating but consider further investigation/discussion as high likelihood or severity rating may warrant more immediate action

Figure 1: Risk Matrix

5 Urban Systems (2018). Cowichan Valley Regional District Climate Risk Assessment.

Cost Estimates

Cost estimates were assigned based on Water Management Division's knowledge of similar projects or feasibility studies and should be used for budgeting purposes only. A fully defined scope will be required for a more accurate estimation. The implementation of Fire Smart Plans are site specific and the detailed scope of work, and associated costs will not be fully understood until the completion of a Fire Smart Assessment.

Comments and Recommendations

1. There is a need to develop an approach to identifying, classifying and prioritizing risk at a corporate level in order to ensure consistency in the CVRD's approach to managing risk.

   Recommendation: A corporate risk management framework outlines a consistent approach to risk identification, classification, prioritization, and management. The risk management framework should identify climate risks as one type of risk to be considered, as well as other types of risk. The risk management framework may leverage the consequence and likelihood definitions from the climate risk assessment tool. The corporate risk management framework will be a standalone document and include risks beyond asset risks, but it should be linked to the CVRD's Asset Management Strategy.

2. Along with a corporate risk management framework, a risk register is needed that incorporates current risk assessment processes as well as the new climate risk tool.

   Recommendation: Develop a data management process that includes a risk register that incorporates current risk assessment processes and the new climate risk tool. The process should include protocols for tracking and entering data into the risk register and reporting updated risk information.

3. The vulnerability and risk assessments involved input from professionals and Urban Systems as well staff members from the CVRD. It was noted during the process that a quality risk assessment requires input from multiple levels of staff (management and operations) and the level of effort (staff time) required to provide accurate information is challenging. However, the quality/usefulness of the assessment is directly impacted by the level of effort of CVRD staff.

   Recommendation: Allocate time and resources to review and update the risk assessment annually when developing operational capital planning budgets. The tool developed as part of previous high-level screening assessment can be integrated into the CVRD's annual planning process with staff time allocated to updating the risk assessments with new information. As with any new program or tool, success will be reinforced by using, reviewing, refining and updating the process and tool. It is likely that as CVRD staff gain familiarity with this tool and the risk assessment process, the response to climate change interactions will be strengthened.

4. In order to continually refine the tool and risk assessment process, the quantity and quality of data collected should be improved over time.

   Recommendation: Develop a monitoring and record keeping process to track the impacts of climate events on the water and sewer systems. This will be most beneficial for recurring events that happen multiple times per year (storm events, power outages, storm surge). Consider developing a form that

operators can fill out after a climate event that provides information on level of damage and/or service disruption associated with the event and the cost of response measures. This information can be used to update the risk assessment scoring for severity categories. In addition, collect data related to responses of natural systems to climate change over time (e.g. surface water composition, groundwater aquifer recharge), condition of natural assets over time and changing functional/service demands of natural assets. Lastly, as geo-spatial continues to improve over time the model should be run using the latest available information with regards to climate impacts.

5. Potential actions for risk management have been identified to address climate change impacts, however, the final stage of risk management requires considering and prioritizing all risks to asset systems, not just those related to climate change.

   Recommendation: Integrate the climate risks identified for each system into the broader risk assessment associated with asset management planning. Climate risks can be included in the asset management risk assessment process that considers other risks related to capacity, condition, future development and population projections. Integrating climate change risks to existing risk assessment frameworks will influence prioritization and implementation of risk management actions, ensuring the most efficient use of financial and staff resources, and improving the resilience of key infrastructure and services.

Title: Arbutus Mountain Sewer Climate Risk Assessment
Date: July 23, 2019
File: 2017.0011.02

Asset System Description

Arbutus Mountain Estates Sewer System services the residential development 'Estates of Shawnigan Station' located south of Shawnigan Lake on Shawnigan Lake Road in Area B (123 users). The system consists of a gravity sewage collection system, untreated sanitary sewer lift station, wastewater treatment plant, treated sanitary sewer lift station, sanitary force main, and sanitary drainage field. Critical equipment is monitored 24-hours a day for malfunctions (such as pump failures).

System Risks

Risk ID	Risk Score (0 to 25)	Projected Climatic Change	Predicted Direct Impacts	Anticipated Outcome of Direct Impact to Level of Service	Risk Management Actions
A	12	Longer and More Intense Storms	Damage to infrastructure due to increased frequency and severity of storms	Restricted access and temporary flooding of facilities. Increased stress on building envelope and eaves/downspouts, leading to potential leakage/internal flooding. Increased inflow and infiltration. Saturation of drainage field and surfacing of effluent. All resulting in a temporary inability to meet local conveyance and treatment demands, surcharging or overflows and an inability to meet environmental and public health requirements.	Implement I/I management solutions (e.g. increased buffer storage, lining mains and manholes, replacing mains). Increase frequency of inspection and maintenance of disposal field to maintain sufficient drainage.
B	12	Wetter Winters	Increased pressure on infrastructure due to more intense precipitation events	Restricted access and temporary flooding of facilities. Increased stress on building envelope and eaves/downspouts, leading to potential leakage/internal flooding. Increased inflow and infiltration. Saturation of drainage field and surfacing of effluent. All resulting in a temporary inability to meet local conveyance and treatment demands, surcharging or overflows and an inability to meet environmental and public health requirements.	Implement I/I management solutions (e.g. increased buffer storage, lining mains and manholes, replacing mains). Upgrade pumps to increase capacity. Increase frequency of inspection and maintenance of disposal field to maintain sufficient drainage.
C	9	Dryer Summers	Damage of infrastructure and interruption of services due to increase in risk of wildfire	Fire damage to the treatment plant, lift station and/or disposal field resulting in an inability to meet conveyance and treatment demands and environmental and public health requirements.	Develop and implement a Fire Smart plan. Implement fire break buffers around disposal field, lift stations and treatment facility.

