Appendix A

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REPORT TO SURFSIDE PARK ESTATES WATER SERVICE COMMITTEE
MEETING OF TUESDAY, FEBRUARY 13, 2024

SUBJECT **Surfside Park Estates Water System Tank Replacement Options Analysis**

ISSUE SUMMARY

To present options for the replacement of the existing storage tanks within the Surfside Park Estates Water System.

BACKGROUND

The existing two storage tanks, integral to suppling water to the Surfside Park Estates Water System (Surfside System), have been identified as having corrosion, poor access, and safety concerns in addition to being non-seismically resilient and connected to significantly leaky piping.

In August 2023, the Capital Regional District (CRD) completed an in-house review of the existing Surfside System and identified possible options for system upgrades (Appendix A). The review included a Surfside System overview, water demand assessment (used for leak calculation and tank sizing), system condition inspection and identified two new feasible siting locations for replacement tanks. The sites identified for potential tank placement were either in the CRD regional park at Mount Parke at an elevation similar to the existing tanks (Option A); or near the existing water treatment plant (Option B) at a lower elevation. The in-house review resulted in recommendations to engage a consulting engineer to further the options analysis and provide a report complete with a Class D cost estimate for the system upgrade options.

In September 2023, the CRD engaged Associated Engineering Ltd. (AE), to complete an in-depth system review and tank replacement options analysis, complete with cost estimates (Appendix B). AE reviewed CRD's site options and included a third option, refurbishing the existing tanks (Option C). AE's assessment of Option A included Thurber Engineering Ltd.'s geotechnical engineering desktop review of the site area (Appendix C), which suggested that slope stability concerns in the park area can be mitigated but tank site placement should be outside the rockfall area. AE's technical review of the options included tank material selection and tank sizing based on provincial regulations governing drinking water storage including or not including fire protection. Tanks were calculated to be approximately 5.5 times larger in volume if sized to provide fire storage. Options A, B and C were then analyzed in context of all findings and cost estimates for the options were calculated. Appendix D shows the location of each option. Option C was not priced, as AE noted that correcting the issues with the existing tanks is expected to be the most expensive option primarily due to the difficulties in improving access and replacing the existing water main to the tanks. The following table provides a summary of AE's Class D cost estimates for Options A and B.

	Cost without fire storage	**Cost with fire storage**
Option A - Gravity System in Mt Parke	$ 1.5 M	$2.4 M
Option B - Pumped System near existing WTP	$ 2.2 M	$3.2 M

AE confirmed the cost estimates are based on a variety of sources including vendor quotes, recent tender costs, and allowances. They also include costs for typical engineering effort and two separate contingencies, both related to the fact that the project is at an early stage of development. The first, a 40% escalation contingency, accounts for the time-related increases in cost that are likely as the project proceeds through decisions and design towards construction; the second, a 30% construction contingency, accounts for scope-related items that will likely be needed but have not been determined at this point without further detail. The contingencies are based on engineering judgement.

AE has recommended that the CRD pursue Option A, the siting of replacement tanks within Mount Parke Regional Park, at a cost of $1.5 million without fire storage or $2.4 million with fire storage. AE noted that the CRD could consider deferring replacement as the external visual inspection suggested that the existing tanks may have useful life remaining. If replacement is deferred, AE recommended a detailed tank condition assessment be conducted, options to renew tank coatings be evaluated and options for improving capacity and resilience of the existing foundation system be conducted by qualified structural and geotechnical specialists. If tank replacement is deferred, higher operation and maintenance costs will be incurred due to the access constraints and water leakage until such time as the tanks are replaced. The 2023 Surfside System operating budget was $106,835 and annual operations costs, specific to the existing tanks, are noted in the table below.

Year	2019	2020	2021	2022	2023	5-year average
Cost ($)	$2,327	$630	$6,326	$5,906	$376	$3,113

ALTERNATIVES

Alternative 1

That staff be directed to:
1. Defer tank replacement and continue to operate the system as is;
2. Budget for preliminary design of Option A to pursue further details on required assessment, investigations, and engineering to confirm scope and refine the cost estimates; and
3. Keep the tank replacement project within the 5-year capital plan and apply for any eligible grants to fund the Option A system replacement within 5 years.

Alternative 2

That staff be directed to:
1. Defer tank replacement and continue to operate the system as is;
2. Budget for and complete a detailed tank condition assessment, complete with tank coatings renewal options, and options for improving the existing tanks foundation system.
3. Keep the tank replacement project within the 5-year capital plan and apply for any eligible grants to fund the Option A system replacement.

Alternative 3

That staff be directed to undertake an alternative approval process to borrow funds up to $2.4 million to carry out the Option A water system improvements as soon as possible.

Alternative 4

That the report be referred back to staff for additional information.

