



**INFRASTRUCTURE COMMITTEE MEETING
OF THE VILLAGE OF LIONS BAY
HELD ON THURSDAY AUGUST 8, 2024 AT 6:00 PM
COUNCIL CHAMBERS, 400 CENTRE ROAD, LIONS BAY
AND VIA ZOOM VIDEO CONFERENCE**

TO JOIN THE MEETING, CLICK HERE:

<https://us02web.zoom.us/j/2780145720?omn=84650586590>

TO JOIN VIA PHONE, DIAL 778-907-2071 AND ENTER MEETING ID: 278 014 5720

AGENDA

- 1. Call to Order**
- 2. Appointment of Recorder**
- 3. Approval of the Agenda**
THAT the agenda be approved as submitted.
- 4. Public Questions & Comments**
- 5. Approval of Minutes**
 - A. Infrastructure Committee Meeting Minutes (and notes) – July 02, 2024 (*page 4*)
THAT the Infrastructure Committee Meeting Minutes of July 02, 2024 be approved as circulated.
- 6. Business Arising from the Minutes**
- 7. Unfinished Business**

| Identifier | Description | Responsible | Status |
|------------|--|-------------|--------|
| 23111 | All I.C. members will be provided with a copy of the IMP and the enhanced Asset Management Plan. The document is complicated and requires a dedicated I.C. meeting to fully understand the implications for the Village. | KB/PWM | |
| 23112 | Convene a February I.C. Round Table Meeting to focus on a 10 and 20 year horizon plan to identify the new and replacement infrastructure requirements and related expenses. | NTA/All | |

Agenda – Infrastructure Committee – July 18, 2024

Village of Lions Bay

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|-------|--|---------|---------|
| 23113 | CAO and/or Council to be asked to allow members of the I.C. to have selective access to the PW document library. | PWM | |
| 23117 | BU will review the SCADA system on behalf of the I.C. and work with the PWM to up-grade the hardware and software. A Requirements Document is anticipated at mid 2024. | BU/PWM | Partial |
| 23121 | HM to assist the PWM in preparing REQ/RFP documentation for estimate and work on water main replacement Creekview Place and for the estimate for Highview Place. HM to assist the PWM and CAO in reviewing submissions once received. | HM/PWM | |
| 24021 | Continue to work with the CAC to prepare a joint recommendation to Council with respect to both short term zone water metering and longer term universal metering. | All | |
| 24022 | Assist the PWM/PWD in any way by providing time and expertise in regards to enabling flow from Alberta Creek to be diverted into the Harvey Creek WTP to supplement our potable treated water supplies during the summer of 2024 and beyond. | All | |
| 24044 | NTA to contact Staff to gain access to the 2015 water supply and tank fill time data and analysis and allow for joint review of improved real time data in 2024. | NTA | |
| 24051 | Review the potential consequences of a major forest fire above the Village on our watersheds and report back to Council with a firm recommendation as to the best course of action to ensure a continuous potable water supply. | All | |
| 24052 | The potential for raw water shortages in 2024, and the possibility for compromised raw water quality after a forest fire necessitates the Village has a full contingency plan for an alternative raw water supply. HM is to prepare a spreadsheet outlining the pros and cons of all the options to allow the I.C. to engage in a full discussion and recommendation to Council at a later date. | HM | |
| 24071 | ASG and DOO are to work together to generate the ENSuRe water quality “trigger points and conditions.” | ASG/DOO | |
| 24072 | BU requested that all water quantity and quality reports (Wells, water analyses etc.) be forwarded to him so a library, with everything in one place, can be maintained. | All | |

8. New Business

- A. Active Transportation Grant ([link to gov.bc.ca](#))
- B. The UBCM Summary Report recommendation (*page 14*)
- C. The ENSuRe trigger points recommendation (*page 16*)
 - i. Comments and discussion from Karl Buhr
 - ii. Comments from the I.C.
 - iii. Costs to implement for the 2024/5 winter season - short term planning discussion
 - iv. Discussion on the potential to utilize the Alberta Creek supply as an alternative option if ENSuRe shuts down Harvey Creek - long term planning discussion
- D. Director of Operations
 - i. On-going I & I into the Kelvin Grove WWTP
 - ii. On-going water losses due to leakage and daily water demand
 - iii. ASAP Up-date - completion timing and budget etc.
- E. Long term water supply options for Lions Bay (*page 21*)

9. Public Questions & Comments

10. Adjournment

11. Next Meeting – September 12 2024



**INFRASTRUCTURE COMMITTEE MEETING
OF THE VILLAGE OF LIONS BAY
HELD ON TUESDAY, JULY 02, 2024 AT 6:00 PM
COUNCIL CHAMBERS, 400 CENTRE ROAD, LIONS BAY
AND VIA ZOOM VIDEO CONFERENCE**

MINUTES

In Attendance : Mayor Ken Berry
Councillor Neville Abbott – Chair
Committee Member Anthony Greville
Committee Member Hilary Monfared
Committee Member Brian Ulrich

Absent with regrets : Councillor Jaime Cunliffe

Staff : Director of Operations Karl Buhr

1. Call to Order

The Chair called the Infrastructure Committee Meeting order at 18:10 pm.

2. Appointment of Recorder

ASG was appointed recorder this meeting.

3. Approval of the Agenda

Moved/Seconded

THAT the agenda of July 02, 2024, Infrastructure Committee be adopted as presented.

BU and HM added an ~~on-~~table item each referencing previously distributed information on evaluating long term water supply options.

CARRIED.

4. Public Questions & Comments

No public comments or delegation were forthcoming.

5. Approval of Minutes

~~A.~~ Infrastructure Committee Meeting Minutes – May 30, 2024

~~A.~~ THAT the Infrastructure Committee Meeting Minutes of May 30, 2024 be approved as circulated.

CARRIED.

6. Business Arising from the Minutes

- A. THAT the Infrastructure Committee Meeting Minutes of April 18, 2024 be amended as follows; Clause 7. D. second sentence be written as “The Mayor, **CAO, PWM** and one resident, have”
CARRIED.

7. Unfinished Business

23112 – Long term planning remains a challenge. The current meeting is set to start addressing long term water supply options, however, the need to address other critical infrastructure deficiencies, such as bridge integrity and water drainage concerns remain and must be addressed once the summer water situation has passed.

24021 – The CAC has revised their water metering proposal in light of the rejection of the water metering by-law, the non consensus within the I.C. and the DOO and is now focusing on climate resilience options rather than climate change actions.

Commented [NA1]: I don't know if this is accurate, but if Karl said it leave it in.

24022 – The Alberta Creek project is on-going as is support form the I.C. This is to continue until completing of the construction phase of the project and it full commissioning.

24044 – Access to the 2015 water supply data (sparse as it is) is still outstanding. More precise information is available in 2024, however, in light of the cool and wet 2024 spring the I.C. still believes there is a benefit to remember how 2015 was successfully managed and apply those lessons to 2024.

24051 – Addressing the need for a Provincial inventory of portable potable water treatment plants for use in an emergency (fire in more than one watershed above Lions Bay) has been added to the Lions Bay [meeting requestsquestion list](#) at the up coming UBCM in September. ASG to prepare a [2-minute2-minute](#) summary question for Council to read.