Recommended Actions for Climate Risk Management

Action	Impact to Risk Levels	Estimated Cost	Timing
Implement I/I management solutions (e.g. increased buffer storage, lining mains and manholes, replacing mains). (Identified in Condition Assessment 10-year Capital and O&M Plan).	Risks A and B Identifying and repairing I&I issues will increase the resilience of the system to handle wetter winters and longer and more intense storms.	Continue to monitor	Important (1-2 Years)
Improve drainage field monitoring by increasing frequency of inspection and maintenance.	Risks A and B Maintaining drainage field operation will improve the resilience of the system to withstand wetter winters and longer and more intense storms.	$1500/year	Important (1-2 Years)
Develop and implement a Fire Smart plan including fire break buffers around disposal field, lift stations and treatment facility.	Risks C Fire breaks will mitigate the risk of damage to critical infrastructure during wildfires.	$5,000	Short term (2 – 5 Years)

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Title: Bald Mountain Sewer Climate Risk Assessment
Date: July 23, 2019
File: 2017.0011.02

Asset System Description

Bald Mountain sewer system (132 users) is located between Youbou and the Town of Lake Cowichan, next to Cowichan Lake, in Area F. The treatment plant is a membrane bioreactor (MBR) plant producing Class A high quality effluent. The treatment works include two membranes with provisions in place for future additional treatment. Discharge of the UV disinfected effluent is into the ground by means of two large infiltration basins. Other assets include the collection system and a lift station. Critical equipment is monitored 24-hours a day for malfunctions (such as pump failures).

System Risks

Risk ID	Risk Score (0 to 25)	Projected Climatic Change	Predicted Direct Impacts	Anticipated Outcome of Direct Impact to Level of Service	Risk Management Actions
A	16	Longer and More Intense Storms	Damage to infrastructure due to increased frequency and severity of storms	Restricted access and temporary flooding of facilities, Increased inflow and infiltration resulting in surcharging or overflows. I&I is not typically a problem but should be monitored with increased precipitation and pressure on the collection system. Local drainage system flooding impacting RIB performance and damaging treatment plant components resulting in a temporary inability to meet local conveyance, treatment and disposal demands.	During storm events, monitor local drainage around WWTP, RIBs and lift station. Monitor I&I and occurrence of surcharging and overflows. Monitor performance of RIBs.
B	16	Wetter Winters	Increased pressure on infrastructure due to more intense precipitation events	Restricted access and temporary flooding of facilities, Increased inflow and infiltration resulting in surcharging or overflows. I&I is not typically a problem but should be monitored with increased precipitation and pressure on the collection system. Local drainage system flooding impacting RIB performance and damaging treatment plant components resulting in a temporary inability to meet local conveyance, treatment and disposal demands.	During storm events, monitor local drainage around WWTP, RIBs and lift station. Monitor I&I and occurrence of surcharging and overflows. Monitor performance of RIBs.
C	8	Dryer Summers	Damage of infrastructure and interruption of services due to increase in risk of wildfire	Fire damage to sewer system facilities, forest fire ash and debris clog RIBs. Potential structural damage to sewer structures resulting in an inability to meet environmental and public health requirements.	Develop and implement a Fire Smart plan. Implement fire break buffers around RIBs, lift stations and treatment facility.

Recommended Actions for Climate Risk Management

Action	Impact to Risk Levels	Estimated Cost	Timing
Develop program to monitor I&I and frequency of surcharging and overflows.	Risks A and B Tracking I&I levels will allow for early intervention.	Continue to monitor	Important (1-2 Years)
Improve RIB monitoring by increasing frequency of inspection and maintenance.	Risks A and B Maintaining RIB functionality will improve the resilience of the system to withstand wetter winters and longer and more intense storms.	Continue to monitor	Important (1-2 Years)
Develop and implement a Fire Smart plan including fire break buffers around RIBs, lift stations and treatment facility.	Risks C Fire breaks will mitigate the risk of damage to critical infrastructure during wildfires.	$5,000	Short term (2 – 5 Years)

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Title: Cowichan Bay Sewer Climate Risk Assessment
Date: July 23, 2019
File: 2017.0011.02

Asset System Description

The Cowichan Bay sewer system is located in Area D and services the community of Cowichan Bay and the surrounding residential area (810 users). The system consists of both gravity and pressurized collection systems discharging to a pump station located at Hecate Park. Sewage is pumped to the Joint Utilities Board (JUB) lagoons, located in Duncan, for sewage treatment and disposal. Critical equipment is monitored 24-hours a day for malfunctions (such as pump failures).

System Risks

Risk ID	Risk Score (0 to 25)	Projected Climatic Change	Predicted Direct Impacts	Anticipated Outcome of Direct Impact to Level of Service	Risk Management Actions
A	12	Wetter Winters	Increased pressure on sewer infrastructure due to more intense precipitation events.	Increased inflow and infiltration and inability to meet conveyance and treatment demands resulting in temporary surcharging or overflows.	Implement I/I management solutions (e.g. increased buffer storage, lining mains and manholes, replacing mains). Upgrade pumps to increase capacity. Coordinate with JUB to identify whether lagoon discharge is a capacity constraint on the system.
B	8	Sea Level Rise	Coastal inundation of critical sewer infrastructure.	Damage/loss of sewer main lines and pumphouse in identified inundation zone resulting in permanent inability to meet local conveyance and treatment demands.	Implement inundation protection infrastructure. Redesign for closed system with drywell. Consider relocating system if permanent sea level rise is imminent.
C	8	Wetter Winters	Damage to critical sewer infrastructure due to flooding of the Cowichan and Koksilah Rivers.	Damage/loss of sewer main lines, particularly washout of exposed pipes under the bridge across the Koksilah River, resulting in inability to meet local conveyance and treatment demands.	Implement flood protection infrastructure. Discharge sewage to the ocean or to a portable treatment plant.
D	6	Longer and More Intense Storms	Damage/increased pressure on sewer infrastructure due to increased frequency and severity of storms.	Increased inflow and infiltration and temporary flooding and restricted access to facilities resulting in surcharging or overflows and temporary inability to meet local conveyance and treatment demands.	Implement I/I management solutions (e.g. increased buffer storage, lining mains and manholes, replacing mains). Upgrade pumps to increase capacity. Coordinate with JUB to identify whether lagoon discharge is a capacity constraint on the system.
E	5	Sea Level Rise	Increased pressure on sewer infrastructure due to higher king tides.	Damage/loss of sewer main lines and pumphouse, temporary flooding and restricted access to facilities resulting in temporary inability to meet local conveyance and treatment demands.	Implement flood protection infrastructure (e.g. bladder bags as temporary solution and retaining structure until further improvements can be made). Redesign for closed system with drywell. Consider relocating system if it is an ongoing issue.