IMPLICATIONS

Financial Implications

Alternative 1
Funding will be required to facilitate staff to pursue a preliminary design and further details on required assessment, investigations, and engineering to confirm Option A scope and budget. Allowing time for staff to refine design and budget estimates through this work will allow more clarity on the amount the Service needs to borrow to fund the work. Keeping the Option A tank replacement on the five year capital plan allows CRD staff to apply for grants in addition to spreading out potential user rates increase required to fund the project. Higher operational costs to maintain the existing difficult to access and leaking system will be incurred until funding is attained to implement Option A.

Alternative 2
Extending the life of the existing tanks will facilitate spreading out the time that the service requires to fund the recommended tank replacement Option A. Funding will be required to facilitate the assessments and evaluations for repairs to the existing site. Given that the tanks will eventually need to be replaced and it will be cost prohibitive to do so on the existing site, any funds spent on repairing the existing site will be in addition to funds required to implement Option A. Higher operational costs to maintain the existing difficult to access and leaking system will be incurred until funding is attained to implement Option A.

Alternative 3
If the Committee elects to implement this alternative, it will add a significant cost burden to the ratepayers. Borrowing funds to complete the work for Option A as soon as possible would increase users annual parcel taxes from $247 to approximately $1,600 dollars.

Service Delivery Implications

Alternative 1
Analysis has indicated that the tanks will eventually need to be replaced and that Option A is recommended. Risk of tank failure is increased with this alternative until the existing system issues identified are addressed through construction of the new tank (Option A).

Alternative 2
Based on a cursory review, the existing storage tanks appear to have some remaining service life. If a detailed tank condition assessment, complete with tank coatings renewal options, and options for improving the existing tanks foundation system is completed, there will be more clarity on the remaining service life of the existing tanks and any options and costs to extend their service life. Risk of tank failure is increased with this alternative until the life of the existing tanks are renewed or Option A construction is complete.

Alternative 3
The existing system issues identified would be addressed through construction of the new system as soon as possible and risk of tank failure would be reduced.

Alternative 4
If the Committee elects to implement this alternative, risk of leaks and tank failure is increased until a solution is implemented.

CONCLUSION

Completed options analysis of the Surfside water storage tanks indicate the tanks appear to have some remaining useful life. If the tanks replacement is deferred for a significant time, it is recommended that the CRD complete a detailed tank condition assessment, complete with tank coatings renewal options, and options for improving capacity and resilience of the existing tanks foundation system, however there will still be issues related to access and leaking watermain with this option.

The tanks eventually will need to be replaced and it is cost prohibitive to do so at the existing site. The recommended location of future storage tanks is within Mount Parke Regional Park (Option A), at a cost of $1.5 million without fire storage or $2.4 million with fire storage. Further assessment, investigation and engineering should be undertaken to confirm cost estimates including archeological, geotechnical, and environmental constraints in addition to fire storage requirements. Borrowing will be required to fund this work and will increase users' annual parcel taxes significantly if no grants are available.

RECOMMENDATION

That staff be directed to:
1. Defer tank replacement and continue to operate the system as is;
2. Budget for preliminary design of Option A to pursue further details on required assessment, investigations, and engineering to confirm scope and refine the cost estimates; and
3. Keep the tank replacement project within the 5-year capital plan and apply for any eligible grants to fund the Option A system replacement within 5 years.

Submitted by:	Natalie Tokgoz, P.Eng., Manager, Water Distribution Engineering and Planning
Concurrence:	Jason Dales, B.Sc., WD IV., Senior Manager, Infrastructure Wastewater Operations
Concurrence:	Joseph Marr, P.Eng., Acting General Manager, Integrated Water Services

ATTACHMENT(S)

Appendix A: CRD's in-house Memo: "Mayne Island – Surfside Park Estate Water System: System Review and Options Analysis for Tank Replacement and Relocation" - August 2023
Appendix B: AE Options Analysis Technical Memo: "Surfside Park Estate Water System Tank Replacement Options Analysis" November 2023
Appendix C: Thurber Engineering Ltd. Report: "Surfside Park Estate Water System, Mayne Island, B.C. Rockfall Hazard Assessment – Revision 1" – November 2023
Appendix D: Surfside Park Estates: Tank Location Options

Memo

TO: Natalie Tokgoz, P.Eng.

FROM: Katarina Konicek, P.Eng.

