WHISTLER

REPORT | **INFORMATION REPORT TO COUNCIL**

PRESENTED:	January 21, 2020	**REPORT:**	20-004
FROM:	Infrastructure Services	**FILE:**	200.2
SUBJECT:	DRINKING WATER TREATMENT UPDATE		

COMMENT/RECOMMENDATION FROM THE CHIEF ADMINISTRATIVE OFFICER

That the recommendation of the General Manager of Infrastructure Services be endorsed.

RECOMMENDATION

That Information Report No. 20-004 regarding Drinking Water Treatment Update be received.

REFERENCES

Appendix “A” - 2019 VCH Evaluation Report Community Water System

Appendix “B” - 2019 VCH Evaluation Report Emerald Water System

Appendix “C” – 2019 Permit To Operate Community Water System

Appendix “D” – 2019 Permit To Operate Emerald Water System

Appendix “E” – Corrosion Control Conceptual Design Memo

May 8, 2018 Information Report to Council - Drinking Water Guidelines Update (not attached)

May 14, 2019 Committee of the Whole Presentation – Drinking Water System Update (not attached)

PURPOSE OF REPORT

As requested in the 2019 Vancouver Coastal Health (VCH) Evaluation Report (for the year 2018), RMOW water managers have had a consultant review the options for pH adjustment in the Community and Emerald Water Systems (the two water systems that serve all of Whistler’s homes and businesses). The purpose of this Report is to share the information provided in the consultant report, describe the potential impact on the long-term management of Whistler’s drinking water system as well as recommend next steps.

DISCUSSION

Excerpt from VCH Evaluation Report for the Community Water System in regards to the pH of Whistler’s water:

“March 15, 2019
As a result of a variety of sources, both surface and ground water, there is some variability of chemical water quality within the system, although no parameters pose an immediate concern. As noted previously the source water in several wells has relatively low pH, below the operational

guideline noted in the Guidelines for Canadian Drinking Water Quality (GCDWQ). Options for pH adjustment should be investigated and a long term plan finalized as a means of improving the chemical stability of the treated drinking water. Changes to the GCDWQ in 2019 include a lowering of the MAC for lead to 5 ppb. At this time VCH is comfortable with the approach taken by the RMOW in terms of advising the public to flush taps before water consumption."

The RMOW is not the Health Authority – present recommendation is to "flush your taps".
The Ministry of Health works together with a provincial health authority, five regional health authorities, and a First Nations health authority to provide high quality, appropriate and timely health services to British Columbians.

The regional health authority for the RMOW is Vancouver Coastal Health. The regional health authorities are responsible for:

- identifying population health needs;
- planning appropriate programs and services;
- ensuring programs and services are properly funded and managed; and
- meeting performance objectives.

Annually, VCH reviews the conditions set out in the RMOW Community and Emerald Water System's "Permit to Operate". These permits include the minimum requirements for providing safe drinking water that are recommended by Vancouver Coastal Health, and Whistler's municipal drinking water has consistently met the requirements of the Permits to Operate.

Once water is delivered to homes and businesses, it is the responsibility of property owners to manage it. **As the Health Authority, VCH recommends residents run (flush) their taps until the water runs cold after it has been sitting in household pipes for several hours.**

This step flushes water that has been sitting for too long without disinfection or has leached metals from fixtures on the private property. In other words, flushing your taps makes sure the water that is being consumed is the same quality as the water that is delivered to people's homes and places of work.

Who is responsible for the water quality at the tap?
The *Drinking Water Protection Act* requires water suppliers (such as RMOW) to deliver potable water to users with defined quality standards, but it does not have a requirement to test the water after delivery to customers.

The water produced and distributed by the RMOW consistently meets the conditions of the Permits to Operate. RMOW staff sample water at 24 locations in the distribution system every second week, and the water is tested for bacteriological data (E. coli & Total Coliform), pH, residual chlorine, temperature and turbidity. Overall potable water chemistry is sampled and tested at least annually.

All samples are analyzed by a laboratory and entered into a database. Any results outside of the guidelines are **flagged immediately** and sent to both VCH and the RMOW water system operating team so that appropriate action may be taken.

Complexity of Source Water Supply
The water chemistry characteristics of the RMOW Community water system is complex because both surface and groundwater sources may be used.

The RMOW Community water supply can be from:

- only surface water;
- only groundwater; or
- both (blended).

The surface water, 21 Mile Creek supply, is not utilized when the creek water is turbid (cloudy), this occurs during rainfall and snowmelt events.

The groundwater is supplied from 14 active wells, which are used when 21 Mile Creek supply is offline or water demand exceeds what 21 Mile Creek can supply alone. The well water supplies are only unavailable during an emergency event such as contamination or equipment malfunction.

Demand is the only other factor that determines what source is being used at any time. Operationally, the RMOW tries to use 21 Mile Creek surface water as much as possible, because it can fill reservoirs under gravity pressure whereas the groundwater sources all have to be pumped (which uses electricity).

Water is treated at eight locations before distribution.

Distributed Water Treatment System
In the Community Water System, water is drawn from the Twenty-One Mile Creek surface water source and undergoes primary disinfection by means of UV treatment. The water then receives primary and secondary disinfection with chlorine injection (for the purpose of destruction or inactivation of pathogens and for protecting the water quality in the distribution system).

The wells are combined into single treatment points where feasible, which is presently a total of seven locations in the Community Water System. The water from ground water wells receives secondary disinfection from chlorine injection.

Any proposed upgrades to ground water treatment based on the present configuration of the system would need to be made at the following seven locations:

- 21 Mile Pump Station (P280),
- Alpine Well #1,
- Alpine Well #2,
- Alpine Well #3,
- Community Pump Station (P247),
- Function Junction, and
- Cheakamus PS (P279).

The Emerald Estates Water System is the eighth location that could require pH adjustment. Water is drawn from the Emerald Estates well sources (three wells) and undergoes primary disinfection by means of UV treatment. The water then receives primary and secondary disinfection from chlorine injection. The new Emerald Estates UV disinfection facility (P290) has space inside the building set aside to add any future upgrades related to water quality treatment.

Definition and ranges of pH for Whistler water
pH is a measure of the acidity/basicity of water, it is measured on a logarithmic scale from 1 to 14.

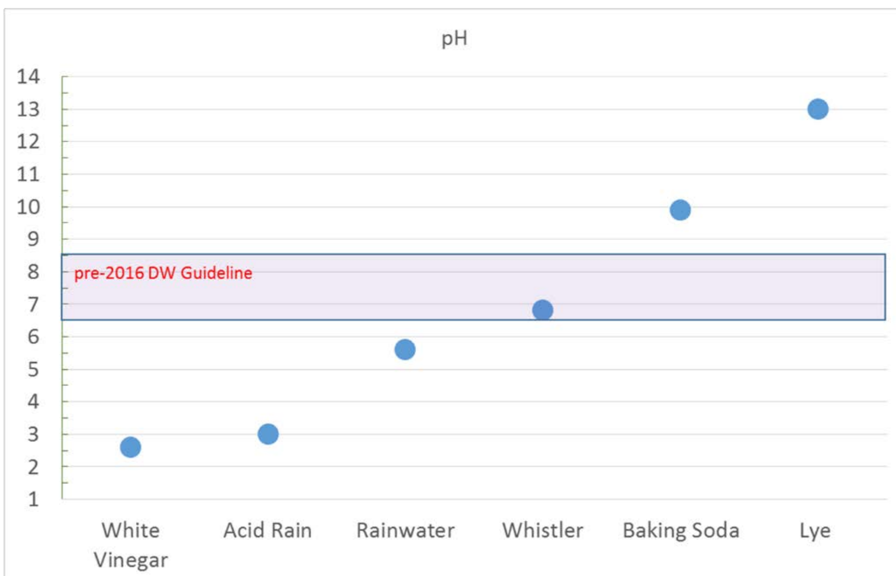
- pH 7 is “neutral”
- pH below 7 is “acidic”
- pH above 7 is “basic”

The Guidelines for Canadian Drinking Water Quality for pH state:

"2.4 Health effects
There is no evidence of an association between the pH of the diet (food or drinking water) and direct adverse health effects. Extreme levels of pH have been linked to some health effects, including irritation of the skin and eyes. The most significant impact of pH on health is indirect and related to exposure to metals leached from the distribution system and to disinfection by-products formed as a result of treatment processes.

3.0 Application of the guideline
Current science indicates that the guideline for the pH of finished drinking water should be flexible to allow systems to determine the most appropriate pH for their individual water quality goals. The acceptable pH range of 7.0-10.5 would provide utilities the flexibility required to achieve water quality goals and to control contaminant concentrations and corrosion by combined treatment approaches appropriate to the materials in the distribution system and premise plumbing. It is important to note that pH cannot be considered in isolation for controlling corrosion. Adjustment of pH by itself is not considered appropriate; other parameters, such as alkalinity and dissolved inorganic carbon, also need to be considered".

Prior to 2016 the Guidelines for Canadian Drinking Water Quality (GCDWQ) recommended an operational guideline range for pH of 6.5 to 8. The guideline that was released in 2016 updated that guideline to an operational range of 7 to 10.

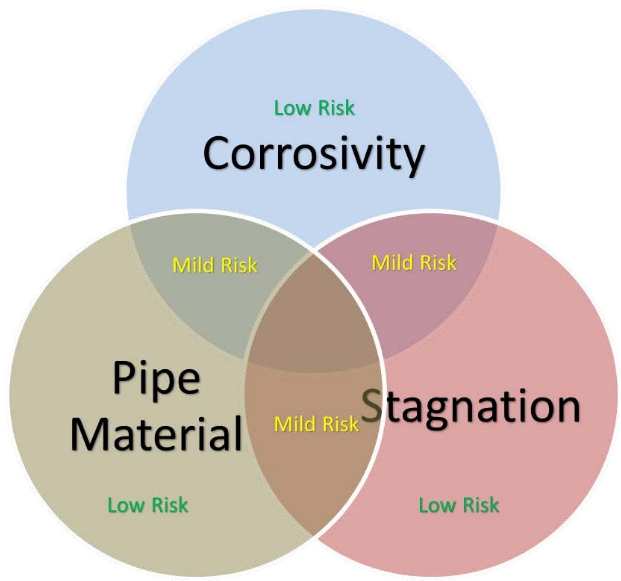


The more the pH is above or below 7 the more chemically reactive the water is or "not stable". pH influences drinking water treatment effectiveness and efficiency, and in the distribution system and consumer systems (private property plumbing), the potential for corrosion.