8. New Business

- A. ASAP Project to date.
The DOO reported the project is moving ahead well and he expects the timeline to be met. ASG agreed to continue to review all water quality analyses and comment as appropriate. BU
- B. Review of the ENSuRe (Excessive Ntu ShUtdown RoutinE) project to date.
The ENSuRe initiative is in place, however, it still requires manual shutdown and start up. ASG and DOO are to work together to generate the ENSuRe water quality “trigger points and conditions.”

- C. Review of the 2023 Water Quality Report.
Currently continuous chlorine analysis is available at 6 of the Village PRV stations, and there are no analysers at the end point in the distribution system. The I.C. will lobby Council to approve the purchase and installation ~~fe-of~~ further in-line chlorine analysers. The I.C. and the DOO agree that pH adjustment is necessary in Lions Bay (pH is the only parameter L.B. water fails on routinely) and the installation of pH adjustment will be higher on the 2025 priority list of projects submitted to Council for budget approval.
- D. Initiation of the long-term raw water source investigation and recommendation.
A solid start was made in determining the best long term options for raw water supply in Lions Bay. The principle question that remains unanswered is ***“The minimum continuous water flow requirement is: XXX”***.
This question needs to be properly answered as from this all else is derived. Considerable attention needs to be paid to the 2024 water usage demand curves and how such demand can be further reduced.
BU requested that all water quantity and quality reports (Wells, water analyses etc.) be forwarded to him so a library, with everything in one place, can be maintained.

9. **Public Questions & Comments**

- A. Resident XXX offered a comment
Can someone assist here – I cannot remember the name of the gentleman who offered some comments at the end regarding snow pack and water supply.

10. **Adjournment**

Moved/Seconded

THAT the Infrastructure Committee Meeting be adjourned.

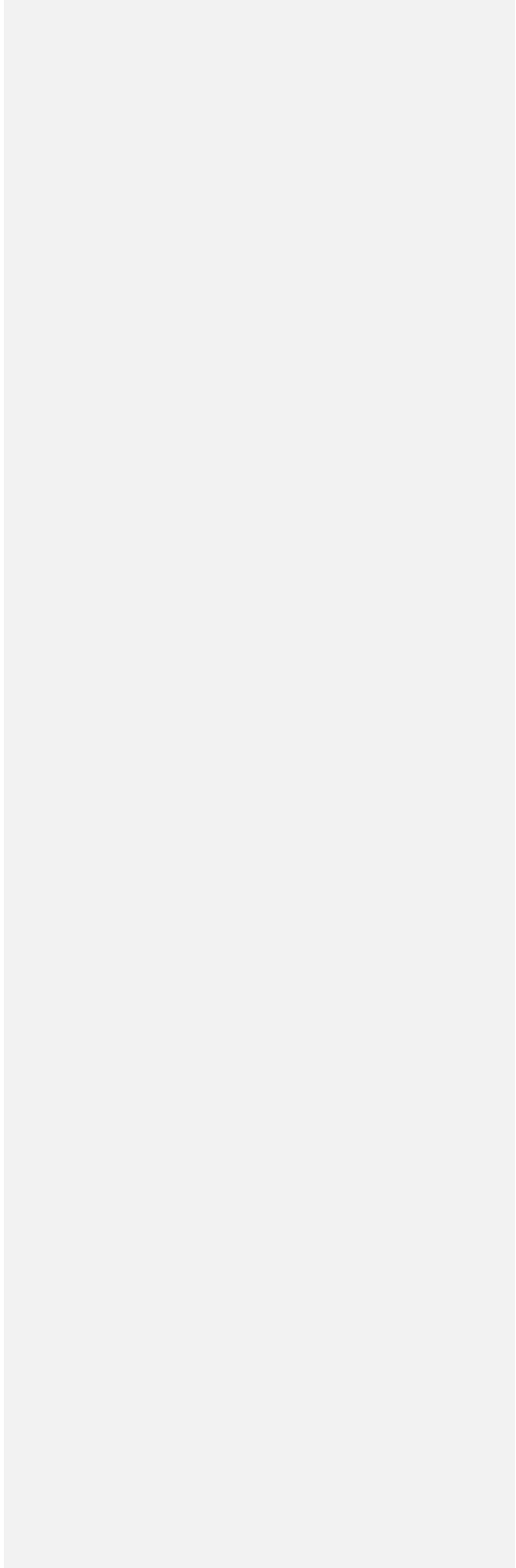
CARRIED

The meeting adjourned at 20:16.

11. **Next Meeting**

Next meeting of the Infrastructure Committee was scheduled for July 18 2024.

Agenda – Infrastructure Committee – July 02, 2024
Village of Lions Bay
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**INFRASTRUCTURE COMMITTEE MEETING
OF THE VILLAGE OF LIONS BAY
HELD ON TUESDAY, July 02, 2024 AT 6:00 PM
COUNCIL CHAMBERS, 400 CENTRE ROAD, LIONS BAY
AND VIA ZOOM VIDEO CONFERENCE**

Discussion and Background Notes

Contributions by: Anthony Greville

Also in attendance: Ken Berry
 Neville Abbott
 Hilary Monfared
 Karl Buhr (PWM)
 Brian Ulrich

Discussion and Background Notes.

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Meeting Notes – Infrastructure Committee – July 02, 2024

Village of Lions Bay

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|-------|---|---------|---|
| 24021 | Continue to work with the CAC to prepare a joint recommendation to Council with respect to both short term zone water metering and longer term universal metering. | All | |
| 24022 | Assist the PWM/PWD in any way by providing time and expertise in regards to enabling flow from Alberta Creek to be diverted into the Harvey Creek WTP to supplement our potable treated water supplies during the summer of 2024 and beyond. | All | |
| 24042 | KB to continue his discussions with the drilling companies to determine the full cost of finding sufficient well water supplies, accessing the well sites permanently, providing energy, pumping costs etc., classifying the water quality, and treating the water the water if necessary (mineral contamination, GUIDI or GARP classifications). | KB | ✓ |
| 24043 | KB to continue his discussions with the British Columbia MoE and Ministry of Health to determine the regulatory requirements and possible treatment steps that will be needed to allow any well water supplies to be added to the existing community water system. | KB | ✓ |
| 24044 | NTA to contact Staff to gain access to the 2015 water supply and tank fill time data and analysis and allow for joint review of improved real time data in 2024. | NTA | |
| 24051 | Review the potential consequences of a major forest fire above the Village on our watersheds and report back to Council with a firm recommendation as to the best course of action to ensure a continuous potable water supply. | All | |
| 24052 | The potential for raw water shortages in 2024, and the possibility for compromised raw water quality after a forest fire necessities the Village has a full contingency plan for an alternative raw water supply. HM is to prepare a spreadsheet outlining the pros and cons of all the options to allow the I.C. to engage in a full discussion and recommendation to Council at a later date. | HM | |
| 24071 | ASG and DOO are to work together to generate the ENSuRe water quality “trigger points and conditions.” | ASG/DOO | |
| 24072 | BU requested that all water quantity and quality reports (Wells, water analyses etc.) be forwarded to him so a library, with everything in one place, can be maintained. | All | |
| 24073 | In light of discussion at the 03 July Finance and Audit Committee Meeting, the documents relating to asset management and asset replacement funding deficiencies need to be up-dated and presented to the F & A C, the CAO | All | |

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| | and staff and the Village as a whole. This should be an early Fall project for this group. | | |
|--|--|--|--|

NOTES:

23112 – Long term planning remains a challenge. The current meeting is set to start addressing long term water supply options, however, the need to address other critical infrastructure deficiencies, such as bridge integrity and water drainage concerns remain and must be addressed once the summer water situation has passed.