Recommended Actions for Climate Risk Management

Action	Impact to Risk Levels	Estimated Cost	Timing
Continue with I&I investigation and repairs (Identified in Condition Assessment 10-year Capital and O&M Plan).	Risks A and D Identifying and repairing I&I issues will increase the resilience of the system to handle wetter winters and longer and more intense storms.	**$50,000/year**	Important (1-2 Years)
Upgrade pumps to increase capacity	Risks A and D Upgrading to high capacity pumps will improve the resilience of the system to handle wetter winters and longer and more intense storms and higher flows from I&I.	$150,000	Important (1-2 Years)
Coordinate with the JUB to confirm capacity constraints of the lagoon and outfall, and timing of any upgrades (Identified in Condition Assessment 10-year Capital and O&M Plan).	Risks A and E Ensure sufficient capacity to handle increased wet weather flows, reducing the likelihood of system bypasses or surcharging.	$0	Important (1-2 Years)
Secure bladder bags for temporary flood protection.	Risks B and C Flood protection for the pump station will decrease consequences of flooding. This is a temporary solution that can be used as sea levels rise until the frequency of flooding becomes unmanageable with the temporary solution.	$50,000	Short term (2 – 5 Years)
Conduct a feasibility study of redesigning or relocating the pump station to improve resilience to coastal flooding and inundation. *Note: should be conducted sooner if any major works will be performed on the pump station.*	Risks B and C Flood protection for the pump station will decrease the consequences of flooding.	Extremely unlikely to find a better location	Medium Term (5-10 Years)

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Title: Eagle Heights Sewer Climate Risk Assessment
Date: July 23, 2019
File: 2017.0011.02

Asset System Description

Eagle Heights sewer system (760 users) is located south of the City of Duncan in Area E, with a small portion in Area D. The system consists of a gravity sewer collection system flowing into the Eagle Heights pump station located on Christopher Road. Sewage is pumped from the Eagle Heights pump station to the Joint Utilities Board (JUB) lagoons for treatment and disposal.

System Risks

Risk ID	Risk Score (0 to 25)	Projected Climatic Change	Predicted Direct Impacts	Anticipated Outcome of Direct Impact to Level of Service	Risk Management Actions
A	12	Longer and More Intense Storms	Damage to infrastructure due to increased frequency and severity of storms	Increased inflow and infiltration resulting in an inability to meet conveyance demands resulting in temporary surcharging or overflows.	Implement I/I management solutions (e.g. increased buffer storage, lining mains and manholes, replacing mains). Upgrade pumps to increase capacity. Coordinate with JUB to identify whether lagoon discharge is a capacity constraint on the system.
B	12	Wetter Winters	Increased pressure on infrastructure due to more intense precipitation events	Increased inflow and infiltration resulting in an inability to meet conveyance demands resulting in temporary surcharging or overflows.	Implement I/I management solutions (e.g. increased buffer storage, lining mains and manholes, replacing mains). Upgrade pumps to increase capacity. Coordinate with JUB to identify whether lagoon discharge is a capacity constraint on the system.
C	4	Wetter Winters	Damage to collection system, pump station and force main due to stream/river flooding extremely unlikely	Damage/loss of sewer main lines and pump station resulting in an inability to meet conveyance demands, temporary surcharging or overflows.	Implement flood protection infrastructure (e.g. bladder bags as temporary solution and retaining structure until further improvements can be made).

Recommended Actions for Climate Risk Management

Action	Impact to Risk Levels	Estimated Cost	Timing
Implement I/I management solutions (e.g. increased buffer storage, lining mains and manholes, replacing mains).	Risks A and B Identifying and repairing I&I issues will increase the resilience of the system to handle wetter winters and longer and more intense storms.	Continue to monitor	Important (1-2 Years)
Upgrade pumps to increase capacity.	Risks A and B Upgrading to high capacity pumps will improve the resilience of the system to handle wetter winters and longer and more intense storms and higher flows from I&I.	$150,000	Important (1-2 Years)
Coordinate with the JUB to confirm capacity constraints of the lagoon and outfall, and timing of any upgrades.	Risks A and B Ensure sufficient capacity to handle increased wet weather flows, reducing the likelihood of system bypasses or surcharging.	$0	Important (1-2 Years)

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Title: Honeymoon Bay Water Climate Risk Assessment
Date: July 23, 2019
File: 2017.0011.02

Asset System Description

Honeymoon Bay water system (497 users) is located west of Mesachie Lake in Area F. The water system services primarily residential properties but also services RV parks and commercial developments. Honeymoon Bay water system receives its water from a groundwater well. The customers' demand dictates water pumping and distribution. The water receives chlorine disinfection before being pumped up to a 454 m^3 water reservoir and is fed back down to the distribution system as required from the customers. The system consists of a well, well pump, water main, treatment building, chlorine injection, pump station to reservoir, steal reservoir and gravity mains. Critical equipment is monitored 24-hours a day for malfunctions, such as high or low chlorine levels or pump failures.