When 21 Mile Creek is available as a sole source (which is about half the time), the pH is approximately neutral. When the wells are being utilized they each supply water with a different pH value, but on a yearly average the pH of the well water is between 6.5 and 7.

What is water corrosivity and why is it of concern?
Sometimes described as “acidic” or “aggressive”, corrosivity is the extent to which water can cause a chemical reaction that will cause a deterioration in the material used in plumbing pipes and fixtures. The three most important characteristics of corrosivity are low pH, low alkalinity and low hardness (referred to commonly as soft water), but many other parameters also have a minor impact on corrosivity.

Private and municipal plumbing systems have some metal components. In private buildings and homes the risk of the metals leaching into water can result from three variables: water corrosivity, pipe material, and water stagnation time. In the municipal water distribution system the risk of metals leaching into the water is low because the water is almost constantly moving due to demand. In the RMOW’s water system, the water quality sampling results consistently meet or exceed all existing guidelines for metals.



Results of most recently commissioned report
In response to the request from VCH to investigate o*ptions for pH adjustment and finalize a long term plan,* the RMOW engaged a consultant to provide Class C conceptual designs of corrosion control systems for our fifteen water sources, which are treated at eight existing treatment sites. This report also provides a background review on current federal and provincial regulations pertaining to corrosion control in drinking water.

In order to keep the approach simple (and not expend too much on consulting fees) at this stage of design only three different types of conceptual system designs were proposed:

- at the Emerald UV Facility (P290),
- at each of the Alpine Wells; W202, W210, W213; and
- at 21 Mile Pump Station (P280), Community Pump Station (P247), Function Junction, and Cheakamus PS (P279).

The reality is each of the sites listed under the third bullet will require slightly different approaches and that the best long-term approach may be to commission larger infrastructure projects in order to combine some of the sources, namely:

1. Combine the three Alpine wells W202, W210, and W213 into an "Alpine Water Treatment Station";
2. Combine Function Junction (W212), and Cheakamus PS (W217/P279) into a "South Whistler Water Treatment Station".

Some work has been done on the South Whistler Water Treatment Station (originally called "Spring Creek Booster Station") but no work has been started on an "Alpine Water Treatment Station".

The proposed conceptual designs were based on a recommended chemical addition of 50 per cent sodium hydroxide solution (NaOH, also known as lye or caustic soda), except for the Emerald UV Facility which was based on the facility's initial design of 8% sodium carbonate solution (Na^2CO^3, also known as soda ash). ***These are not necessarily the best final chemical selections***, as this will take more research based on actual water chemistry, the health and safety risk to the water system operators and the risks associates with transporting the chemicals to each site.

For each site, equipment sizing, such as dosing pumps, was estimated using the peak flows. Chemical storage tanks were sized using the maximum monthly operating averages, whereas the annual chemical consumption was estimated using the annual operating averages.

There are a number of chemicals that can be used to raise pH. The RMOW has concerns about the best choice of chemical, and this decision will require further investigation, including but not limited to:

- the health and safety aspects that this infrastructure will mean for the water operating team;
- the potential impact to the existing treatment process (specifically the chlorine dosing rate);
- the potential impact to the environment since ~50 per cent of the water in summer is used for irrigation;
- the potential impact to the Wastewater Treatment Plant biological treatment process;
- the sustainable supply of these chemicals (some require large amounts of energy to create and some are mined);
- the impact of transporting liquid or solid chemicals up Highway 99 year-round or the logistics of mixing chemicals onsite;
- the temperature and humidity which certain chemicals will need to be kept year-round.

What Are the Next Steps?

The following steps are planned / underway at this time:

1. Continuing to reiterating VCH's recommendation that all consumers freshen water by flushing until cold before drinking;
2. Educating private property owners regarding their responsibility for the condition of their building's plumbing and for taking any necessary remedial action to minimize potential exposure to metals deriving from the plumbing and fixtures on their property.
3. Adding a project budget in 2021 for a feasibility design:
    a. To combine the three Alpine Wells into a single location (W202 + W210 + W213);
    b. To combine the Function Junction and Cheakamus wells into a single location with additional treatment for iron and manganese (P279 + W212), plus function as a pump station to fill the Gondola Way and Cheakamus reservoirs;
4. Add a project budget to review the types of chemicals recommended for use, considering all the pros and cons, and based on experience gained from other municipalities with similar water quality parameters.
5. Before proceeding to treat the well water supply for pH the RMOW will need to inform the community and collect feedback especially considering the following factors:

a. pH when 21 Mile Creek is being utilized is neutral;
b. pH is only one of the factors that contributes to water corrosivity; and
c. the recommendation from VCH to freshen water by “flushing until cold before drinking” will continue.

WHISTLER 2020 ANALYSIS

Whistler 2020 Strategy	TOWARD Descriptions of success that resolution moves us toward	Comments
Water	Residents and visitors are educated about and encouraged to protect and conserve natural water resources.	The goal of this report (and accompanying presentation) is education, in order to raise awareness of the value of our water and the need to protect and conserve it.
Water	All potable water is used sparingly and only used to meet appropriate needs.	By raising awareness of the value of our drinking water we are ensuring future generations recognise the importance of conservation efforts.

This Drinking Water Treatment Guidelines Update does not move our community away from any of the adopted Whistler2020 Descriptions of Success.

OTHER POLICY CONSIDERATIONS

There are no other identified policy considerations at this time.

BUDGET CONSIDERATIONS

The capital costs estimated in the report to upgrade each of the facilities includes a 30 per cent contingency and an estimated 15 per cent for engineering design fees. The total estimated capital cost for pH adjustment of Whistler’s well water is $5.7 million. These estimates do not include any land acquisitions that may be needed to accommodate the expansion of the building envelopes at these sites.

LOCATION	EMERALD	ALPINE WELLS			OTHERS			
ID NUMBER	P290	W202	W210	W213	P247	P280	W212	P279
ROUNDED TOTALS	$120,000	$880,000	$930,000	$910,000	$710,000	$710,000	$730,000	$700,000

The operational costs have not had a formal analysis completed, but staff estimate that at least another two full-time staff would be needed and at least $200,000 a year in chemicals would be required. This appears to be a significant increase on the present operating budget of approximately $2 million per year.

The resulting capital and operating costs would need to be added to the long-term financial plan for the water supply system, as the present reserve level only allows for replacement of water infrastructure as it presently exists, not this level of expanded services.

COMMUNITY ENGAGEMENT AND CONSULTATION

There is no proposed community engagement or consultation at this time. This would occur after additional information is collected.

SUMMARY

The RMOW encourages everyone in Whistler to continue to drink tap water that has been flushed and not switch to bottled water.

Flushing taps until water runs cold is an effective step anyone can take to reduce their exposure to lead in drinking water. Anyone with concerns about their drinking water is encouraged to have their water independently tested. A list of labs in the Lower Mainland is available at whistler.ca/drinkingwater. Questions about health should be directed to Vancouver Coastal Health.

As requested by Vancouver Coast Health, the RMOW has begun the process of investigating options for pH adjustment to improve the chemical stability of our treated drinking water. More work needs to be done to determine the best course of action for pH adjustment, but all of the options are complex and will have significant cost implications.

Respectfully submitted,

Gillian Woodward
UTILITIES GROUP MANAGER

for
James Hallisey
GENERAL MANAGER OF INFRASTRUCTURE SERVICES

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Water System Report

Inspection Information	
Facility Name:	**RMOW Community Water System**
Facility Number:	1110299
Officer:	Dan Glover
Inspection type:	Evaluation
Inspection date:	March 15, 2019
Follow-up Inspection Required:	**No**
Hazard Rating:	**Low**

Critical Hazards

These items relate to public health or safety, and must receive immediate attention.

Operation & Maintenance

These items must be corrected within a designated time period.

Comments

A total of 455 bacteriological samples were submitted in 2018 indicating the minimum sampling frequency was exceeded. Only 1 sample indicated a low total coliform count indicating overall bacteriological water quality was consistently good throughout the year. In view of the stable chlorine residual levels, the one sample noted above may be due to a mishap in the sample collection procedure.

As a result of a variety of sources, both surface and ground water, there is some variability of chemical water quality within the system, although no parameters pose an immediate concern. As noted previously the source water in several wells has relatively low pH, below the operational guideline noted in the guidelines for Canadian Drinking Water Quality (GCDWQ). Options for pH adjustment should be investigated and a long term plan finalized as a means of improving the chemical stability of the treated drinking water. Changes to the GCDWQ in 2019 include a lowering of the MAC for lead to 5 ppb. At this time VCH is comfortable with the approach taken by the RMOW in terms of advising the public to flush taps before water consumption. It is also anticipated that a new MAC for manganese will be introduced in the coming months. This is a departure from the current guideline where an aesthetic objective is in place for manganese. A review of water quality from all ground water sources should be undertaken to determine if any supply strategies will be necessary once the new manganese standard is introduced.

Amalgamation of the former Van West service area was completed in 2018 and improved sampling points have been established. The water sources which formerly

serviced this area are no longer in use but full decommissioning is not yet complete. A plan for decommissioning these works and a Construction Permit Application should be prepared with a goal of completing the works in the next 18 months.