24021 – The CAC has revised their water metering proposal in light of the rejection of the water metering by-law, the non consensus within the I.C. and the DOO and is now focusing on climate resilience options rather than climate change actions.

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24051 – Addressing the need for a Provincial inventory of portable potable water treatment plants for use in an emergency (fire in more than one watershed above Lions Bay) has been added to the Lions Bay question list at the up coming UBCM in September. ASG to prepare a 2 minute summary question for Council to read.

Alberta Supply Augmentation Project.

The DOO reported that the ASAP project is moving ahead well. A revised Plan B is now being pursued, whereby Alberta Creek water flows under gravity into the Oceanview Tank and is then pumped up to the Harvey Creek WTP intake. The advantage is that instead of a 10,000 usg storage tank at Alberta Creek, the project can use the 100,000 IG (so 120,000 usg, or 455,000 L) available at Oceanview. It was reported the Oceanview tank does not require any significant rehabilitation before it can be re-commissioned into service.

The volume of water maintained in the Oceanview tank will vary as a function of demand – the principal reason for this is to prevent “stale water” from accumulating in the Oceanview tank if it is full and not required. The “swings in demand” will be taken in the Oceanview tank; it is expected that in the height of the “dry season” the tank will be filled and drained several times a day.

Pumping against 65 m of head from the Oceanview tank to the Harvey Creek WTP was a challenge, however a multistage centrifugal pump from Europe was found. The major issue was a low flow (> 70 usgpm) opposite the significant head, causing an issue with Net Positive Suction (NPSH) and potential pump cavitation.

It is estimated the change in design will save the Village approximately \$100,000 ~~off the original budget of \$720,000~~. The project, as if 02 July, was considered to be on time.

ENSuRe (Excessive Ntu ShUtdown RoutinE) Project.

The ENSuRe project is currently in place, however, it is subject to manual action steps only, at this time. The basic principle is that the water intakes will be closed if there is a signal of greater than 4 NTU for longer than 20 minutes.

Should this raw water quality not trigger the UV reactors to shutdown, due to low UVT, then the intake valves have to be closed, and subsequently opened, manually.

The Drinking Water Officer has approved this protocol as a part of the Filtration Exemption programme, but it is still not completely satisfactory. There are two significant concerns with the practical application of the initiative;

- 1) The operators have to access the water treatment plants during periods of high rains, and while they are not going to the intakes (only the WTP) this is not without risk, and may take time should the rain event occur at night over a long weekend in winter.
- 2) It has been determined that the installed turbidity meters limit out at 10 NTU. So, when the plant records a turbidity of 10 NTU, this may be inaccurate (and probably is) in that the actual turbidity could be well above 10 NTU, but still only be shown as 10 NTU.

The DOO requested the I.C. to provide some assistance in determining the optimum raw water quality “trigger points” that will initiate an ENSuRe shutdown of one or both water treatment plants. It was agreed that a suitable SOP should be in place before mid October.

Review of the 2023 Water Quality Report.

The 2023 Water Quality Report had been reviewed in draft form by the I.C. and their input was incorporated into the final version submitted to the Provincial Drinking Water Officer.

The main “take away” was the narrowing of the curves between August and September supply and demand curves. The DOO reported that twice in 2023 the operating staff were recommending Level 3 water restrictions be announced, but twice there were fortuitous rainfall events and allowed Level 2 restrictions to remain in place all year.

It is the goal of the DOO to maintain Level 2 restrictions throughout the summer of 2024, however, the Village may not be so lucky, especially if demand creeps up again. It was noted that the demand curves were very variable in 2023, and were increasing significantly just prior to the late summer rain events. More consumer education is required to avoid Level 3 restrictions.

It was also noted that the sterling work done by the Public Works Department in reducing demand from 800,000 usgpd in early July 2023 to 307,000 usgpd on 01 July 2024 has been encouraging. What is unknown is the demand that might occur in late August when the cool and wet spring is past. Should there be an extended period of hot weather and no precipitation in August, demand curves will have to be publicly commented on.

It was also noted, that in addition to reducing demand, supply has been increased. The ASAP project will likely supply somewhere close to an extra 70,000 usgpd, and the recalculation of the retention time in the Magnesia Creek Storage Tank will allow for increased usage of the Magnesia Creek source, maybe enough extra can be drawn from Magnesia Creek to supply up to 100 additional residences – and so take some of the stress off the Harvey Creek source.

Currently continuous chlorine analysis is available at 6 of the Village PRV stations, however, there are no analysers at the end points in the distribution system. In reality, it is the free chlorine residual at the last end users that are the determining factors in chlorine additions/dosage at the

water treatment plants. The I.C. will lobby Council to approve the purchase and installation of further in-line chlorine analysers.

The I.C. and the DOO agree that pH adjustment is necessary in Lions Bay (pH is the only water quality parameter L.B. water fails on routinely) and the installation of pH adjustment will be higher on the 2025 priority list of projects submitted to Council for budget approval.

Initiation of the long-term raw water source investigation and recommendation.

Both BU and HM submitted documents to assist in the start of the discussion to address the need to secure future raw water supplies in Lions Bay. It was initially agreed that the best way to address this very significant concern is to first determine the volume of water that will be required for long term sustainability, and once this has been determined, then look at potential sources to meet this demand, and finally at quality issues, and how to address them.

A solid start was made in determining the best long term options for raw water supply in Lions Bay. The principle question that remains unanswered is **“The minimum continuous water flow requirement is: XXX”**. This question needs to be properly answered as from this all else is derived.

Based on the review of the 2023 Water Quality Report, and the discussions with the DOO, considering the significant gains made in leak control, it was thought at a peak summer demand of 500,000 usgpd would not be unreasonable. 500,000 usgpd, calculates out to be 1,892,650 L, so 1.9 mm litres, divided by 1400 residents, is 1,350 litres per person per day (lpppd). Considering the West Vancouver average consumption rate is 425 lpppd, Metro Vancouver is 290 lpppd and Nanaimo is 260 lpppd, 500,000 usgpd in Lions Bay gives a lot of allowance for watering the vegetables and plants!

If we are to assume Lions Bay residents consume the same 400 lpppd as in West Vancouver, and leaks are at 50% of total demand, then total demand would only be 800 lpppd, or 1.12 mm litres, or 295,881 usgpd, so 300,000 usgpd. 300,000 usgpd is the current rate of consumption.