System Risks

Risk ID	Risk Score (0 to 25)	Projected Climatic Change	Predicted Direct Impacts	Anticipated Outcome of Direct Impact to Level of Service	Risk Management Actions
A	16	Dryer Summers	Reduced recharge of groundwater sources due to decrease in precipitation.	Reduced capacity of source aquifer resulting in an inability to meet water demand.	Develop additional well and storage reservoir to increase capacity during summer months.
B	12	Dryer Summers	Increased watering and irrigation needs due to decreased precipitation and drought.	Increased demand on water source and pumping and treatment requirements resulting in faster depletion of water storage and reduced supply for other system uses.	Develop additional well and storage reservoir to increase capacity during summer months. Enhance public communication related to water conservation. Implement water and irrigation restrictions. Create incentives for xeriscaping and sustainable storage practices.
C	12	Warmer Summers	Increased demand on services due to potential extension of summer and tourism season and growing season.	Demand exceeds capacity of source aquifer resulting in an inability to meet demand and water conservation goals.	Development of additional well and storage reservoir to increase capacity during summer months. Enhance public communication related to water conservation. Increase water storage capacity on a regional and individual level, including rain barrel collection systems.
D	6	Wetter Winters	Damage to infrastructure due to lake flooding	Infrastructure damage from increase in debris and sediment and potential damage to distribution system in low lying areas, particularly the wells and pump station as they are located in the lake floodplain, resulting in a temporary inability to meet water demand or quality standards.	Evaluate options for protecting infrastructure.
E	6	Dryer Summers	Damage of infrastructure and interruption of services due to wildfire	Fire damage to well #1, well #2 and the reservoir resulting in inability to meet water demand and quality standards.	Develop and implement a Fire Smart plan. Implement fire break buffers around wells and reservoir.

Recommended Actions for Climate Risk Management

Action	Impact to Risk Levels	Estimated Cost	Timing
Develop additional well (Identified in Condition Assessment 10-year Capital and O&M Plan).	Risks A, B, C and D Capacity of the source aquifer and ability to meet increasing tourism and irrigation demands are among the highest risks to the system. Increasing source capacity with an additional well and storage capacity will enhance the resilience of the system.	Complete in September 2019 for $500,000	Important (1-2 Years)
Enhance public communication related to water conservation. Implement water and irrigation restrictions. Create incentives for xeriscaping and sustainable storage practices.	Risks A, B and C Water conservation and demand side management of water use will reduce the pressure on the source aquifer and storage capacity of the system.	Shared cost $500/year per system	Important (1-2 Years)
Secure bladder bags for temporary flood protection.	Risk D Flood protection for the well head will decrease the consequences of flooding. This is a temporary solution that can be used until relocation of infrastructure is deemed necessary.	$50,000	Short term (2 – 5 Years)
Develop and implement a Fire Smart plan including fire break buffers around well #1, well #2 and the reservoir.	Risks E Fire breaks will mitigate the risk of damage to critical infrastructure during wildfires.	$5,000	Short term (2 – 5 Years)

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Title: Mesachie Lake Sewer Climate Risk Assessment
Date: July 23, 2019
File: 2017.0011.02

Asset System Description

Mesachie Lake sewer system is located in the community of Mesachie Lake in Area F (49 users). The system consists of a collection system, septic tanks and disposal fields.

System Risks

Risk ID	Risk Score (0 to 25)	Projected Climatic Change	Predicted Direct Impacts	Anticipated Outcome of Direct Impact to Level of Service	Risk Management Actions
A	16	Longer and More Intense Storms	Damage to infrastructure due to increased frequency and severity of storms	Increased issues with inflow and infiltration and flooding of disposal fields resulting in surcharging and overflows and a temporary inability to meet local conveyance and treatment demands.	Implement I/I management solutions (e.g. increased buffer storage, lining mains and manholes, replacing mains). Relocate drainage fields to an area with high drainage capacity.
B	16	Wetter Winters	Increased pressure on infrastructure due to more intense precipitation events	Increased issues with inflow and infiltration and flooding of disposal fields resulting in surcharging and overflows and a temporary inability to meet local conveyance and treatment demands.	Implement I/I management solutions (e.g. increased buffer storage, lining mains and manholes, replacing mains). Relocate drainage fields to an area with high drainage capacity.
C	3	Wetter Winters	Damage to sewer infrastructure due to lake flooding	Damage to treatment buildings, disposal fields and collection system due to lake flooding resulting in temporary surcharging or overflows and an inability to meet conveyance and treatment demands.	Implement flood protection infrastructure. Relocate septic tanks and disposal fields outside of the flood plain.

Recommended Actions for Climate Risk Management

Action	Impact to Risk Levels	Estimated Cost	Timing
Upgrade treatment and collection system to a STEP system. (Identified in Condition Assessment 10-year Capital and O&M Plan). Construct disposal field above floodplain.	Risks A and B Upgrades to the collection system will provide an opportunity to address I&I issues and increase resilience to future conditions.	In Progress – Completed by March 2020 for $1.8M	Important (1-2 Years)
Conduct a feasibility study of redesigning or relocating the drainage fields to an area with higher drainage capacity.	Risks A and B Improvements to the drainage field design and relocation to an area with higher drainage will decrease the risk of drainage field flooding and surcharging and overflows.	Included in STEP system upgrade	Important (1-2 Years)
Secure bladder bags for temporary flood protection.	Risk C Flood protection for the treatment buildings will decrease consequences of flooding. This is a temporary solution that can be used in a lake flood scenario.	Continue to monitor	No immediate or short-term actions required. Continue to monitor and re-evaluate annually or as new data is acquired
Conduct a feasibility study of redesigning or relocating the system outside of the floodplain or designing flood protection infrastructure. *Note: If STEP system upgrade proceeds in the short-term, consider the floodplain and location of new infrastructure.*	Risks C Relocating or protecting critical infrastructure from flood risks will decrease the potential impacts to the community during a flood event.	Included in STEP system upgrade	No immediate or short-term actions required. Continue to monitor and re-evaluate annually or as new data is acquired