Source water protection continues to be an important factor in the ongoing provision of safe drinking water. Ongoing work should include a review of the current state of all water sources (both surface and ground water) and an inventory of the areas adjacent to all water sources. It is recommended that this become an annual program and form the basis for an updated Source Water Protection Plan. A variety of tools can be considered to enhance protection of the wellheads and the 21 Mile Creek surface source such as increased signage, public education and access controls where appropriate. An emphasis of the importance of source water protection should also be factored into the updated OCP.

Significant work has been completed related to implementing cross connection control measures throughout the RMOW. We are optimistic of bylaw approval in the near future which would facilitate this program and place emphasis on Industrial, Commercial and Institutional premises. Your efforts in this regard are an excellent addition to the multi-barrier approach in place. As noted previously VCH has some concerns with respect to the presence of some of the water service piping which passes through private developments to supply further properties. As strata and other development are considered as a 'system within a system' and therefore exempt from the requirements of the Drinking Water Protection Regulations (DWPR) there is limited control over water quality within these properties; the piping arrangements within the private / strata property are left to the design engineer to follow good engineering practice. VCH advocates no further such servicing be considered by the RMOW. We will continue to review the service connection from the RMOW to these developments for the purpose of issuing a Construction Permit to the RMOW as well as assessing the need for backflow protection.

In December 2018 a power failure followed by a series of control failures resulted in a significant quantity of untreated surface water enterring the distribution system. This unexpected occurrence highlights the need to re-evaluate how the entire system responds to emergencies in terms of critical infrastructure. We understand a temporary UPS upgrade is being completed which should prevent this from recurring however there may be better strategies to implement which would reduce the risk of non-potable water reaching the consumer. It is recommended you consider the most likely risks to the treatment works, determine the back-up power demand required to ensure water disinfection can continue uninterrupted during such events and the operational demands associated. This should include reassessment of the need for on-site auxiliary power generation.

Please review and update your Emergency Response and Contingency Plan (ERCP) to ensure contact information is updated. As we discussed, consideration should be given to managing events such an interface wildfire - including a BWA should you need to augment supply with flow from back up sources. Ideally your ERCP should be practised in a desktop exercise to assess for gaps and communication efficiency. Attached is an updated contact list for VCH for inclusion in the ERCP.

Thank you for submitting your 2017 annual monitoring report. Your 2018 annual report

is not due until June 30, 2019.

Dan Glover
DWO

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Water System Report

Inspection Information	
Facility Name:	**RMOW - Emerald Estates Water System**
Facility Number:	11076
Officer:	Dan Glover
Inspection type:	Evaluation
Inspection date:	March 15, 2019
Follow-up Inspection Required:	**No**
Hazard Rating:	**Low**

Critical Hazards

These items relate to public health or safety, and must receive immediate attention.

Operation & Maintenance

These items must be corrected within a designated time period.

Comments

Bacteriological sampling results in 2018 indicate the sampling frequency and water quality were satisfactory throughout the year. Of the 46 samples submitted for analysis, none (0%) were positive for total coliform bacteria or e. coli.

The UV treatment system installation was completed in 2018 and a final inspection was conducted in July. At that time it was noted that the UV reactors installed were a different model than indicated on the Construction Permit. Confirmation received that the unit installed is validated; some further information on the treatment works was requested by PH Engineer.

As discussed previously the ground water supplying the Emerald Estates wells appears to be soft with respect hardness and low in alkalinity, with a typical pH value close to 7.0. The new Operational Guideline for pH has been recently revised under the GCDWQ, now specifying a higher pH range from 7.0 to 10.5. We understand the new UV treatment facility may allow for supplementation for pH adjustment. Options for pH adjustment should be investigated for this system and a long term plan finalized as a means of improving the chemical stability of the treated drinking water.

Source water protection continues to be an important factor in the ongoing provision of safe drinking water for this system. Ongoing work should include a review of the current state of the wells and an inventory of land uses on the areas adjacent to them. It is recommended that this become an annual program and form the basis for an updated Ground Water Resource Protection Plan. Several methods can be used to

enhance protection of the wellheads such as increased signage, public education and access controls where appropriate. An emphasis of the importance of source water protection should also be factored into the updated OCP, now in draft.

Changes to the GCDWQ in 2019 include a lowering of the MAC for lead to 5 ppb. At this time VCH is comfortable with the approach taken by the RMOW in terms of advising the public to flush taps before water consumption.

Significant work has been completed related to implementing cross connection control measures throughout the RMOW. We are optimistic of bylaw approval in the near future which would facilitate this program and place emphasis on Industrial, Commercial and Institutional premises. Your efforts in this regard are an excellent addition to the multi-barrier approach in place.

Please review and update your Emergency Response and Contingency Plan (ERCP) to ensure contact information is updated. As we discussed, consideration should be given to managing events such an interface wildfire - including a BWA should you need to augment supply with flow from back up sources. Ideally your ERCP should be practised in a desktop exercise to assess for gaps and communication efficiency. Attached is an updated contact list for VCH for inclusion in the ERCP.

Thank you for submitting your 2017 annual monitoring report. Your 2018 annual report is not due until June 30, 2019.

Dan Glover
DWO

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HEALTH PROTECTION

PERMIT TO OPERATE

A Water Supply System

Purveyor: Resort Municipality Of Whistler
Facility Name: RMOW Community Water System

Conditions of Permit

Minimum bacteriology sampling frequency is 25 per month (distribution).
Update and implement the Source Water Protection Plans (ground water and surface water).
Implement your Cross-Connection Control Program.
Maintain the uni-directional flushing program annually.
Review the Emergency Response Plan and update at least annually.
Blackcomb Creek source may not be used without prior authorization from VCH.

July 1, 1992
Effective Date
March 18, 2019
Revised Date

Drinking Water Officer

This permit must be displayed in a conspicuous place and is not transferable.

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HEALTH PROTECTION

PERMIT TO OPERATE

A Water Supply System

Purveyor: Resort Municipality Of Whistler
Facility Name: RMOW - Emerald Estates Water System

Conditions of Permit

Maintain FAC level at 0.4 ppm minimum post reservoir.
Update and implement the Ground Water Resource Protection Plan.
Minimum bacteriology sampling frequency is 4 per month (distribution).
Implement the Cross-Connection Control Program.
Maintain the Uni-Directional Flushing Program.
Review the Emergency Response Plan and update annually.
Obtain P. Eng. sign-off by July 01, 2019 on UV treatment system installed.

July 1, 1992
Effective Date
March 18, 2019
Revised Date

Drinking Water Officer

This permit must be displayed in a conspicuous place and is not transferable.

RESORT MUNICIPALITY OF WHISTLER
REPORT NUMBER: 18P-00256-00

CORROSION CONTROL CONCEPTUAL DESIGN

TECHNICAL MEMORANDUM

OCTOBER 2019

FINAL

CORROSION CONTROL CONCEPTUAL DESIGN

TECHNICAL MEMORANDUM

RESORT MUNICIPALITY OF WHISTLER

FINAL

PROJECT NO.: 18P-00256-00
DATE: OCTOBER 2019

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October 15, 2019

RESORT MUNICIPALITY OF WHISTLER
4325 Blackcomb Way
Whistler, BC
V8E 0X5

Attention: Gillian Woodward, Utilities Group Manager

Dear Ms. Woodward:

Subject: Corrosion Control Conceptual Design - Technical Memorandum

Please find attached a final copy of the Corrosion Control Conceptual Design -Technical Memorandum. This draft includes an overview of the current regulation surrounding the corrosion control requirements for drinking water supplies, as well as, Class “C” cost estimates to provide corrosion control to eight (8) existing water facilities in Whistler.

Should you have any questions regarding the content of this report. Please do not hesitate to contact the undersigned.

Yours sincerely,

Patricia Oka, P.Eng.
Project Engineer - Infrastructure

PO/lp
Encl.

WSP ref.: 18P-00256-00

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REVISION HISTORY

FIRST ISSUE

March 11, 2019	DRAFT 1			
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September 6, 2019	DRAFT 2			
Prepared by	Reviewed by	Approved By		
Patricia Oka, P.Eng.	Thomas Munding, P.Eng.			
October 15, 2019	FINAL			
Prepared by	Reviewed by	Approved[1] By		
Patricia Oka, P.Eng.	Thomas Munding, P.Eng.	Trevor Dykstra, P.Eng.		

SIGNATURES

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Senior Process Engineer - Water

APPROVED[1] BY

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Director - Water

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CONTRIBUTORS

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Senior Engineer	Thomas Munding, P.Eng.
Engineer	Patricia Oka, P.Eng.

EXECUTIVE SUMMARY

This report provides an overview of the current regulations and guidelines pertaining to corrosion control in drinking water systems, proposes design configurations for eight (8) existing water facilities within the Resort Municipality of Whistler (RMOW), and presents class "C" capital cost estimates for design implementation for corrosion control at the eight water facilities.

Corrosion is a common issue in Canadian drinking water supplies. Corrosion in drinking water systems is typically induced by water with low pH and hardness values, which may oxidize and leach metals from the distribution piping and plumbing systems. Lead, copper and iron are the metals that are most commonly found to exceed the drinking water quality guidelines, due to their presence in water distribution, plumbing and fixtures.

Of the three metals, lead is known to have the most impact on public health. Research studies have indicated adverse neurodevelopmental effects from increased blood lead levels (BLL). Subsequently, the Federal-Provincial-Territorial Committee on Drinking Water (CDW) have made the proposal to reduce the maximum acceptable concentration (MAC) for lead from 0.010 mg/L to 0.005 mg/L based on the current analytical achievability (Health Canada, 2017) to enhance the existing public-health barrier to lead exposure.