Figures also noted were that the flow in Harvey Creek on 02 July was 280 usgpm, or 400,000 usgpd, and the lowest ever flow rate recorded was 180 usgpm, or 260,000 usgpd. Magnesia Creek can offer a low of 110 usgpm, or 160,000 usgpd, while Alberta Creek can offer 70,000 usgpd under the ASAP initiative. Adding these low raw water supply numbers together we can see a total “low supply” of 490,000 usgpd.

Is 500,000 usgpd a good target to aim for? Undecided, and hopefully the summer of 2024 will assist in this determination.

Considerable attention needs to be paid to the 2024 water usage demand curves and how such demand can be further reduced.

The other issues briefly reviewed, and for obvious further consideration include; should the alternatives be for a total replacement (pipeline from Metro Vancouver) or for peak shaving only (wells and/or desalination)?

Can wells supply all the needs of the Village, or is the realistic supply from 3 or 4 wells only enough for seasonal relief?

Can we consider a gravity fed pipeline tunnel from Enchantment Lake as a realistic option for a total supply replacement? Many other utilities rely on blended lake and creek sources to meet their ever increasing demand – why not Lions Bay?

Lots of questions need consideration and realistic answers over the next few months.

BU requested that all water quantity and quality reports (Wells, water analyses etc.) be forwarded to him so a library, with everything in one place, can be maintained.

20 July, 2024.

Information Report to the Infrastructure Committee.

Emergency Water Treatment Plant Options in the event there is a major forest fire in the Harvey Creek, Magnesia Creek, and Alberta Creek watersheds.

Draft comments for Council to present at the 16 – 20 September, 2024 UCBM Meeting.

In the event there is a ~~small~~-wildfire above Lions Bay, in a single watershed, it is likely the water quality in that watershed will be compromised for many years to come. Depending on which watershed is impacted ~~However, with proper management,~~ and ~~depending on~~ the intensity of the fire, it is possible the Village ~~will~~may be able to supply the water demand from our other two watersheds.

The more significant concern arises if there is a ~~“major fire”~~ that impacts two or all three watersheds and compromises the entire Village water supply for many years. In the absence of a water filtration plant, which includes coagulation and flocculation stages, the Village will be unable to supply potable water to its residents for up to 5 years.

These risks to potable water supply are due to changes in the frequency, duration, magnitude, and speed of raw water quality fluctuations, specifically increases in turbidity and natural organic matter, humas etc. (NOM). Wildfires often result in increased solids loadings to water treatment plants in terms of ash content and runoff from soils due to loss of groundcover, and increased transport of terrestrial NOM of altered character.

Short term issues that may occur in the weeks and months after an event are mostly due to increased turbidity due to ash from post-fire erosion, spikes in NOM, and pH and alkalinity changes. Longer term issues that can occur over several years include:

- Increased turbidity from soils due to loss of vegetation – this can continue for years,
- Increased NOM,
- Changed character of NOM,
- Algal growth and associated byproducts: algal toxins and taste and odors that result from release of nutrients after a fire and warmer temperatures due to loss of shade cover,
- Iron and manganese.

Should there be a major forest fire in all three watersheds above Lions Bay, on the Howe Sound Crest Trail (plenty of opportunities for human caused fires) that compromises the raw water quality in ~~all any of the three~~ creeks, Lions Bay will be unable to supply potable water to its residents; the literature, and recent experiences, suggest this situation could last for at least 5 years.

This situation is not unique to Lions Bay but would apply to any small community that relies on creek flow for its water and does not have a filtration system.

One potential solution, and the reason for this ~~delegation request~~, would be if the Province were to maintain an inventory (~~6 – 10 units~~) of various capacity portable water treatment plants that smaller communities and First Nations communities could call on in times of emergency. The equipment manufacturers and vendors all indicate they can readily assemble the necessary portable water treatment plants (WTP) trailers, however, the lead time would be 6 – 8 months, whereas the community would need a functioning WTP in place before the ~~first next fall~~ rain falls, so within weeks to 3 months of the fire.

We are asking that the Ministry of Emergency Management and Climate Readiness ~~XXX XXXX~~ puts together a task force of engineers, small communities, First Nations communities and ISC, to determine the best flow capacities and design criteria, and to purchase the initial portable water treatment plants to be available for the summer of 2025. Further purchases, to bring the total number of units to 6 – 10 should be made prior to the 2026 fire season.

Commented [NA1]: What is this? Vendors? Suppliers?

Commented [NA2]: I think this should be left to the task force to decide.

The Village has a significant volume of additional background information, and local expertise, that could be available to the relevant government representative to allow such an initiative to begin the project evaluation process.

To emphasize our situation; without immediate higher level government -assistance, the Village of Lions Bay will not be able to supply potable water to our residents in the event of a significant fire in our watersheds, however, this major deficiency can be readily addressed by proper planning and by the inventory of the necessary portable WTP trailers.

Thank you for your attention, and hopefully future actions steps, to resolve this concern for us and for all other smaller communities.

28 July, 2024.

Information Report to the Infrastructure Committee.

Trigger Points to Enact the Excessive Ntu ShUTDOWN Routine (ENSuRe) protocol in Real Time.

Recommendation.

The ENSuRe trigger point should be 80% UVT at all times, or raw water carrying 4 NTU of mineral turbidity for as long as it takes to replace 10% of the volume in the storage reservoirs.

Longer term (1 – 2 years), the turbidity parameter should be replaced with a particle counts for 2 - 7 µm particles and particles greater than 7 µm in size for the same 10% reservoir volume.

Also, in the 2 – 3 year horizon, if Alberta Creek is determined to be spring fed and less susceptible to rain events causing an increase in particulate concentration, the addition of Alberta Creek water to replace the Harvey Creek supply discontinued as a consequence of ENSuRe.

Background.

Lions Bay does not filter its raw water source, and often fails to meet the requirements of the Guidelines for Canadian Drinking Water Quality. The Province of British Columbia can offer a filtration exemption option as long as four criteria are met; including that the treated water *“Average daily turbidity levels measured at equal intervals (at least every four hours) immediately before the disinfectant is applied are around 1 nephelometric turbidity unit (NTU) and do not exceed 5 NTU for more than two days in a 12-month period.”* And *“A watershed control program is maintained that minimizes the potential for fecal contamination in the source water.”*

Lions Bay has difficulty meeting these two criteria. This note focuses on the need to maintain a low turbidity loading immediately prior to disinfection. Turbidity in our two intake creeks is variable, especially after a heavy rain event; of particular concern is that the turbidity meters often limit out at 10 NTU, meaning we do not know how high our raw water turbidity entering the disinfection stage really is. All we do know is that raw water turbidity is often higher than 10 NTU for extended durations.

To satisfy the local Vancouver Coastal Health (VCH) Drinking Water Officer (DWO), it has been proposed that whenever the raw water turbidity in the creeks exceeds a set point, the intake is shut off until raw water quality returns to an acceptable level. During the time when the intakes are shut down, the Village will supply potable water from the reservoirs until the fire fighting reserve capacity is met. This protocol has been given the name Excessive Ntu Shutdown Routine (ENSuRe)

The question posed is; what are the trigger points, in terms of raw water absolute turbidity and duration of this elevated turbidity readings that would cause the ENSuRe protocol to be enacted?