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Title: Mesachie Lake Water Climate Risk Assessment
Date: July 23, 2019
File: 2017.0011.02

Asset System Description

Mesachie Lake water system (101 users) is located west of Lake Cowichan in Area F. Water is pumped from a groundwater well directly into the distribution system as it fills the reservoir. If the well is not running, water is gravity-fed from the reservoir to the distribution system. The water does not currently require any treatment. As directed by the Island Health Authority a backup chlorination system is in place should disinfection be required. Critical equipment is monitored 24-hours a day for malfunctions (such as pump failures).

System Risks

Risk ID	Risk Score (0 to 25)	Projected Climatic Change	Predicted Direct Impacts	Anticipated Outcome of Direct Impact to Level of Service	Risk Management Actions
A	16	Longer and more Intense Storms	Damage to infrastructure due to increased frequency and severity of storms	Increased stress on building envelope and eaves/downspouts, particularly the treatment building, which is in poor condition, leading to potential leakage/internal flooding resulting in damage or loss of system components and an inability to meet demand and water quality standards.	Rebuild/repair treatment building.
B	9	Wetter Winters	Increase in enteric diseases due to increase in run off and exacerbation of sanitary contamination issues	Increased need to activate disinfection system. Increased frequency of boil water advisories and inability to meet quality standards.	Evaluate and address sanitary leakage issues. Increase water quality monitoring frequency and activate disinfection system, when necessary.
C	6	Longer and more Intense Storms	Damage to facilities due to severe winds	Damage to treatment building, pump station and/or reservoir due to fallen trees or debris resulting in an inability to meet demand and water quality standards.	Clear trees around treatment building, pump station and reservoir to prevent damage from tree fall.
D	3	Wetter Winters	Damage to infrastructure due to lake flooding	Damage to system components located in the flood plain (treatment building and pump station) resulting in an inability to meet water demands and quality standards.	Evaluate options for protecting or relocating infrastructure.
E	3	Dryer Summers	Damage of infrastructure and interruption of services due to wildfire	Fire damage to water system facilities, in particular, the reservoir which is located in a heavily forest area designated as an extreme fire risk zone, resulting inability to meet water demands.	Develop and implement a Fire Smart plan. Implement fire break buffer around the reservoir.

Recommended Actions for Climate Risk Management

Action	Impact to Risk Levels	Estimated Cost	Timing
Rebuild/repair treatment building.	Risk A The treatment building is currently in poor condition and a rebuild/repair will increase its resilience to more intense weather and ability to protect critical water system components.	$25,000	Important (1-2 Years)
Evaluate and address sanitary leakage issues.	Risk B Addressing the current source of sanitary contamination in the vicinity of the groundwater well will decrease the risk of health issues.	Continue to monitor	Short term (2 – 5 Years)
Increase water quality monitoring frequency and activate disinfection system, when necessary.	Risk B If sanitary leakage and contamination near the groundwater well continue to be an issue, increase monitoring and activation of the disinfection system will reduce the risk of health issues.	Continue to monitor	Short term (2 – 5 Years)
Clear trees around treatment building, well and reservoir to prevent damage from tree fall.	Risks C and E The risk of treefall damage and wildfire damage will be reduced by clearing of trees around critical water system components	In progress $0 Timberwest responsibility	Short term (2 – 5 Years)
Conduct a feasibility study of redesigning or relocating the treatment building and well to improve resilience to flooding. *Note: should be conducted sooner if any major works will be performed on treatment plant and pump station.*	Risk D Relocation or design of flood protection for the well and treatment building will decrease the consequences of flooding.	Continue to monitor	Short term (2 – 5 Years)
Develop and implement a Fire Smart plan including fire break buffers around the well, treatment facility and reservoir.	Risks C and E Fire breaks will mitigate the risk of damage to critical infrastructure during wildfires.	$5,000	Medium Term (5-10 Years)

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Title: Mill Springs Sewer Climate Risk Assessment
Date: July 23, 2019
File: 2017.0011.02

Asset System Description

Mill Springs sewer system (263 users) is located south of Mill Bay in Area A. The system consists of a gravity collection system flowing to an Eco-fluid Upflow Blanket Filtration treatment plant. The treated effluent is pumped to ground for disposal. Critical equipment is monitored 24-hours a day for malfunctions (such as pump failures).

System Risks

Risk ID	Risk Score (0 to 25)	Projected Climatic Change	Predicted Direct Impacts	Anticipated Outcome of Direct Impact to Level of Service	Risk Management Actions
A	16	Longer and More Intense Storms	Damage to infrastructure due to increased frequency and severity of storms and storm surges	Temporary flooding and restricted access to facilities. Increased inflow and infiltration and potential saturation and erosion of the disposal field resulting in surcharging or overflows and a temporary inability to meet local conveyance and treatment demands.	During storm events, monitor local drainage around WWTP, disposal field and lift station. Implement I/I management solutions (e.g. increased buffer storage, lining mains and manholes, replacing mains). Upgrade pumps to increase capacity. Monitor performance of disposal field.
B	16	Wetter Winters	Increased pressure on infrastructure due to more intense precipitation events	Temporary flooding and restricted access to facilities. Increased inflow and infiltration and potential saturation and erosion of the disposal field resulting in surcharging or overflows and a temporary inability to meet local conveyance and treatment demands.	During storm events, monitor local drainage around WWTP, disposal field and lift station. Implement I/I management solutions (e.g. increased buffer storage, lining mains and manholes, replacing mains). Upgrade pumps to increase capacity. Monitor performance of disposal field.
C	3	Dryer Summers	Damage to disposal field and treatment building and interruption of services due to increase in risk of wildfire	Fire damage to sewer system facilities, particularly the drainage field which is located in a high risk wildfire zone resulting in an inability to meet environmental and public health requirements.	Develop and implement a Fire Smart plan. Implement fire break buffers around disposal field, lift stations and treatment facility.