The class "C" capital cost estimate to implement corrosion control at the existing Emerald UV Facility (P290) is approximately $120,000. The budget includes costs associated with supply and install of two 2,000-L storage tanks, a duplex dosing skid, and a supply pipe to an existing injection point. An 8% soda ash solution was assumed to be required to provide pH adjustment for corrosion control, as specified in the initial design of the UV facility. As the facility was designed with the provision for this corrosion control system, no additional costs are foreseen for building upgrades.

The class "C" capital cost estimates to provide corrosion control to the Alpine well sites are estimated to range from $880,000 to $940,000 per site, depending on the dosing requirement. This budget was estimated with the assumption that a new structure would be built. Corrosion control would be provided with a pH adjustment using a 50% caustic soda solution, as per KWL's recommendation (2015). Aside from housing the new corrosion control system, the new building would also house the existing hypochlorite dosing system, as well as a new 150 Ø SS process pipe that would allow above-ground injections of caustic and hypochlorite solutions. The estimated footprint of the new structure is estimated to be 6.4m L x 7.4m W.

For the 21 Mile Creek, Community Pump Station, Function Junction, and Cheakamus Pump Station sites, the estimated costs to provide corrosion control to the existing systems range between $700,000 and $730,000 per site, depending on the dosing requirement. The budget was estimated with the assumption that a new structure would be built to house the new corrosion control system. The estimated footprint of the new structure is estimated to be 6.4m L x 7.4m W. Corrosion control would be provided with a pH adjustment using a 50% caustic soda solution, as per KWL's recommendation (2015). It is proposed that the caustic solution would be supplied and injected into the existing contact tanks at 21 Mile Creek, Community Pump Station, and Cheakamus Pump Station. At Function Junction, it is proposed that the caustic solution be injected at the chlorine injection point in the existing chlorination building.

Alternative chemicals to caustic soda and soda ash are also presented in this report, including stabilized calcium hydroxide at 35% suspension and stabilized magnesium hydroxide at 65% suspension. Calcium hydroxide and magnesium hydroxide have reaction times of 1 minute and 30 minutes, respectively. Both react slower than the immediate reaction time of the proposed 50% caustic soda. The slower reaction times result in significantly lower exposure risks to the operators. Injection with either of these alternative chemicals would increase both pH, and hardness (via calcium or magnesium addition), resulting in increased corrosion protection. A disadvantage of using calcium hydroxide is that it requires an approximately 50% larger storage volume than caustic soda. The disadvantage of magnesium hydroxide is that the system requires a contact tank or pipeline with sufficient travel time to meet the 30 minute dissolution time. Further investigation would be required to determine if use of either calcium hydroxide or magnesium hydroxide would be feasible at each site. Otherwise, substitution with either of these chemicals would only require minor modifications to the proposed system, such as addition of mixers to the storage tanks. Dosing with caustic soda has been assumed for the class "C" cost estimation.

TABLE OF CONTENTS

TABLES

FIGURES

1 INTRODUCTION

This report was prepared in response to the 2017 Vancouver Coastal Health (VCH) report which outlined the recent increase in the operational guideline for pH under the Guidelines for Canadian Drinking Water Quality (GCDWQ) and its direct impact on the compliance of Resort Municipality of Whistler's (RMOW) existing water systems. VCH requested RMOW to provide remediation strategies for the non-compliant sites and review the guidelines on corrosion control in water supplies.

This report provides a background review on current federal and provincial regulations pertaining to corrosion control in drinking water, conceptual designs of corrosion control systems for 15 water sources, and estimated capital costs of implementation. The conceptual design and estimated capital costs presented in this report were informed by the chemical recommendations made in the 2015 Water Distribution Corrosion Study by Kerr Wood Leidal (KWL) (Kerr Wood Leidal, 2015).

1.1 REGULATION REVIEW

Corrosion in drinking water is regulated through a number of federal and provincial statutes and guidelines, including the *Drinking Water Protection Act*, *BC Plumbing and Building Code*, the *Public Health Act*, the *School Act*, the *Community Care and Assisted Living Act, BC Interim Guideline on Evaluation and Mitigating Lead in Drinking Water Supplies*, and the *Guidance on Corrosion in Drinking Water Distribution System.* These statutes and guidelines recognize the complexity of corrosion in distribution and how centralized mitigation alone may not be sufficient to mitigate the matter. Multiple parties, including property owners, water suppliers and health officers are responsible for minimizing the risk of and mitigating corrosion in drinking water (BC Health Protection Branch, 2017).

Corrosion is a common issue in Canadian drinking water supplies. It can be caused by several factors, including water quality, age and materials of the system, and stagnation time of water in the system. Corrosion can lead to leaching of metals, particularly lead, copper and iron as they are commonly present in drinking water distribution systems, plumbing and fixtures. Subsequently, elevated levels of these metals near or above the GCDWQ are used to indicate the occurrence of corrosion in a system.

Lead is known to have adverse health effects on the most vulnerable populations, such as infants, children, and pregnant women. In March 2019, the GCDWQ adopted a new maximum acceptable allowance (MAC) of 0.005 mg/L or ALARA. The ALARA guideline is based on the current analytical achievability (Health Canada, 2017) to reinforce the existing public-health barrier to lead exposure. This is a significant drop from the previous MAC of 0.010 mg/L which was established by the World Health Organization (WHO) based on a 1992 provisional weekly intake of lead that was known to have no effects on blood lead levels (BLL). Since then, newer studies have linked high lead intake to reductions in the intelligence quotient (IQ) in children. Although the threshold below which lead is no longer associated with adverse neurodevelopmental effects is unknown, the new ALARA guideline sets a higher standard for water suppliers to minimize public exposure to lead beyond the MAC level.

Copper and iron, on the other hand, are known to be essential for the human body within certain intake levels. Excessive copper intake can cause negative effects to the gastrointestinal tract and can be especially harmful to formula fed infants, who are ingesting higher volumes of tap water. In 2018, Health Canada proposed a new MAC and aesthetic objective (AO) for copper in 2018 set at 2.0 mg/L and 1.0 mg/L, respectively[2]. The previous guideline for copper in drinking water was only an aesthetic guideline of 0.3 mg/L.

The first step to implementing a corrosion control program is to conduct a monitoring program at consumers' taps to assess if and to what degree corrosion may be occurring, and whether corrective measures are required. Although corrosion would lead to the leaching of several contaminants, the 2009 *Guidance on Controlling Corrosion in Drinking Water Distribution Systems* suggests that lead should be the primary focus of the monitoring program,

[2] This study was conducted prior to the release of the new *Copper in Drinking Water* guideline dated June 2019.

owing to the adverse health effects that it has on human health (Health Canada, 2009). This document suggests a two-tier sampling program in assessing the presence of lead within a residential distribution system, based on a minimum stagnation period of 6 hours. Tier 1 sampling provides initial screening for lead concentrations throughout the residential distribution system. Should the results indicate that more than 10% of the sites contain lead at concentrations exceeding the MAC, then Tier 2 sampling should be conducted. Tier 2 sampling is conducted at a reduced number of sites than in Tier 1 with the objective to provide sufficient lead profile data for the system. The document suggests a routine annual sampling, typically between May and October as lead is expected to be highest in these months.

In 2017, along with the proposal to reduce lead's MAC, the Federal-Provincial-Territorial CDW also proposed a new sampling protocol based on a random daytime (RTD) method to better reflect consumer use and determine the typical public exposure to lead in drinking water (BC Health Protection Branch, 2017; Health Canada, 2017)[3]. In RDT, samples are taken from a cold water tap without prior flushing or stagnation period. In addition, the protocol requires a year-round sampling to account for any seasonal variations. The same RDT sampling protocol was proposed for copper monitoring in the 2018 public consultation for copper in drinking water (Federal-Povincial-Territorial Committee on Drinking Water, 2018)[3]. While the running average data may draw a more representative picture of public exposure to the above metals, a larger dataset and longer sampling period is required to produce a representative running average for a water supplier such as Whistler.

Once risks from lead, copper or iron in drinking water are confirmed, Health Canada recommends that corrective measures be adopted to minimize public health risks. Once in place, an appropriate monitoring program should be used to confirm the effectiveness of the mitigation actions (Health Canada, 2009). It is worth noting that, although the target is to achieve reduction of lead/copper/iron in drinking water at the tap, water suppliers are not responsible for the maintenance or replacement of plumbing beyond service lines and other fixtures upstream of the curb stop. Beyond the service lines, property owners are responsible for the condition of the plumbing and any mitigation or remedial actions required to minimize lead/copper/iron exposure (BC Health Protection Branch, 2017).

1.2 PROJECT BACKGOUND

The RMOW has requested that WSP conduct conceptual design work for the installation and implementation of corrosion control systems at eight (8) existing treatment locations. This work was informed by the recommendations made in the 2015 Water Distribution Corrosion Study by KWL (Kerr Wood Leidal, 2015). The 8 treatment locations are as follows:

1. 21 Mile Pump Station (P280),
2. Emerald UV Facility (P290),
3. Alpine Well #1,
4. Alpine Well #2,
5. Alpine Well #3,
6. Community Pump Station (P247),
7. Function Junction, and
8. Cheakamus PS (P279).

This section provides a background overview of the report and existing site conditions at the locations that are being considered for the development of our conceptual designs to mitigate corrosion within the RMOW's distribution system.

[3] The proposed new protocol was accepted and released in March 2019.

1.2.1 WATER DISTRIBUTION CORROSION STUDY (KWL, 2015)

Fifteen (15) water sources were tested in duplicates for total dissolve solids (TDS), temperature, alkalinity, pH, calcium, chlorine and sulfate contents. Data obtained indicated a consistently low pH of between 6.0 and 7.0, low alkalinity of between 15 and 70 mg/L, and low hardness of between 9 and 80 mg/L as $CaCO_3$.

Corrosivity analysis was conducted with the Rothberg, Tamburini and Winsor (RTW) model to estimate Calcium Carbonate Precipitation Potential (CCPP) and Aggressiveness Index (AI). AI is typically used to evaluate the corrosivity of water to asbestos cement (AC) pipes, as portions of RMOW's water distribution system include AC pipes. Aggressive water typically has CCPP value of lower than -10 and AI value of less than 10.