Technical Observations.

Turbidity, in and unto itself, does not present a public health concern; indeed, there is no correlation found (within the scientific community) between turbidity and the presence of pathogens. Everyone has, at some time, “bitten the dust” on a beach or sports field, and a little silica ingestion is not harmful at all. It is generally agreed that the 1.0 NTU upper limit on turbidity is a risk management decision/tool, and any direct correlations are extremely complex, site specific and not fully understood.

However, what turbidity can do is impede the efficiency of the disinfection processes. Mineral turbidity particles have surface crevices and faults etc. which can provide a “hiding place” for smaller bacteria and viruses, making chlorine disinfection, which relies on direct contact, less effective. Inorganic turbidity can provide a shield, preventing UV radiation impacting pathogens, and can also deflect the radiation. Organic turbidity can consume both free chlorine and absorb UV radiation, making the prescribed dosages unavailable to inactivate any pathogens present.

The GCDWQ states (July 2024 edition) “*Treatment limits for individual filters or units: - Conventional and direct filtration: ≤ 0.3 NTU - slow sand and diatomaceous earth filtration: ≤ 1.0 NTU - membrane filtration: ≤ 0.1 NTU.*” And “*Particles can harbour microorganisms, protecting them from disinfection, and can entrap heavy metals and biocides.*”

Several peer reviewed studies have concluded that an increase in turbidity from 1 – 10 NTU will cause an 8 fold decrease in chlorine disinfection efficiency. Over a similar range, the mean UV dosage applied was lowered by between 5% and 33%. For the UV process (the primary disinfection process in Lions Bay), mineral turbidity at 13 NTU renders UV almost ineffective, whereas a turbidity of less than 4 NTU has a “reasonable” negative impact. However, organic turbidity has a significant effect even at the 4 NTU level.

Turbidity is the presence of particulate matter in water, and is measured by the attenuation of a light beam caused by the scattering and/or adsorption of light. The degree of attenuation is dependant on particle size, shape, and concentration in the water sample. Larger particles will scatter more light which will increase the turbidity reading, while smaller particles will scatter less light, and will result in a lower turbidity reading. Turbidity readings do not, by themselves, offer a comment on the size of the particles present in the water, and their relative effect on disinfection.

The literature suggests that turbidity particles greater than 7 μm can have a significant effect on bacterial disinfection, whereas particles greater than 1 μm can compromise viral disinfection protocols. To give a little perspective, protozoa (Cryptosporidium and Giardia) are typically between 5 and 12 μm in size, E. Coli (and other bacteria) are approximately 2 μm in diameter and viruses are between 0.01 and 0.05 μm . Looking further down, SiO₂ turbidity would be larger particles, while colloidal organic turbidity would have smaller particles sizes.

While many operating permits require that turbidity measurements be reported to regulating authorities, almost universally, water treatment plant operating staff use particle counting to make operational decisions, and simply report turbidity as required. Seldom are turbidity measurements used to make important operating decisions, primarily because an increase in particles often precedes an increase in turbidity by 2 – 3 hours.

Finally, when operating a full water treatment plant, the “rule of thumb” is that the treated water turbidity from a clarifier (of any configuration) be between 0.2 – 0.5 NTU, or more likely 200 – 300 particles per 100 ml, and that the subsequently filtered water going to the disinfection process be 0.01 – 0.025 NTU, or less than 15 particle counts per 100 ml.

Particle counters are widely available and are widely used in the local water treatment community. The specifications in a typical bottom of the line particle counter will provide analysis and data record particle counts in a liquid between 2 - 100 μm as total counts per 100 ml, and in up to 3 different ranges (usually $< 2 \mu\text{m}$, $2 - 7 \mu\text{m}$, and $> 7 \mu\text{m}$). These ranges are totally flexible, and user designated, and are sometimes assigned as being viruses, bacteria, and protozoa.

Application at Lions Bay.

In Lions Bay the project is to determine the ENSuRe protocol trigger limits, where the DWO is looking at turbidity. Based on the literature and regulation, it would be very easy to assign 4 NTU as the limit as the negative effects on disinfection are still “reasonable” at 4 NTU.

In terms of when to enact ENSuRe once the raw water reaches 4 NTU, the recommendation would be when the volume of 4 NTU water added represents 10% of the effective volume of the reservoirs. The 10% criterium matches the T-10 calculation used to determine HDT in a clearwell, and so further determine the t in the Ct calculation for overall disinfection efficacy. Practically speaking, this will mean 10% of the water in the reservoir might be less than optimally disinfected, whereas 90% of the water will be fully and properly disinfected. When aqueous mixing in the reservoir is considered, all potable water leaving the reservoir will be adequately disinfected, and will not be quality compromised at all.

A much more sophisticated option is to install particle counters on the raw water lines close to where the turbidity meters are currently located and so consider not the total light scattering associated with turbidity, but rather the light scattering effects associated with particles in the range between 2 and 7 μm and perhaps greater than 7 μm . It is unlikely there will be significant viral loadings in the watershed, but it is very likely there will be bacterial infection (*E. Coli*) and cysts. Bacteria will be $2+ \mu\text{m}$ in size and mineral turbidity particles greater than 7 μm can compromise bacterial disinfection.

Mineral particle counts of less than 2 μm , which may contribute significantly to overall NTU can be considered to have limited negative effects in Lions Bay. However, organic particulate, which will have a smaller particle size will not be ignored; they will be considered with the internal (and hopefully one day external) UVT measurements.

The second limit built into the ENSuRe protocol must be to maintain UVT in the water to be disinfected at above 80% always. This protocol is currently in place, and the UV system will shut itself down and stop flow should the UVT be less than 70%. To provide added comfort, this UVT shutdown point can be elevated to 75 – 80%?

As an initial starting point, the particle counts for 2 – 7 µm particles could be arbitrarily set at 1,000 or 1,500 cnts/100 mL. As always, it would be necessary to properly calibrate the particle counter to determine the background counts and size distribution in the creeks and get an understanding of what the numbers are telling us before setting the trigger point in stone.

However, once the data from the particle counters can be “properly read” the information so gathered will be far more sensitive and provide quality input for informed and improved decision making than the turbidity meters will alone.

This process may well take a year, as background measurements throughout the year on both (or all three) creeks will have to be measured and the change in particle count size and distribution associated with heavy rainfall, and their correlation (or lack thereof) to turbidity properly assessed.

Optional Advantage for Alberta Creek Source.

One potential advantage of employing the ENSuRe protocol, and of having the Alberta Creek source on line is the possibility that Alberta Creek could be used in both the summer and winter time as a supplemental raw water source.

There is some indication that Alberta Creek has different raw water characteristics than the surface water seen in Harvey and Magnesia Creeks. The water quality in Alberta Creek (based on a handful of analyses only) is similar to that seen in Harvey Creek when Harvey Creek is groundwater supplied. If Alberta Creek is also spring fed, or has a significant percentage of spring water (rather than snow melt surface water) it is possible this source might be less susceptible to significant turbidity variability as a function of rainfall. If so, there might be some alternative benefits to having the Alberta Creek source on line.