Recommended Actions for Climate Risk Management

Action	Impact to Risk Levels	Estimated Cost	Timing
Implement I/I management solutions (e.g. increased buffer storage, lining mains and manholes, replacing mains).	Risks A and B Identifying and repairing I&I issues will increase the resilience of the system to handle wetter winters and longer and more intense storms.	$50,000/year	Important (1-2 Years)
Improve disposal field monitoring by increasing frequency of inspection and maintenance.	Risks A and B Maintaining disposal field functionality will improve the resilience of the system to withstand wetter winters and longer and more intense storms.	Continue to monitor	Important (1-2 Years)
Develop and implement a Fire Smart plan including fire break buffers around disposal field, lift stations and treatment facility.	Risks C Fire breaks will mitigate the risk of damage to critical infrastructure during wildfires.	Complete 2019 - $5,000	Medium Term (5-10 Years)

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Title: Saltair Water Climate Risk Assessment
Date: July 23, 2019
File: 2017.0011.02

Asset System Description

Saltair water system is located south-east of Ladysmith in Area G and primarily residential homes but it also services select commercial properties (864 users). The source of water for this system is Stocking Lake, located to the west of the service area. Water flows from the lake, through the treatment plant and is then stored in an 819 m^3 above-ground reservoir. The water receives both UV-light and chlorine disinfection and is fed from the reservoir to the customers by gravity. Critical equipment is monitored 24-hours a day for malfunctions (such as high or low chlorine levels or pump failures).

System Risks

Risk ID	Risk Score (0 to 25)	Projected Climatic Change	Predicted Direct Impacts	Anticipated Outcome of Direct Impact to Level of Service	Risk Management Actions
A	12	Longer and more Intense Storms	Damage to infrastructure due to increased frequency and severity of storms and storm surges	Significant damage or loss of system components, particularly water mains along the coast resulting in an inability to meet demand and quality standards.	Evaluate options for protecting or relocating infrastructure.
B	9	Sea Level Rise	Damage to infrastructure due to higher king tides and concurrent storm surges	Significant damage or loss of system/system components resulting in an inability to meet demand and quality standards. Particularly watermains suppling coastal properties.	Evaluate options for protecting or relocating infrastructure.
C	6	Longer and More Intense Storms	Damage to energy transmission networks due to severe windstorms	Loss of power to treatment systems and pump stations with no back up power resulting in an inability to meet demand and water quality standards.	Implement a back up power supply.
D	6	Dryer Summers	Damage of infrastructure and interruption of services due to wildfire	Fire damage to treatment building and reservoir and contamination of surface water source. Resulting in an inability to meet water demands and quality standards.	Develop and implement a Fire Smart plan. Implement fire break buffers around the treatment building, pump station and reservoir.
E	6	Dryer Summers	Increase in erosion and/or decrease in slope stability due to insect disease and loss of vegetation	Further degradation of water quality in Stocking lake from increased sediment leading to increased stress on water treatment facilities resulting in an inability to meet water demands and quality standards.	Add filtration to current water treatment plant. Develop groundwater sources and abandon surface water source.
F	3	Sea Level Rise	Damage/loss of infrastructure due to coastal inundation	Significant damage or loss of system/system components resulting in an inability to meet demand and quality standards. Particularly watermains suppling coastal properties.	Implement inundation protection infrastructure. Consider relocating system if permanent sea level rise is imminent.

Recommended Actions for Climate Risk Management

Action	Impact to Risk Levels	Estimated Cost	Timing
Conduct a feasibility study of redesigning or relocating the coastal water mains to improve resilience to coastal flooding and inundation.	Risks A, B and F Flood protection for the water mains will decrease consequences of flooding associated with king tides and storm surges.	$10,000	Important (1-2 Years)
Install a generator for back up power (Identified in Condition Assessment 10-year Capital and O&M Plan).	Risk C Back up power will decrease the consequences associated with frequent and prolonged power outages	Installed in 2019 - $20,000	Short term (2 – 5 Years)
Develop and implement a Fire Smart plan including fire break buffers around pump stations, treatment facility and reservoir.	Risk D Fire breaks will mitigate the risk of damage to critical infrastructure during wildfires.	$5,000	Short term (2 – 5 Years)
Add filtration to current water treatment plant.	Risk E Adding filtration will reduce the risk of water quality degradation and inability to meet standards.	$5,000,000 from WSP Feasibility Study	Short term (2 – 5 Years)
Develop groundwater wells to replace surface water source.	Risk E Reducing dependence on surface water will mitigate the potential impacts on the system from changing lake conditions such as degraded water quality.	In Progress - $100,000	Short term (2 – 5 Years)

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Title: Sentinel Ridge Sewer Climate Risk Assessment
Date: July 23, 2019
File: 2017.0011.02

Asset System Description

Sentinel Ridge sewer system is located in Area A, south of Mill Bay, and services residential properties, town-homes and a marina (95 users). The system consists of both gravity and pressurized collection systems that transport sewage to a Membrane Bioreactor (MBR) treatment plant producing high quality, Class A effluent. The treated effluent is discharged to ground using rapid infiltration basins (RIBs). Critical equipment is monitored 24-hours a day for malfunctions (such as pump failures).