The corresponding sources and the water quality of the 8 treatment locations are listed and summarized in Table 1-1. The water quality values presented are the average of the duplicates, retrieved from the KWL report (2015).

Table 1-1 RMOW's Source Water Quality

SITE	WELL	TDS (mg/L)	pH	ALKALINITY as $CaCO_3$ (mg/L)	Ca as $CaCO_3$ (mg/L)	SO_4 (mg/L)	CCPP VALUE	AI VALUE
P280 21 Mile PS	W218	63.5	6.4	15.5	12.6	20.9	-37.78	8.64
	W219	51.0	6.3	22.0	11.7	13.6	-	-
P290 Emerald UV	W201-1	188.5	6.3	48.0	27.3	14.6	-100.38	9.42
	W201-2	84	6.7	50.5	23.9	11.5	-48.76	9.78
	W201-3	105	6.7	43.5	24.1	15.0	-46.26	9.67
Alpine 1	W202	37.5	6.5	18.0	9.0	7.2	-34.26	8.66
Alpine 2*	W210	37.5	6.5	18.0	9.0	7.2	-	-
Alpine 3	W213	138.5	6.7	35.5	39.2	62.3	-38.88	9.79
P247 Community	W205-1	260.0	6.2	51.5	57.3	89.0	-130.23	9.69
	W205-2	368.0	6.3	66.0	79.6	109.0	-129.71	9.67
	W205-3	193.0	6.3	60.5	44.4	57.0	-132.30	9.68
	W211	229.5	6.2	59.0	48.2	61.1	-143.52	9.65
Function Junction	W212-1	205	6.2	32.5	18.6	13.5	-99.59	8.93
	W212-2	279.0	6.1	38.5	19.6	11.0	-127.57	8.98
P279 Cheakamus	W217	51.0	6.4	22.5	11.4	11.0	-46.02	8.81

*W210 water quality values assumed to be the same as W202.

The sampling program indicated a systemic corrosive characteristic across the tested water sources. Corrosion risk was estimated to be particularly high in Cheakamus, Emerald and the Community sites based on the above data and analysis. Additional indications of existing corrosion problems in the systems include:

— Complaints of green (copper) staining in the Cheakamus crossing area;

- Significant water loss in the Emerald Estate neighborhood, which is presumed to be corrosion-associated failures of metal pipes/ fittings;
- Various point failures of existing AC pipes in the village area, including three failed valve clusters in the last three years which was presumed to be corrosion-related.

Corrosion mitigation was proposed by modifying water chemistry to achieve a CCPP of -4. Three different chemicals were assessed in the KWL report (2015), caustic soda (50%), hydrated lime (35%) and soda ash (8%). Table 1-2 presents the estimated dosages of these chemicals required to mitigate corrosion risks at Cheakamus, Emerald and Community wells.

Table 1-2 Recommended Chemical Concentrations (excerpt from KWL Report, 2015)

WATER SOURCE	REQUIRED CONCENTRATION		
	Caustic Soda (mg/L)	Hydrated Lime (mg/L)	Soda Ash (mg/L)
Combined Community Wells P247	50	44	125
Emerald Estates W201-1	46	40	118
Emerald Estates W201-2	20	18	53
Emerald Estates W201-3	19	17	49
Cheakamus Crossing Well W217	19	16	49

The report recommends the use of 50% caustic soda over the other options based on cost efficiency, operation and maintenance requirements, and low scaling risk. Furthermore, KWL recommended that the RMOW conduct additional investigation to verify risks of corrosion through continuous potable water and soil/groundwater sampling, and opportunistic distribution pipe sample collections (i.e. pipe coupons and fittings) from routine maintenance/repair and future replacement of the distribution system. KWL also suggested the RMOW to determine the baseline corrosion level by monitoring material loss within a municipal building and conduct a pilot study prior to implementation of any corrosion mitigation system.

1.2.2 SITE DESCRIPTIONS AND CAPACITIES

For this conceptual study, RMOW provided WSP with monthly flow averages from the year of 2017 and annual flow averages from 2015 to 2017 for each site. Chemical consumption was estimated using the maximum monthly flow at each site, derived from the 2017 monthly data. Peak flow was assumed to be equal to the source capacity at each site. This number is useful for determining equipment sizes. Table 1-3 summarizes the operating flow range at the eight (8) treatment sites.

Table 1-3 Nominal Capacities at the Eight Sites of Interest Based on 2015 – 2017 Operating Data

	UNIT	PEAK FLOW	MAX. MONTHLY AVG.	ANNUAL AVG.
P280 - 21-Mile Pump Station	L/s	74[1]	80	47.6
P290 – Emerald UV Facility	L/s	56	20.3	15.9
W202 – Alpine Well #1	L/s	34.7	20.4	10
W210 – Alpine Well #2	L/s	22.1	10.7	5.0
W213 – Alpine Well #3	L/s	18.9	10.0	5.0
P247 – Community PS	L/s	103.4	55	34.9

	UNIT	PEAK FLOW	MAX. MONTHLY AVG.	ANNUAL AVG.
W212 – Function Junction	L/s	41.0	24.8	12.3
P279 – Cheakamus PS	L/s	74.0	50	18.8

[1]Only W218 is presently used for routine operation and its maximum design capacity is 74 L/s.

Further information on current conditions at the listed facilities is summarized in the following sections.

P280 21-MILE PUMP STATION

The existing P280 21-Mile Pump Station ("P280 PS") provides chlorination to the treated 21-Mile Creek water from the 21-Mile Creek UV (P281) and the 21-Mile aquifer of Wells 218 and 219 (which is not yet in use for routine operations). The two sources have independent piping and treatment in the pump station, as the two sources are typically used in substitute of the other depending on the creek's turbidity. As requested by the RMOW, pH adjustment for the corrosion control will be provided in the P280 PS only for the groundwater source at a rate of 74 L/s. The existing P280 PS is not large enough to house a new corrosion control system. The PS will have to be extended or a new structure must be built to house the new system.

P290 EMERALD UV FACILITY

The existing P290 Emerald UV Facility ("P290") provides UV disinfection and chlorination to the Emerald Estate's groundwater wells W201-1, W201-2, and W201-3. P290 has a maximum operating flow of 30 L/s but has the capacity to operate at a higher flow of 60 L/s ("ultimate flow") during emergency events, such as fire. The operating pressure at the station is approximately 20 psi. P290 was designed and constructed with an extra injection point and with space to accommodate a future corrosion control system using 8% soda ash solution.

W202 ALPINE WELL #1

The existing facility at the Alpine Well #1 chlorinates (for secondary disinfection) extracted groundwater from well W202. The well can supply approximately 35 L/s with an operating pressure of 150 psi. The existing facility is not large enough to house a new corrosion control system. An extension or additional building would be required.

W210 ALPINE WELL #2

The existing facility at the Alpine Well #2 chlorinates (for secondary disinfection) extracted groundwater from well W210. The average values of different water quality parameters of well W210 indicated in Table 1-1 were assumed to be similar to that of well W202, based on data from Piteau Associates report 2017 (Piteau Associates, 2017). The well can supply approximately 22.1 L/s with an operating pressure of 150 psi. The existing facility is not large enough to house a new corrosion control system. An extension or additional building would be required.

W213 ALPINE WELL #3

The existing facility at the Alpine Well #3 is a below-ground chamber which chlorinates (for secondary disinfection) extracted groundwater from well W213. Table 1-1 presents the average values of different water quality parameters of well W213 retrieved from the KWL report. The well can supply approximately 19 L/s with an operating pressure of 150 psi. The existing facility is not large enough to house a new corrosion control system. A new building would be required.

P247 COMMUNITY BOOSTER PUMP AND PRV

The existing P247 Community Booster Pump and PRV Station ("P247") includes a chlorination system for secondary disinfection. The groundwater sources are from wells W205-1, W205-2, W205-3, and W211. The wells produce 27 L/s, 38 L/s, 21 L/s, and 18 L/s, respectively. However, their maximum combined supply capacity is only 71 L/s[4]. The required chlorine contact time is provided with the sub-grade chlorine contact tank, following the

[4] RMOW correspondence (comment made by reviewer C.Westaki August 2019)

injection point. The existing facility is not large enough to house a new corrosion control system. An extension or additional building would be required.

W212 FUNCTION JUNCTION WELLS 1 AND 2

The existing Function Junction Pump Station ("W212") includes a chlorination system to provide secondary disinfection. The groundwater sources are from wells W212-1 and W212-2. Well W212-2 is located inside the building, whereas W212-1 is located outside, adjacent to the building. Well W212-2 is not presently in use due to high iron and manganese levels. Well 212-1 can supply 41 L/s at 230 psi. The existing facility is not large enough to house a new corrosion control system. An extension or additional building would be required.

P279 CHEAKAMUS CROSSING PUMP STATION

Cheakamus Crossing Pump Station (P279) chlorinates (for secondary disinfection) water from the adjacent W217 well that flows into the pump station's sub-grade clear well tank. The existing facility is not large enough to house the new corrosion control system. An extension or additional building would be required.

2 BASIS OF DESIGN

Three (3) conceptual system designs are proposed for 1). the Emerald Pump Station, 2). Alpine Wells, and 3). the remaining sites. The proposed conceptual design was based on KWL's recommended chemical of 50% caustic soda solution, except for the Emerald UV Facility which was based on the facility's initial basis of design using an 8% soda ash solution.

The caustic soda dosages for Cheakamus and Community were estimated in KWL's report and indicated in Table 1-2. WSP's RTW assessment confirmed that the suggested dosages were appropriate to bring the different corrosion indices to near neutral. The same approach was adopted for estimating the chemical dosages for the remaining facilities. Table 2-1 presents the target ranges that were used in the RTW model to determine approximate chemical dosages for the remaining sites.