All speculation at this time, but a concept worth examining.

If Alberta Creek is predominately spring fed, and is less susceptible to turbidity fluctuations during and after rain events, then with proper monitoring, it might possible that when Harvey Creek needs to be shut down, due to excessive particulate matter in the water, with the advance warning provided by the particle counters, Alberta Creek could be put back on line and used as a replacement source.

Looking further ahead, if this becomes a possibility, it should be easier to tighten up the ENSuRe trigger points such that the turbidity criterium for filter avoidance could be met on a year round basis. Not impossible.

This action step would require Alberta Creek supply to be available all year, and not “moth balled” over the winter months, but the benefits of the third raw water supply source could be extended beyond the 6 – 8 week summer period so far anticipated, and into a year round benefit to provide an improved return for the monies spent!

A quick calculation, factoring on line diameter, material of construction, internal frictional losses, and slope etc., suggests the maximum flow through the existing line from the Alberta Creek intake to the Oceanview Road tanks is 110 usgpm. This further calculates out to be 158,400 usgpd, or 599,590 litres per day, or 416 litres per person per day. This volume of water is equal to the per capita consumption in West Vancouver today.

In Lions Bay we are still experiencing approximately 50% water losses, primarily due to leakage, and our winter time daily demand is hovering around 300,000 usgpd.

If everything falls into place in terms of water quality from Alberta Creek, a simple twinning of the line and the purchase of a second pump (one should really be required for redundancy purposes anyway) might allow for the entire Village to be supplied from Alberta Creek during the winter time.

This possibility could significantly improve potable water reliability, and good old climate resilience in the face of anticipated extreme weather events, including higher volume rainfall due to increased water capacity of the hotter air.

Lots to consider long term beyond the simple ENSuRe trigger points.

Lions Bay long term Water supply strategy

Problem Statement:

Under certain conditions, Lions Bay could face future potential for water shortage and/or poor, unacceptable water quality.

Potential Water Shortage – mostly a seasonal risk

Lions Bay currently draws its water supply from surface water via two Howe Sound mountain creeks; Harvey and Magnesia Creeks. During 9-10 months of the year the water supply from the creeks is well in excess of the village's consumption demands. However, in some years, when snowpack is low, the hot summer months see the creeks' flows very low or non-existent, risking supply not being able to meet demand. This is the seasonal nature of the risk. Uncommon events like earthquakes or other disasters could also induce water shortages.

The minimum continuous water flow requirement is: **500,000 USgal/day, without ever having to revert to the restrictions of water conservation level 3.**

Potential Water Quality – mostly a risk from uncommon events

Although the Village deals with periodic water quality issues due to its lack of filtering as part of the treatment system, these incidents are short lived. With this system, however, a forest fire in the Village's watershed could present more serious long term water quality issue. The current system cannot remove or treat the contaminants that would leach out of the burned forest bed into the creeks, and ultimately our water distribution system for up to 5 years after a fire.

The minimum continuous water quality requirements are: XXX

Objective:

Identify and implement Improvements to the Village's water system so that the needed water quantity and quality can be provided to residents continuously 24/7/365, even during and/or after the risk situations mentioned in the problem statement.

'Improvements' does not exclude completely replacing the existing system with something totally new. However, despite its shortcomings, the Village's water supply system (intake, treatment, distribution) has had a lot invested in it and is worth trying to build upon and improve, as opposed to abandoning in lieu of something new. Ideally, any improvement(s) would address both potential shortage and potential quality issues at the same time, but separate solutions to the separate issues may prove to be more practical.

Addressing water shortage (supply) issues

*For 9 or 10 months of every year we have much more water than we need or can use.
(aka a reliability issue)*

The recurring (seasonal) risk of water shortage during the summer months requires peak shaving; a short term solution to provide water over and above that of the existing supply system, to meet temporarily high demand.

The only two solutions to peak demand are to reduce demand or obtain more water from another source, separately or in combination. Reducing demand relies on residents' cooperation and although historically effective, may not be enough in the future.

Consequently this assessment focuses on how to obtain water from other sources, primarily for peak shaving, but also with the possibility to be a full-time long term water source. (The feasibility and cost of a full-time replacement water source to solve a periodic, peak shaving issue, will obviously be difficult to justify).

Monitoring of demand over the last couple of years shows that the village's per capita consumption has been as high as 3 times the 300,000 usg/day average of other urban areas, Vancouver specifically. This is mostly due to leakage, which is being addressed aggressively. Reducing the Village's water consumption to meet that average will be a challenge in the medium term due to the age of the current water infrastructure. Therefore the initial target demand has been set at 500,000 usg/day for this assessment.

Potential new water sources:

These are the to-date identified sources of additional water that could be tapped to augment the Village's current creek supply (with no ranking as to cost or feasibility):

- Mountain lake or reservoir
- Wells
- Pipeline from other jurisdiction (Metro/North Vancouver or Squamish)
- Desalination plant
- Draw from more surrounding creeks
- Rain Collection
- Natural springs
- Floating water supply barge
- Man-made additional storage pond in gravel pit
- Do nothing
- Other?

These options have in the past been assessed in various levels of detail and need to be more thoroughly evaluated and ranked against several criteria to identify the top candidate(s). The following table shows the current subjective or qualitative status and understanding of these options.

| Potential Additional Water Sources | | | | | |
|------------------------------------|---|--|---|----------------------------------|--------------------------------------|
| Source | Current understanding of the source cost/feasibility (1-10) | Additional water volume possible (1 to 10) | Level of Technical or political difficulty (1-10) | Relative Cost (10 = high) (1-10) | Time to implement (10 = long) (1-10) |
| Mountain Reservoir | •• | •••••••• | •••••••• | •••••••• | •••••••• |
| Wells | ••••• | ••••• | •••• | •••• | •••• |
| Pipeline from West Van | •••• | •••••••• | ••••• | ••••• | ••••• |
| Desalination Plant | ••• | •••••••• | •••• | •••• | •••• |
| Surrounding Creeks | • | •• | •••• | ••••• | ••••• |
| Rain Collection | •• | •• | ••• | •••• | ••• |
| Natural Springs | - | ? | ? | ? | ? |
| Floating Barge | • | •• | •••• | ••••• | ••• |
| Storage Pond | • | ••• | ••• | •••• | •••• |
| Do nothing | •••••••• | 0 | 0 | 0 | 0 |
| Combinations of the above | - | - | - | - | - |

The current level of understanding of each additional water source dictates the accuracy or validity of ranking for each of the associated topics (volume, difficulty, cost, time). More details of the current understanding of each source are provided below.

Mountain Reservoirs – Natural and man-made

Mountain lakes/reservoirs capture rain and snowmelt, providing reliable water supply, depending on the size, and eliminate the intermittency characteristic of creek flow sources. The Capilano reservoir supplies the City of Vancouver in such a manner. The potential for such a supply for Lions Bay is more limited. Natural reservoirs like Enchantment Lake and possibly Deeks Lake are two mountain lakes above Lions Bay that are possible candidates, Enchantment, more so because of its proximity.