System Risks

Risk ID	Risk Score (0 to 25)	Projected Climatic Change	Predicted Direct Impacts	Anticipated Outcome of Direct Impact to Level of Service	Risk Management Actions
A	16	Longer and More Intense Storms	Damage to infrastructure due to increased frequency and severity of storms and storm surges	Restricted access and temporary flooding of facilities, Increased inflow and infiltration resulting in surcharging or overflows. Local drainage system flooding impacting RIB performance and damaging treatment plant components resulting in a temporary inability to meet local conveyance, treatment and disposal demands.	During storm events, monitor local drainage around WWTP, RIBs and lift station. Implement I/I management solutions (e.g. increased buffer storage, lining mains and manholes, replacing mains). Upgrade pumps to increase capacity Monitor performance of RIBs.
B	16	Wetter Winters	Increased pressure on infrastructure due to more intense precipitation events	Restricted access and temporary flooding of facilities, Increased inflow and infiltration resulting in surcharging or overflows. Local drainage system flooding impacting RIB performance and damaging treatment plant components resulting in a temporary inability to meet local conveyance, treatment and disposal demands.	During storm events, monitor local drainage around WWTP, RIBs and lift station. Implement I/I management solutions (e.g. increased buffer storage, lining mains and manholes, replacing mains). Upgrade pumps to increase capacity Monitor performance of RIBs.
C	12	Sea Level rise	Damage to infrastructure due to higher king tides	Restricted access and temporary flooding of facilities at the Marina with surcharging and overflows resulting in a temporary inability to meet local conveyance and treatment demands.	Implement inundation protection infrastructure. Redesign for closed system with drywell. Consider relocating system if permanent sea level rise is imminent.
D	8	Warmer Summers	Increase in nuisance odour emitted from waste facilities	Increase demand on odour control mechanisms resulting in intensification of current odour issues.	Upgrade odour control mechanisms.
E	4	Sea Level Rise	Damage/loss of pump station, force main and collection system in the Marina due to coastal inundation	Loss of sewer main lines and lift station in identified inundation zone resulting in a permanent inability to meet local conveyance and treatment demands, surcharging or overflows. This applies to the Marina properties and infrastructure only.	Implement inundation protection infrastructure. Redesign for closed system with drywell. Consider relocating system if permanent sea level rise is imminent.
F	3	Dryer Summers	Damage to RIBs and interruption of services due to increase in risk of wildfire	Fire damage to sewer system facilities, particularly RIBs resulting in an inability to meet environmental and public health requirements.	Develop and implement a Fire Smart plan. Implement fire break buffers around RIBs.

Recommended Actions for Climate Risk Management

Action	Impact to Risk Levels	Estimated Cost	Timing
Implement I/I management solutions (e.g. increased buffer storage, lining mains and manholes, replacing mains).	Risks A and B Identifying and repairing I&I issues will increase the resilience of the system to handle wetter winters and longer and more intense storms.	**n/a pressure system to gravity feed to inspect**	Important (1-2 Years)
Improve monitoring of the RIBs by increasing frequency of inspection and maintenance.	Risks A and B Maintaining RIBs functionality will improve the resilience of the system to withstand wetter winters and longer and more intense storms.	Continue to monitor	Important (1-2 Years)
Conduct a feasibility study of redesigning or relocating the Marina pump station to improve resilience to coastal flooding and inundation.	Risks C and E Flood protection for the pump station will decrease the consequences of flooding.	$10,000	Important (1-2 Years)
Secure bladder bags for temporary flood protection.	Risk E Flood protection for the pump station will decrease consequences of flooding. This is a temporary solution that can be used as sea levels rise until the frequency of flooding becomes unmanageable with the temporary solution.	$50,000	Short term (2 – 5 Years)
Add Purafil unit to the WWTP for odour control (Identified in Condition Assessment 10-year Capital and O&M Plan).	Risk D Installing a Purafil unit will reduce the risk of continued and intensified nuisance odours.	n/a already installed	Short term (2 – 5 Years)
Develop and implement a Fire Smart plan including fire break buffers around RIBs.	Risks C Fire breaks will mitigate the risk of damage to critical RIBs during wildfires.	$5,000	Medium Term (5-10 Years)

Title: Shawnigan Lake North Water Climate Risk Assessment
Date: July 23, 2019
File: 2017.0011.02

Asset System Description

The Shawnigan Lake North water system is located north-west of the Village of Shawnigan Lake in Area B (680 Users). The water system services residential dwellings and an elementary school. The Shawnigan Lake North water system uses Shawnigan Lake as its primary source water. Two groundwater wells supplement the supply of water, but the wells do not have the capacity to provide water for the entire system. Water supplied from Shawnigan Lake is pumped to a treatment building (located off Decca road) and receives chlorine disinfection before being pumped to the water storage reservoirs located at the end of Gregory Road. Water from the groundwater wells is pumped to a treatment building (located off Ingot road) where it receives chlorine disinfection before being pumped to the storage reservoirs.