Table 2-1 Treatment Targets to Corrosion Indices

CORROSION INDICES	TARGET RANGE
pH	7.0 to 9.0
Precipitation Potential (mg/L)	-5.0 to 5.0
Langelier Index	-0.5 to 1
Aggressiveness Index	11.0 to 12.0
Ryznar Index	> 6.0

For each site, equipment sizing, such as dosing pumps, was estimated using the peak flows. Chemical storage tanks were sized using the maximum monthly operating averages, whereas the annual chemical consumption was estimated using the annual operating averages. The following sections discuss the basis of the three conceptual designs mentioned above.

2.1 EMERALD UV FACILITY

The conceptual design of the Emerald's corrosion system was based on the following assumptions:

- pH correction using an 8% soda ash solution, made from 99.9% soda ash powder and water.
- Existing facility to house the new corrosion control system.
- Two (2) 2,000-litre storage tanks of approximately 1,630 mm Ø x 1,200 mm H, mounted with a shaft mixer to allow complete mixing of the soda ash powder into solution.
- One (1) duplex dosing system operating as duty-standby, mounted on the wall next to the tanks.
- New polyvinylidene fluoride (PVDF) chemical supply pipe to the injection point. Supply pipe comes with a containment sleeve to prevent spraying in the event of a pipe break.

The new storage tanks would be sitting on an existing fibre-reinforced plastic (FRP) grating over an above-grade chemical sump. The transfer of the powder into the mixing tanks would be done manually by the operators as required. Approximately 7 x 25- kg bags of soda ask would be required per tank to make the 8% soda ash solution. The existing chemical room at the UV Facility is estimated to have sufficient storage for approximately 160 x 25-kg soda ash bags or 7 weeks of additional storage at maximum monthly consumption. Figure 2-1 presents the proposed layout for the corrosion control system for the Emerald UV Facility.

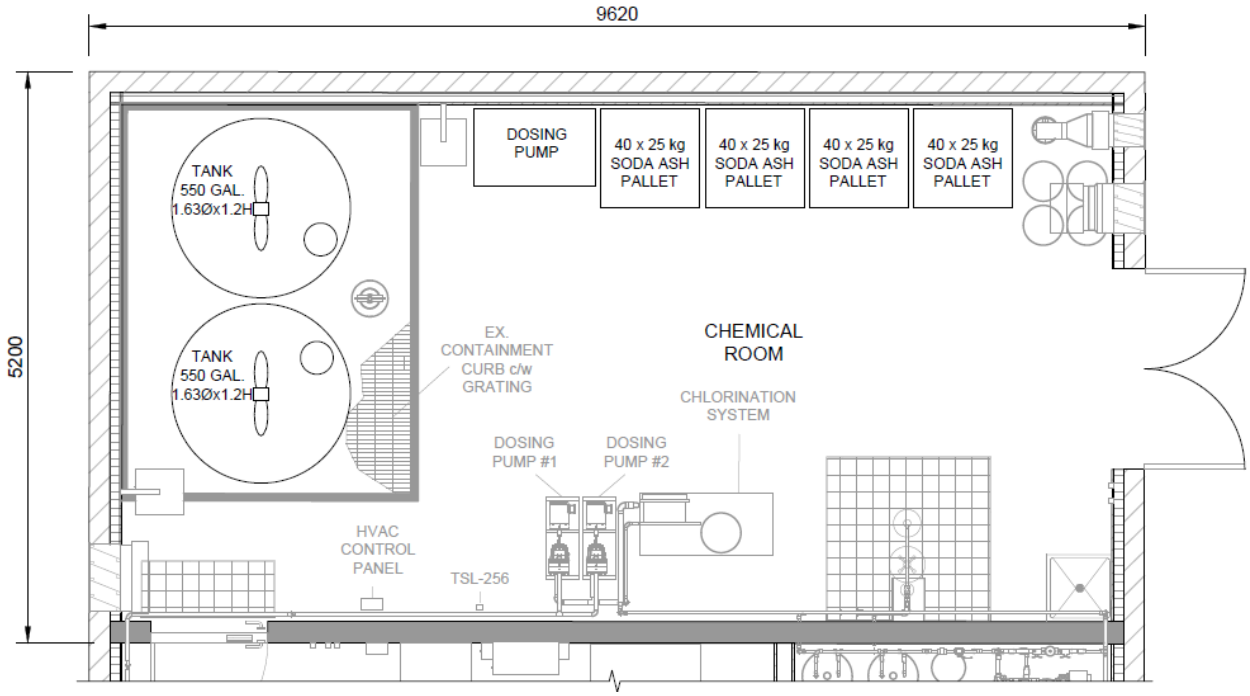

Figure 2-1 Proposed New Corrosion Control System for the Emerald UV Facility (P290)

Table 2-2 summarizes the UV Facility flow rate and the estimated soda ash consumption at maximum day demand (MDD). The estimated soda ash dosage to meet the treatment target is 60 mg/L.

Table 2-2 Estimated Soda Ash Consumption at Emerald Pump Station

	UNIT	VALUE
Peak Hour Flow	L/s	56.0
Maximum Monthly Average	L/s	20.3
Annual Average	L/s	15.9
Estimated Dosage	mg/L	60.0
8% Soda Ash Solution at MDD	L/day	1,216
99.8% Soda Ash Powder at MDD	25-kg Bag/Mo.	118
Station storage capacity	160 x 25-kg Bags	41 days

2.2 ALPINE WELLS

The conceptual design of the individual Alpine wells' corrosion systems was based on the following assumptions:

- Corrosion control would be implemented via pH correction using a 50% caustic soda solution, as per KWL's recommendation.
- New building structure to house the existing chlorination system and the new corrosion control, as well as electrical components. The proposed structure would be approximately 7,400 mm L x 6,400 mm W.

- A new SS Ø150 mm groundwater supply into the new building for corrosion control and chlorine disinfection.
- One (1) 700-litre storage tank of approximately 1,067 mm Ø x 1041 mm H.
- One (1) transfer pump for the caustic soda.
- One (1) duplex dosing system operating as duty-standby.
- One (1) emergency shower.
- Sub-grade spill containment with FRP grating. Containment volume is equivalent to 110% of the largest tank in the room.
- Process instrumentations includes online flowmeter and pH-chlorine analyzer.
- Enclosed electrical room.
- No back-up power to be provided in case of service power interruption (same as existing design).
- Figure 2-2 presents the proposed facility layout at each of the Alpine well sites.

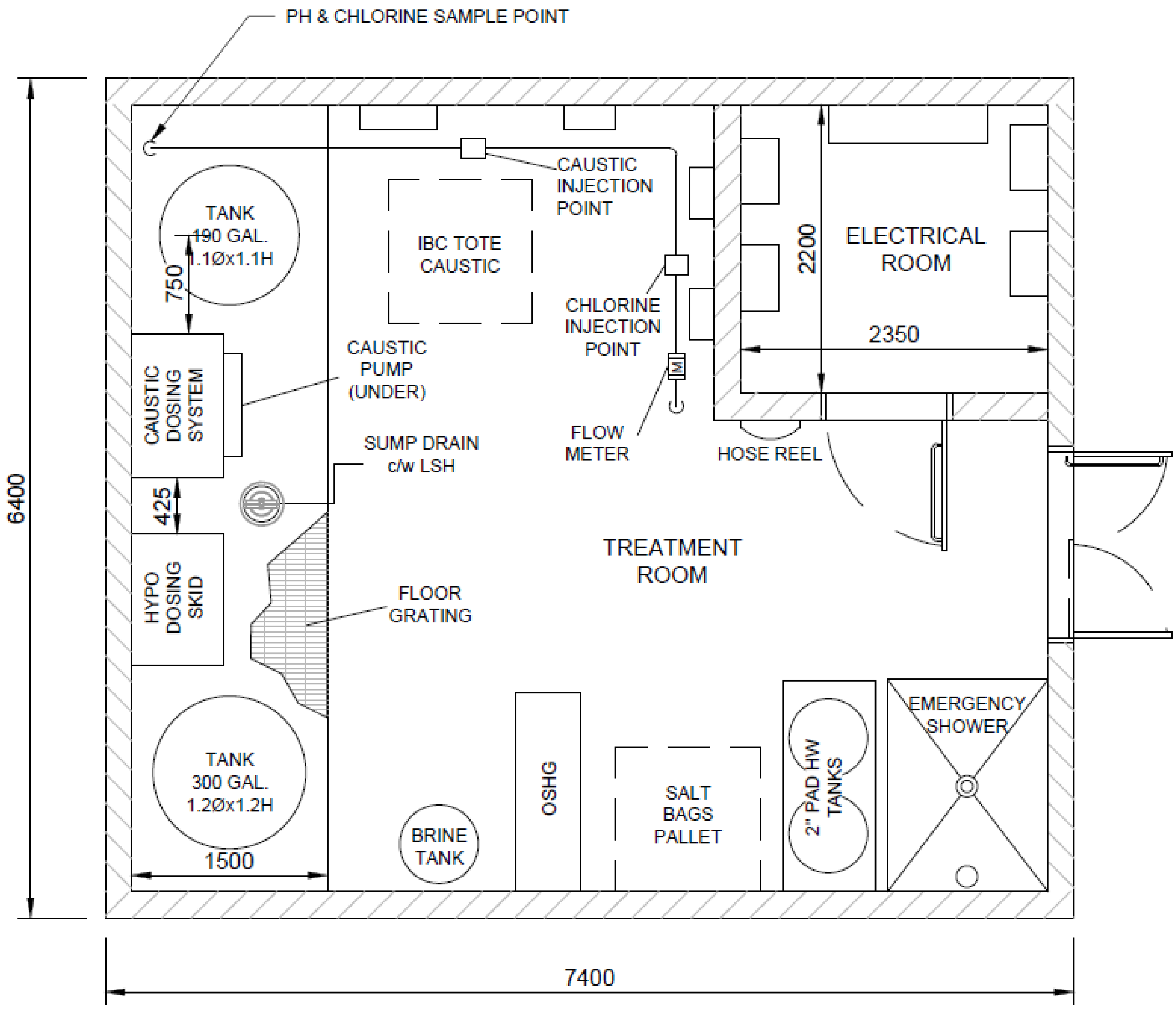

Figure 2-2 Proposed New Corrosion Control Facility for the Alpine Well Sites

The new Alpine facilities would replace the existing Alpine huts which are assumed to be near their end-of-life. Sufficient space for an on-site hypochlorite generation (OSHG) system, a 600 mm Ø Brine tank, a 1,150-litre chlorine storage tank of 1,170 mm Ø x 1,219 mm H, and duplex dosing pumps were assumed to size for an adequate space within the new structure. Both the caustic and chlorine storage tanks will be sitting on an FRP grating over a sub-grade chemical sump. Flow through the facility would be measured by an online flowmeter. Both pH correction and chlorine dosing would be flow-paced based on the flowmeter and reading from the online analyzer.