Tapping into Enchantment Lake would require either pumping water up over the Howe Sound Ridge and into the Harvey catchment or drilling directly through the mountain to allow gravity feed the entire distance to Lions Bay. The lake and almost entire distance to Lions Bay is on crown land which would trigger numerous political and environmental hurdles.

The Capilano reservoir is a man-made lake held back by a large dam constructed many years ago. Creating such a structure on crown land to back up Harvey or Magnesia creeks today would face even more hurdles than tapping into Enchantment Lake, so it ranks high (i.e. poorly) on all categories and is not realistically included any further in these discussions.

This option involves elements outside the Lions Bay Municipal boundaries therefore various political, regulatory, environmental and other hurdles from outside jurisdictions would be encountered.

State of our assessment:

Previous Feasibility Studies or Evaluations available: None
Consensus from evaluations to date – Water Volume: None
Consensus from evaluations to date – Feasibility: None
Consensus from Cost Estimates available to date: None

Wells

Well water as an additional source started getting significant attention in 2015 which was a dry summer with supply concerns. Subsurface water in the Harvey and Magnesia creek beds kept filling our tanks that summer albeit slowly, so the value of wells was considered. A brief survey showed that several communities along Howe Sound get portions or all of their water from wells. Some, but not all communities treat their well water for arsenic. None of the Lions Bay creek sources contain any significant arsenic, which is encouraging, but deeper subsurface water quality will remain unknown until a test well is drilled.

Further investigations into the feasibility and cost of wells in the Village have been conducted this year which give best understanding to date of the drilling costs. Further cost, treatment and access elements need to be added to these latest assessments to get a complete understanding of the option.

All parts of this option would be contained within the Lions Bay Municipal boundaries so hurdles from outside jurisdictions, aside from Vancouver Coastal Health, are minimal.

State of our assessment:

Previous Feasibility Studies or Evaluations available:
-Piteau Associates Hydrological Assessment, 19 March 2005
-B. Ulrich Survey Feb 2017
-M. Sredzki Delegation to Council 19 March 2024
-Ken Berry email report on meeting with Hydrologist, Ridgline & Piteau, 3 May 2024
-Other?
Consensus from evaluations to date – Water Volume: None
Consensus from evaluations to date – Feasibility: None
Consensus from Cost Estimates available to date: Partial: drilling only – \$30-\$35K per 200 ft

Pipeline from Metro/North Vancouver

This option makes Lions Bay reliant on water supply from another jurisdiction with much larger capacity, either Squamish or West Vancouver, the latter being the more capable and practical. It's not know if Squamish has either the capacity or desire to supply another jurisdiction. Triggered by the 2015 dry spell, discussions were held with West Vancouver to explore the possibility of a pipeline to Lions Bay from the Capilano supply system. West Vancouver did not outright reject the proposal and a subsequent preliminary cost estimate was floated with the IC at the time. This would entail a surface or buried

pipeline from Horseshoe Bay to Lions Bay along the Sea to Sky highway. Rough cost estimates of \$XXX per km prompted the option to be set aside as too expensive at the time.

This option involves elements outside the Lions Bay Municipal boundaries therefore various political, regulatory, environmental and other hurdles from outside jurisdictions would be encountered.

State of our assessment:

Previous Feasibility Studies or Evaluations available:

- Discussions, ? from LB and ? from West Van, ? 2016?
- Other ?
- Other ?
- Other ?

Consensus from evaluations to date – Water Volume: None, but assumed to be sufficient

Consensus from evaluations to date – Feasibility: None

Consensus from Cost Estimates available to date: Partial: \$xxx per km

Desalination Plant

Lions Bay is situated immediately next to an endless supply of water if it can be made potable; i.e. desalinated. A desalination plant could be sized only for peak shaving, or for a larger permanent supply of the entire Village all year round. The former would feed into the existing treatment system. The latter would essentially replace the existing creek supply system including decommissioning the UV reactors. However post treatment to maintain residual chlorine levels in the distribution system is still required. In addition to the plant itself, both scenarios require a large pump system to lift the water to either the Harvey or Magnesia tanks or both, in order to enter the distribution network. Either way, desalination is an expensive option, obviously more so if it becomes a permanent solution.

All parts of this option would be contained within the Lions Bay Municipal boundaries so hurdles from outside jurisdictions, aside from Vancouver Coastal Health, are minimal.

State of our assessment:

Previous Feasibility Studies or Evaluations available:

- Discussions, ? from LB and ? from ?supplier, ? 2016?
- Other ?
- Other ?
- Other ?

Consensus from evaluations to date – Water Volume: None, but assumed to be sufficient

Consensus from evaluations to date – Feasibility: None, but

Consensus from Cost Estimates available to date: Rough estimate: \$xxx

Surrounding Creeks

Lions Bay has water licenses for all 3 creeks running through its municipal boundaries, and re-activation of draw from Alberta creek is being implemented as this summary is being written. When the project is

complete it will be better understood how much additional water it will supply to the system during peak periods. Alberta Creek seems to still flow in late summer when Harvey and Magnesia dry to a trickle.

There are other creeks in the vicinity of the Village, most notably Rundle & Lonetree Creeks to the south and M creek to the north. These could potentially provide additional water to augment in peak periods although, being creeks, they too will have reduced flow in dry periods. Consequently this option has not been discussed at any length but deserves a slot in this analysis.

Drawing water from these additional creeks would require obtaining a water license for each and constructing intakes on each with pipeline feeds into our current treatment systems. The water quality of these creeks is currently unknown, and absent any assessment it is not known if the amount of additional water available would be worth the investment.

This option involves elements outside the Lions Bay Municipal boundaries therefore various political, regulatory, environmental and other hurdles from outside jurisdictions would be encountered.

State of our assessment:

Previous Feasibility Studies or Evaluations available: None
Consensus from evaluations to date – Water Volume: None
Consensus from evaluations to date – Feasibility: None
Consensus from Cost Estimates available to date: None

Rain Collection

The Island of Bermuda has no fresh groundwater and relies almost 100% on collection of rainwater for its water supply. (only recently have some tourist hotels been able to afford desalination to support the high demand of the arriving cruise ship passengers). That rainwater capturing infrastructure was built over many years so any such infrastructure of comparable capacity for Lions Bay would not be a near term solution. However, initiating it now as a long term strategy would be both effective and cost effective.

Every residence in Bermuda must have minimum 13,000 liter cistern capacity under the building for each bedroom in the residence, for collection of rain. Consequently every inch of rooftop space is designed for effective rain collection. This would need to be incorporated into Lions Bay building bylaws for all new buildings and allowed to take effect over time, with very minimal cost to the village.

In the short term, however, rain collection would be limited to programs that encourage residents to collect rain in barrels and tanks for use in applications like gardens, washing cars and applications that do not require treated potable water from our system. Ad hoc initiatives like this were undertaken in the dry summer of 2015 with residents buying collection barrels etc, but there is currently no ongoing village-endorsed program to encourage this.