System Risks

Risk ID	Risk Score (0 to 25)	Projected Climatic Change	Predicted Direct Impacts	Anticipated Outcome of Direct Impact to Level of Service	Risk Management Actions
A	20	Longer and More Intense Storms	Damage to energy transmission networks due to severe storms	Loss of power to treatment systems and pump stations resulting in an inability to meet demand and water quality standards.	Ensure backup power is available. Address challenges with refueling back up generator during prolonged power outages.
B	16	Warmer Summers	Changes to lake ecosystems, including change in temperature, chemical composition, habitat/species, and increase in algal blooms.	Increased demands on surface water treatment systems and potential blockages of surface water intakes resulting in an inability to meet water quality standards.	Upgrade surface water treatment facilities and add additional groundwater wells to provide backup supply when needed. Replace surface water source with groundwater sources. Deploy temporary portable potable water treatment plant.
C	16	Dryer Summers	Damage to infrastructure and interruption of services due to wildfire	Fire damage to water system facilities and/or forest fire ash and debris contamination of surface water sources resulting in an inability to meet water demands and quality standards. In particular, the reservoir, groundwater wells and treatment facility are at high risk of wildfire.	Develop and implement a Fire Smart plan. Implement fire break buffers around wells, treatment facilities and reservoirs.
D	12	Dryer Summers	Increase in erosion and/or decrease in slope stability due to loss of vegetation	Increased sediment in surface water source (Shawnigan Lake) leading to increased stress on water treatment facilities resulting in an inability to meet water demands and quality standards. Water quality is currently a concern as disinfection by products have been increasing.	Upgrade surface water treatment facilities and add additional groundwater wells to provide backup supply when needed. Replace surface water source with groundwater sources.
E	6	Dryer Summers	Reduced recharge of groundwater sources due to decrease in precipitation	Reduced capacity of source aquifer resulting in an inability to meet water demands. However, GW is a secondary source as surface water from Shawnigan Lake is the primary water source.	Develop additional groundwater sources.
F	6	Wetter Winters	Damage to infrastructure due to lake flooding	Infrastructure damage from increase in debris and sediment and potential damage to facilities due to flooding, particularly the pump station and break tank, resulting in an inability to meet water demands and quality standards.	Evaluate options for protecting or relocating infrastructure. Replace surface water source with groundwater sources.

Recommended Actions for Climate Risk Management

Action	Impact to Risk Levels	Estimated Cost	Timing
Develop a generator refueling strategy for prolonged power outages and integrate into the treatment plant emergency response procedures.	Risk A Maintaining backup power supply during prolonged power outages will decrease the impact of power outages on level of service.	$10,000 feasibility study Capital Cost = $100,000 to $1M	Immediate Action Required
Develop new groundwater wells to replace surface water source (Identified in Condition Assessment 10-year Capital and O&M Plan).	Risks B, D, E and F Reducing dependence on surface water will mitigate the potential impacts on the system from changing lake conditions such as degraded water quality and flooding.	In Progress - $100,000	Important (1-2 Years)
Upgrade surface water treatment facility(Identified in Condition Assessment 10-year Capital and O&M Plan). *Note that is only required if surface water system is maintained. The other option is to replace the surface water system with groundwater.*	Risks B, D and F Improving treatment capacity will increase resiliency of the system to degrading water quality issues.	$6,000,000 – from WSP feasibility study	Important (1-2 Years)
Develop and implement a Fire Smart plan including fire break buffers around wells, treatment facilities and reservoirs.	Risks C Fire breaks will mitigate the risk of damage to critical infrastructure during wildfires.	$5,000	Important (1-2 Years)
Consider purchasing a portable potable water treatment plant.	Risk B Ability to supply back-up emergency potable water	$250,000	Important (1-2 Years)

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Title: Youbou Climate Risk Assessment
Date: July 23, 2019
File: 2017.0011.02

Asset System Description

The Youbou Water System is located in Area I and is serviced by both a surface water source (Youbou Creek) and a groundwater source (580 users). Two separate treatment plants provide both chlorine and UV disinfection to the two source waters. An interconnection of the two sources exists at Arnold Road enabling one system to feed the other, if required. Water from the Youbou Creek source flows through the treatment plant and into a 1148 m^3 steel reservoir before entering into the distribution system. Water from the groundwater well is pumped to two reservoirs with a combined capacity of 468 m^3 before it enters into the distribution system. Critical equipment is monitored 24-hours a day for malfunctions (such as high or low chlorine levels or pump failures).

System Risks

Risk ID	Risk Score (0 to 25)	Projected Climatic Change	Predicted Direct Impacts	Anticipated Outcome of Direct Impact to Level of Service	Risk Management Actions
A	12	Dryer Summers	Reduced recharge of groundwater sources due to decrease in precipitation	Reduced capacity of source aquifer. As the intent is to move to solely groundwater supply, the result of this impact is an inability to meet water demands.	Monitor aquifer levels for declining trends. Develop additional wells. Develop additional storage capacity.
B	6	Longer and More Intense storms	Damage to infrastructure due to increased frequency and severity of storms.	Increased stress on building envelopes and eaves/downspouts leading to potential leakage/internal flooding resulting in damage or loss of system components and an inability to meet demand and water quality standards.	Monitor buildings and local drainage systems. Evaluate options for localized flood protection.
C	4	Wetter Winters	Damage to infrastructure due to lake flooding.	Damage to critical infrastructure due to flooding, particularly well #2 and well #4 which are in the Lake Cowichan Floodplain, resulting in an inability to meet water demands and quality standards.	Evaluate options for protecting or relocating infrastructure.
D	3	Dryer Summers	Damage to infrastructure and interruption of services due to wildfire	Fire damage to water system facilities, in particular, the reservoirs, resulting in an inability to meet water demands and quality standards.	Develop a Fire Smart plan. Implement fire break buffers around wells, treatment facilities and reservoirs.

Recommended Actions for Climate Risk Management

Action	Impact to Risk Levels	Estimated Cost	Timing
Develop additional well.	Risks A Increasing source capacity with an additional well will enhance the resilience of the system to both climate change and population and economic growth.	In Progress - $250,000	Important (1-2 Years)
Develop monitoring system	Risk B & C Flood protection to mitigate localized drainage issues will improve the resilience of the system during major storm events.	Continue to monitor	Important (1-2 Years)
Develop and implement a Fire Smart plan including fire break buffers around reservoirs, treatment facilities and wells.	Risks D Fire breaks will mitigate the risk of damage to critical infrastructure during wildfires.	$5,000	Medium Term (5-10 Years)

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