The estimated dosage range for the Alpine water characteristics (Table 1-1) is approximately 13 to 16 mg/L. Table 2-3 summarizes the estimated caustic consumption at the W202, W210, and W213 Alpine well sites.

Table 2-3 Estimated Caustic Soda Consumptions at the W202, W210 and W213 Alpine Well Sites

	UNIT	W202	W210	W213
Peak Flow	L/s	34.7	22.1	18.9
Maximum Monthly Average	L/s	20.4	10.7	10.0
Annual Average	L/s	10	5.0	5.0
Estimated Dosage	mg/L	16	13	16
50% Caustic Solution	L/day	36.8	15.7	18.1
	Tote/Mo.	1.0	0.4	0.5
Storage Tank Capacity	days	19.0	44.6	38.7
Facility Storage Capacity (1 tote + tank)	days	46	108	93

2.3 REMAINING SITES

The conceptual design for the remaining four sites P280 21-Mile PS, P247 Community PS, W212 Function Junction, and P279 Cheakamus PS, was based on the following assumptions:

- Corrosion control would be with pH correction using a 50% caustic soda solution, as per KWL's recommendation.
- A new building structure to house the new corrosion control system and its electrical components. The proposed structure would be approximately 7,400 mm L x 6,400 mm W.
- New PVDF chemical supply pipe to a new injection point in the existing facility.
- One (1) 2,080-litre storage tank of approximately 1,626 mm Ø x 1,219 mm H.
- One (1) transfer pump for the caustic soda.
- One (1) duplex dosing system operating as duty-standby.
- One (1) emergency shower.
- Sub-grade spill containment with FRP grating. Containment volume is equivalent to 110% of the largest tank in the room.
- One (1) new pH probe and analyzer.
- Enclosed electrical room.
- No back-up power to be provided in case of service power interruption (same as existing design).

Ideally, the new facilities would be located adjacent to or as an extension to the existing facilities. The proposed injection point for three of the sites is their existing chlorine contact tank or clearwell. At Function Junction, is it recommended that the caustic soda solution be injected at the same location as the existing chlorine injection point to maintain low pressure injection, and to reduce the retrofit cost.

Depending on the location of the new facility, the caustic supply line between the buildings may need to be insulated and heat-traced to prevent the caustic from freezing. Typically, a Ø100mm SCH40 galvanized steel conduit would be used for a short distance, overhead run between buildings. A new pH probe and analyzer would be installed at the existing facility to monitor the downstream pH. Control signals between the buildings could be routed through an electrical conduit adjacent to the caustic dosing line conduit. Figure 2-3 presents the proposed layout for the above-mentioned sites.

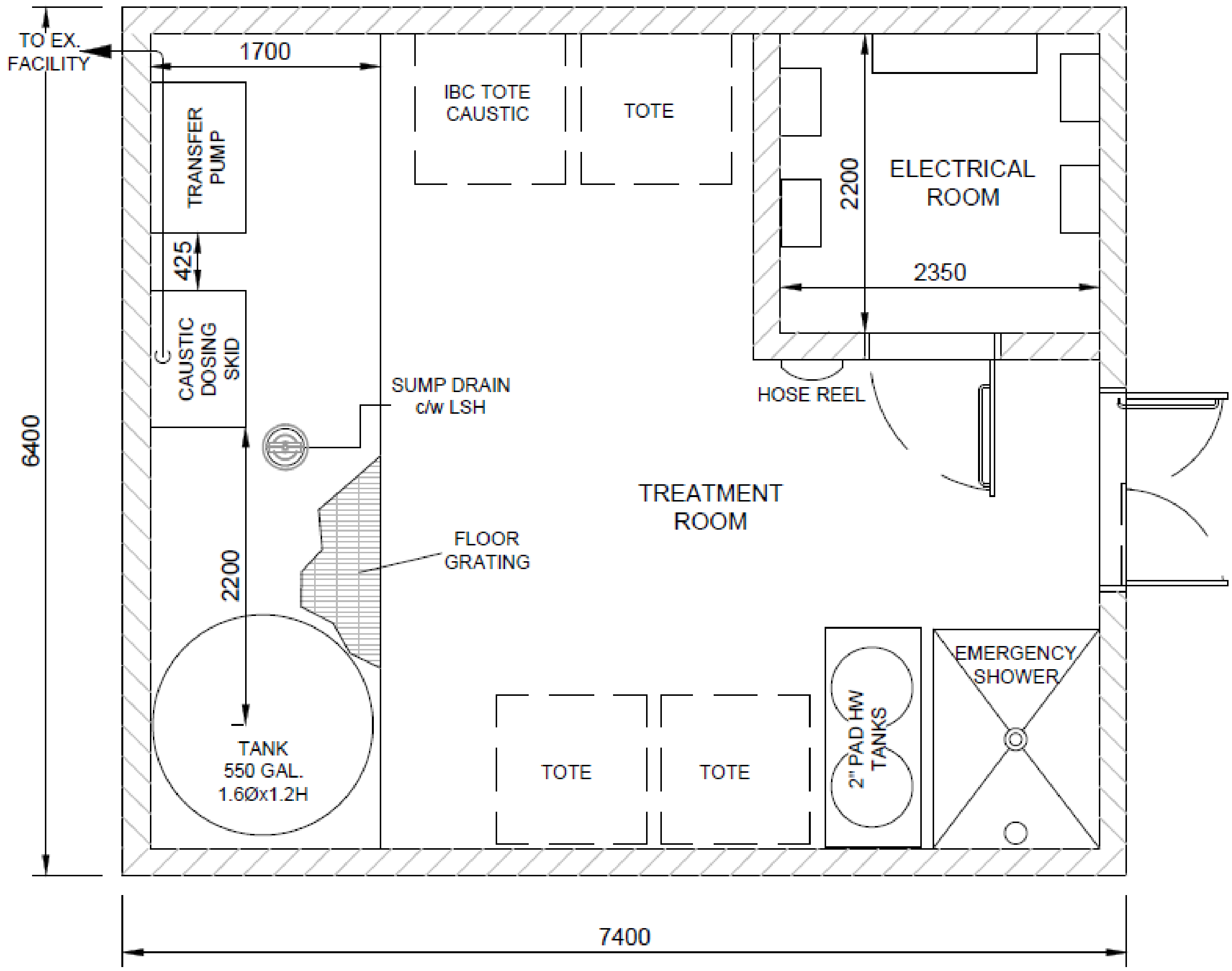

Figure 2-3 Proposed New Corrosion Control Facility for P280, P247, W212, and P279 Pump Stations

Table 2-4 summarizes the estimated caustic soda consumptions at the above sites given the site water characteristics summarized in Section 1.2.

Table 2-4 Estimated Caustic Soda Consumptions at the P280, P247, W212, and P279 Pump Stations

	UNIT	P280	P247	W212	P279
Peak Flow	L/s	111	103.4	41	74
Maximum Monthly Average	L/s	80	55	24.8	50
Annual Average	L/s	47.6	34.9	12.3	18.8

	UNIT	P280	P247	W212	P279
Estimated Dosage	mg/L	18	50	44	20
50% Caustic Soda Solution	L/day	162.7	311.0	123.3	113.0
	Tote/Mo.	4.4	8.4	3.3	3.0
Storage Tank	days	12.5	6.5	17.0	18.4
Facility Storage Capacity (4 totes + tank)	days	37	19.5	51	55

3 ALTERNATIVE CHEMICALS

Caustic soda is a strong base, classified as Hazard class 8, packing group II-III. Operating conditions using the proposed 50% caustic soda solution are expected to be challenging due to the safety hazards related to the chemical at this concentration. It is highly corrosive to metals and reactive with certain solutions such as water and acids. Contact with water or moisture may generate sufficient heat to boil and 'sputter'. Contact with acid can produce a violent reaction and toxic fumes. A proper safety procedure for handling and an emergency response plan would be required to ensure operators' safety. It should also be noted that at 50% concentration caustic soda will freeze at 11ºC. To prevent freezing, continuous heating inside the new building to a suitable temperature (> 20°C) and heat-tracing of dosing line would be required to maintain a workable solution temperature.

Two alternative chemicals were looked at to provide comparisons and alternatives that may offer RMOW higher safety and operating benefits over the 50% caustic solution. They include a stabilized calcium hydroxide suspension at 35% concentration ("lime slurry") and a stabilized magnesium hydroxide suspension at 65% concentration. The following sections provide further information on both alternative chemicals.