All parts of this option would be contained within the Lions Bay Municipal boundaries so hurdles from outside jurisdictions, aside from Vancouver Coastal Health, are minimal.

State of our assessment:

| | |
|--|--------------------------------|
| Previous Feasibility Studies or Evaluations available: | None |
| Consensus from evaluations to date – Water Volume: | None but anticipated to be low |
| Consensus from evaluations to date – Feasibility: | None |
| Consensus from Cost Estimates available to date: | None |

Natural Springs

It is not known if there are any underground springs in proximity of the Village that could supply water if tapped. The fact that Alberta Creek continues to flow in dry summers when Harvey and Magnesia are reduced to a trickle implies that there might be a significant underground source of water in addition to the background subsurface moisture that feeds the creeks when snowpack or rain is absent. Although the Village will soon be taking advantage of the flow in Alberta Creek the initiative will provide only limited information as to the existence of a natural spring in the catchment. There does not seem to be any identified water flows in the area during dry times that might indicate the presence of springs outside the Alberta Creek catchment. Consequently, there has been no significant or meaningful discussion about natural springs as an additional water source.

The ongoing UBC hydrology study that Lions Bay has commissioned is intended to help understand the nature of subsurface water in our watersheds and ultimately how much it can be relied on as part of our water source. Any such results would hopefully identify the existence of natural springs in the area. The study, however, has been hampered somewhat by technical issues (communications with test sites etc) so meaningful results and conclusions are not expected in the near term.

This option involves elements unknown but potentially outside the Lions Bay Municipal boundaries therefore various political, regulatory, environmental and other hurdles from outside jurisdictions would be encountered.

State of our assessment:

| | |
|--|------|
| Previous Feasibility Studies or Evaluations available: | None |
| Consensus from evaluations to date – Water Volume: | None |
| Consensus from evaluations to date – Feasibility: | None |
| Consensus from Cost Estimates available to date: | None |

Combinations of described sources

It may turn out that none of the aforementioned additional water sources can alone provide the required improvements to the Village's existing water system. In combination, however, several of them may prove to be effective solution with palatable cost and timeframe. This is a concept that has not been discussed much but which presents numerous combinations of water sourcing that might easily relieve peak demand issues.

For example, wells may never supply sufficient water for the whole village but would be worth tapping for the immediate zone(s) around them. At the same time, a small desalination plant could supply properties within close proximity to the shoreline without the expense of pumping water all the way up

the main tanks. These two, temporarily isolated from the main distribution system, would reduce demand on the main Harvey/Magnesia supply enough to make it through peak periods comfortably. Such a scenario necessarily involves monitoring, coordination, and controls, not to mention possible taxation and clerical issues.

This option involves elements mostly but not all inside the Lions Bay Municipal boundaries therefore a few political, regulatory, or environmental hurdles from outside jurisdictions may be encountered.

State of our assessment:

| | |
|--|------|
| Previous Feasibility Studies or Evaluations available: | None |
| Consensus from evaluations to date – Water Volume: | None |
| Consensus from evaluations to date – Feasibility: | None |
| Consensus from Cost Estimates available to date: | None |

Addressing water quality issues

There are basically three categories of contamination that can affect water quality, each caused by or coming from a different source or event. These are particulate contamination, biological contamination and dissolved organics contamination. The Lions Bay water treatment system consists of UV reactors followed by chlorine injection. This system effectively deals with only some of the above contaminants.

Particulate contamination

The current Lions Bay water treatment system does not effectively address particulate contamination.

This type of contamination is normally present in moving surface water as in creeks and rivers, and to a lesser extent still surface water as in lakes and reservoirs. Particles of various sizes suspended in the water themselves usually do not represent a health hazard, but they make the water murky and give it an unattractive appearance. More importantly however, they can reduce or completely inhibit the effectiveness of systems that treat the water for biological or toxic elements. Mud washed down the creek and into the water system after a winter storm is an example of what Lions Bay experiences periodically. The current treatment system does not deal with turbidity and consequently if it is high enough, it shuts down the UV reactors.

Dealing with particulate contamination usually involves physical removal of the particles from the water by various forms of filtration.

Biological contamination

The current Lions Bay water treatment system does effectively address biological contamination under certain conditions (i.e., low turbidity)

This category includes microorganisms, viruses and other pathogens in the water which can cause illnesses in humans. It also is most commonly associated with surface water and is caused mostly by human and animal activity in the watershed. The list of these contaminants is well established and a common example of this would be e-coli contamination from human or animal feces. The Lions Bay UV reactors effectively de-active pathogens in the water but only when the water is clear (low turbidity and high transmissivity).

Dealing with biological contamination can be done by physical removal of the pathogens from the water by various filtration methods or by sterilizing/deactivating or killing the pathogens using UV, Ozone, chlorine or other methods so their continued presence in the water is harmless.

Dissolved organics and metals (DOM)

The current Lions Bay water treatment system does not effectively address dissolved organics contamination.

This type of contamination is most commonly recognized in ground water as in wells and springs but can also be found in surface water after significant events, notably forest fires. This type of contaminant is not a short-lived effect, often being an inherent characteristic of the ground water (arsenic content for example), or from an unusual even causing long term lingering effect like leaching of elements from a burned forest into the surface water.

Some non-biological elements, compounds or metals dissolved into water are beneficial or desirable, but others are toxic and harmful and need to be dealt with. Since Lions Bay draw its supply from surface water, dissolved organics has not been much of an issue for water quality and the water treatment system was therefore not designed to handle DOM. However, the risk of a forest fire in the watershed(s) above Lions Bay poses a risk of DOM's entering the water supply, and rendering it unpotable despite the current treatment system.

These types of contaminants cannot be removed by physical means alone but must be treated chemically, which can often generate solids which must be removed physically.

Improving the Lions Bay system for water quality

Given that the current Village treatment system is only a partial solution against the complete field of contaminants, this discussion outlines options that would render the water system more complete in its ability to provide good potable water under most conditions.

Potential treatment system improvements:

These are the to-date identified possible improvements to the existing water treatment system that would allow it to deal with contaminants which it currently does not:

- Membrane Filtration
- Flocculation
- Advanced Oxidation

These options have in the past been assessed in various levels of detail and need to be more thoroughly evaluated and ranked against several criteria to identify the top candidate(s). The following table shows the current subjective or qualitative status and understanding of these options.

| Potential Water Treatment Improvements | | | | | | |
|--|--|----------------------------|-----------------------------|----------------------------------|----------------------|--------------------------|
| Improvement technology | Current understanding of the technology (1-10) | Treats Turbidity (1 to 10) | Treats Bio pathogens (1-10) | Treats Dissolved Organics (1-10) | Relative Cost (1-10) | Time to implement (1-10) |
| Membrane Filtration | ●●●●●●●● | ●●●●●●●● | ●●●●● | - | ●●●●●●●● | ●●● |
| Flocculation | ●●●●●●●● | - | - | ●●●●●●●● | ●●●●●●●● | ●●● |
| Advanced Oxidation | ? | ? | ? | ? | ? | ? |
| Other? | - | - | - | - | - | - |