3.1 CALCIUM HYDROXIDE

Calcium hydroxide ($Ca(OH)_2$) is available in many forms, including a 100% dry powder and in a pre-made stabilized slurry suspension form at 35% to 38% concentration. The dry powder option would require special equipment, such as a hopper, dry powder feeder, and a continuous tank mixer, to incorporate the solids into a consistent slurry and maintain solids suspension. The capital, operation, and maintenance of such equipment, however, would typically make the option unattractive for small water systems. The 35%-38% pre-made lime slurry is available in 1,000 L totes with NSF certification for drinking water application. Calcium hydroxide suspension has lower reactivity than caustic soda, which reduces the risk to the operators. For example, it may take minutes of exposure time to inflict a chemical burn with 35% lime slurry, as opposed to seconds for caustic soda. A light mixer for the tank would be required to prevent the suspension from settling, however the operation of this mixer can be made intermittent.

The disadvantage of using this lime slurry is that it would require a larger dosage volume of approximately 1.5 times that of the 50% caustic soda. Reaction time for the calcium hydroxide to dissolve post injection may take up to a minute, whereas caustic soda dissolves in water almost instantaneously due to its higher reactivity. A benefit to using calcium hydroxide is that it adds calcium hardness to the water reducing corrosivity whereas caustic adds sodium and no hardness. Table 3-1 summarizes the estimated chemical consumption at each site using 35% calcium hydroxide, and the effect it has on the storage availability given the proposed storage tanks in Section 2.

Table 3-1 Estimated Consumption using 35% Calcium Hydroxide

	DOSAGE (mg/L)	CONSUMPTION (L/d)	TOTE/Mo.	TANK CAPACITY (DAYS)	FACILITY STORAGE (DAYS)
P280 - 21-Mile Pump Station	16	255	7.0	8.0	25
P290 – Emerald UV Facility	21	85	2.3	23.5	91
W202 – Alpine Well #1	14	57	1.5	12.0	31
W210 – Alpine Well #2	11	24	0.6	30.0	72
W213 – Alpine Well #3	14	28	0.7	25.0	62
P247 – Community PS	44	482	13.0	4.3	13
W212 – Function Junction	38	188	5.0	11.0	34

	DOSAGE (mg/L)	CONSUMPTION (L/d)	TOTE/Mo.	TANK CAPACITY (DAYS)	FACILITY STORAGE (DAYS)
P279 – Cheakamus PS	17	169	4.6	12.0	37

3.2 MAGNESIUM HYDROXIDE

Magnesium hydroxide ($Mg(OH)_2$) in a stable suspension is commonly known as Milk-of-Magnesia and is typically used as an antacid or a laxative agent. At 65% concentration, magnesium hydroxide is an unclassified chemical under WHIMS and Transportation of Dangerous Goods. It has very low solubility and reactivity, subsequently there is no exposure risk to operators or risk of over-dosing the water pH above 9.0. Although limited, products which are NSF certified for drinking water are available.

The solution is typically delivered in a tanker truck that is equipped with an air-sparging mixing system to keep it in suspension or in 1000 L totes. Once delivered, the solution should be periodically mixed to keep it in a 'pumpable' suspension state. If left unmixed for long periods (weeks or months) the suspension will settle to form a firm pack (like fine beach sand under water) that would need to be resuspended by mixing before it could be transferred from the tote.

Magnesium hydroxide has the benefit of adding magnesium hardness to the water as opposed to adding sodium from NaOH. Compared to the other alternatives, a 65% magnesium hydroxide would provide the most hydroxide ions and therefore buffer effect to the water. The estimated dosage would be 43% to 45% lower than that of the caustic soda. The disadvantage of magnesium hydroxide would be in its poor solubility in water. Reaction time to fully dissolve in the water post injection is estimated to take from 10 to 30 minutes. Hence, the use of this chemical would require the presence of an existing contact tank or pipeline with sufficient travel time before the first consumer to meet the required dissolution time. Table 3-2 summarizes the estimated chemical consumption at each site using 65% magnesium hydroxide, and the effect it has on the storage availability given the proposed storage tanks in Section 2.

Table 3-2 Estimated Consumption using 65% Magnesium Hydroxide

	DOSAGE (mg/L)	CONSUMPTION (L/d)	TOTE/Mo.	TANK CAPACITY (DAYS)	FACILITY STORAGE (DAYS)
P280 - 21-Mile Pump Station	13	89	2.4	23.4	85
P290 – Emerald UV Facility	18	31.3	0.8	64.0	310
W202 – Alpine Well #1	12	21.0	0.6	33.0	105
W210 – Alpine Well #2	9.5	8.7	0.2	80.5	245
W213 – Alpine Well #3	11.5	10.0	0.3	70.0	211
P247 – Community PS	36	170.0	4.6	12.0	44
W212 – Function Junction	33	70.0	1.9	30.0	116
P279 – Cheakamus PS	14.5	62.0	1.7	33.5	126

For substitution of the caustic soda with either calcium hydroxide or magnesium hydroxide suspensions, minor modifications to some equipment such as addition of mixers to the caustic storage tanks would be required. However, the new corrosion control facilities footprint, general layout and costing may remain the same. Before deciding to use either the calcium hydroxide or magnesium hydroxide, it is recommended to perform jar testing with these products to ensure suitable dissolution reaction rates to confirm that there is not an unacceptable increase in the treated water's turbidity, and to confirm a suitable supplier and negotiate a purchase agreement for the product.

4 CLASS C CAPITAL COST ESTIMATES

Class "C" cost estimates to provide corrosion control to the eight different facilities are presented in Table 4-1. Class "C" cost estimates can be defined as follows:

"An estimate prepared with limited site information and based on probable conditions affecting the project. It represents the summation of all identifiable project elemental costs and is used for program planning, to establish a more specific definition of client needs and to obtain preliminary project approval." – EG BC Cost Estimate Definitions, 2009.

As such, a 30% cost accuracy was assumed with the addition of a 15% project engineering cost.

For the pH adjustment system at the Emerald well, it was assumed that the dosing skid could be simply plumbed into place and no other changes to the building or mechanical system would be required. As a result, no costs were allocated to civil, building, plumbing, HVAC and instrumentation in the cost estimate.

For each of the Alpine well sites, a new building was proposed to house the existing chlorination system and the new corrosion control system. The cost estimate only assumes those costs associated with the corrosion control system and none from the existing chlorination system. The assumed electrical cost includes treatment controls and foreseeable BC Hydro service upgrade for the new building. Costs that are foreseeable but not included in the estimate are as follows: communication equipment, demolition cost for the existing building, backup power, and land acquisition.

For the remaining four sites, 21-Mile, Community PS, Function Junction, and Cheakamus PS, the cost estimate assumes for a new building to house the corrosion control infrastructure, built adjacent to the existing pump station. The proposed chemical injection for the corrosion control is directly into the chlorine contact tank or clearwell located in the existing building. The proposed building for these sites has the same construction and size as that proposed for the Alpine well sites. The assumed electrical cost includes treatment controls and foreseeable BC Hydro service upgrade for the new building. No communication equipment has been priced for in this estimate, nor have backup power systems or land acquisition.

Table 4-1 Class "C" Cost Estimates

DISCIPLINE	EMERALD	ALPINE WELLS			OTHERS			
	P290	**W202**	**W210**	**W213**	**P247**	**P280**	**W212**	**P279**
GENERAL	$14,000	$95,000	$95,000	$95,000	$86,000	$86,000	$86,000	$86,000
CIVIL	$0	$59,000	$59,000	$59,000	$18,000	$15,000	$18,000	$15,000
BUILDING	$0	$131,000	$131,000	$131,000	$131,000	$131,000	$131,000	$131,000
DOSING SYSTEM	$26,000	$12,000	$49,000	$26,000	$19,000	$10,000	$31,000	$10,000
PROCESS-MECH	$29,000	$55,000	$55,000	$55,000	$23,000	$23,000	$23,000	$23,000
PLUMBING	$0	$42,000	$42,000	$42,000	$40,000	$40,000	$40,000	$40,000
HVAC	$0	$35,000	$35,000	$35,000	$35,000	$35,000	$35,000	$35,000
ELECTRICAL	$5,000	$115,000	$115,000	$115,000	$93,000	$103,000	$93,000	$93,000
INSTRUMENTATION	$0	$15,000	$15,000	$15,000	$7,000	$6,000	$7,000	$6,000
SUB-TOTAL	**$74,000**	**$559,000**	**$596,000**	**$573,000**	**$452,000**	**$449,000**	**$464,000**	**$439,000**
CLASS C CONTINGENCY (30%)	$22,200	$167,700	$178,800	$171,900	$134,700	$134,700	$134,700	$134,700
GST (5%)	$4,800	$36,300	$38,700	$37,200	$29,300	$29,200	$29,900	$28,700
SUB-TOTAL	**$101,000**	**$763,000**	**$813,500**	**$782,100**	**$616,000**	**$612,900**	**$628,600**	**$602,400**
PROJECT ENGINEERING (15%)	$16,000	$115,000	$123,000	$118,000	$93,000	$92,000	$95,000	$91,000
ROUNDED TOTAL (excld. PST)	**$120,000**	**$880,000**	**$940,000**	**$900,100**	**$710,000**	**$710,000**	**$730,000**	**$700,000**

5 REFERENCES

BC Health Protection Branch. (2017). *Interim Guidelines on Evaluating and Mitigating Lead in Drinking Water Supplies, School, Daycares and Other Buildings.* BC Health Protection Branch.

Federal-Povincial-Territorial Committee on Drinking Water. (2018). *Copper in Drinking Water - Guideline Technical Document for Public Consultation.* Ottawa: Health Canada.

Health Canada. (2009). *Guidance on Controlling Corrosion in Drinking Water Distribution Systems.* Ottawa: the Minister of Health.

Health Canada. (2017). *Lead in Drinking Water Document for Public Consultation.* Ottawa: Health Canada.

Kerr Wood Leidal. (2015). *Water Distribution Corrosion Study.* Vancouver.

Piteau Associates. (2017). *Groundwater Monitoring Summary.* Vancouver.