DATE: August 21, 2023

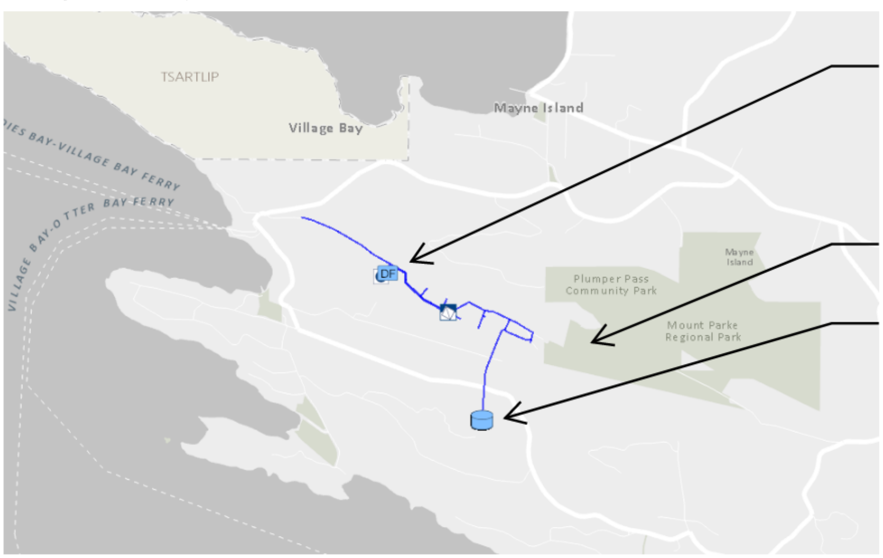
SUBJECT: **Mayne Island – SURFSIDE PARK ESTATE WATER SYSTEM: System Review and Options Analysis for Tank Replacement & Relocation**

CRD IWS staff have completed an in-house review of the existing Surfside System and have identified possible options for system upgrades. The system review and options analysis were triggered by the poor condition of the water storage tanks and the desire to act on the replacement or upgrades to the tanks prior to their failure. This information will be provided to a Consulting Engineer to further review and verify the options analysis and to produce a final report with a Class D cost estimate. The final report, complete with cost estimates for multiple options, will be presented to the Surfside Park Estates Water Service Committee.

System Overview

The Surfside Park Estate Water System (Surfside System) is located on the southwest side of Mayne Island and is part of the Southern Gulf Island Electoral Area. The Surfside System consists of one operating well, a small treatment facility (arsenic removal and mini clearwell), one pump station, one pressure control station (PCS), two storage tanks, and distribution piping. The service area includes approximately 110 lots and there are 70 water customers currently registered with the CRD. The Surfside System is operated by the CRD IWS Saanich Peninsula & Gulf Island Operations (Operations).

Figure 1 - System Overview



The two water storage tanks are located at the southern end of the Surfside System at an approximate elevation of 128m (TWL: 137m, based on record drawings). These tanks provide the community with water via gravity. The existing tanks are cylindrical steel horizontal tanks and each has a capacity of approximately 45m^3 (9,900 Imp.Gal, 11,900 US.Gal). The 150 mm PVC pipe connecting the reservoir tanks to the Surfside System acts as both a fill line and distribution line.

The operating well (Well #5A), water treatment facility, and pump station are all located near the west end of the system and are on the same site at an elevation of 38m. The pump station provides sufficient pressure to fill the reservoir tanks to TWL 137m.

The PCS is located centrally within the Surfside System at an elevation of 68m and provides water to the lower elevation lots (38-68m) at reduced pressures. The reduced pressure zone has an HGL of 100m. The PCS is located below the road grade and includes three pressure reducing valves with the following sizes and set points (based on 2023-06-09 Operational information):

- 1” 45psi (31.7m)
- 2” 42psi (29.6m)
- 3” 38psi (26.8m)

A Strategic Asset Management Plan for the Surfside System was complete December 2011 (attached) and provides supplemental information regarding the water system.

<u>Water Demand</u>
Based on the water production spreadsheet (‘WaterProductionLSAMonthlySpreadsheet’) maintained by the CRD IWS Operations group, the average water production in the service area is 31.7 m^3/day. The actual average metered water demand is 13.7m^3/day and the system requires approximately 1 m^3/day for operational water usage. The remainder of the approximately 17 m^3/d is deemed leakage. This leakage is discussed further in the ‘System Condition’ section below.

Based on a review of the Surfside System water demand data and discussions with CRD IWS Operations staff, the tank sizes are likely sufficient to meet demand and likely do not need to be upsized. That said, the current storage capacity does not accommodate fire flow volume. To accommodate fire storage of 4,000L/min for 1.5hrs, based on FUS (Simplified Method, up to 4560sq.m. and 3-10m separation) the required tank storage would result in a 28 day turn over. The current tanks storage volume allows water to turn over every 7-8 days and water quality does not deteriorate. If the storage volume was larger, the water retention time would be longer and the water quality would likely deteriorate. Additional system maintenance and potentially new infrastructure would be required to maintain water quality if the tanks were upsized. Further investigations into fire flow demands, domestic demands, and tank sizing are required as part of the consultant’s analysis.

<u>System Condition</u>
Based on conversations with CRD IWS Operations in May 2023, the Surfside System storage tanks are in poor condition and their current location is a challenge for maintenance as there is no road access. A site inspection of the tanks was completed by CRD IWS on Oct 15, 2021. Tank deterioration, tank support deterioration and site access were noted as key issues. The inspection report is attached to this memo.

A similar storage tank system, located on Mayne Island as part of the Skana Water system, was reviewed by Stantec Consulting in 2016. Stantec's subsequent assessment report, complete with recommendations for tank upgrades, is attached to this memo for reference as the tanks are very similar to the Surfside tanks.

It is noted above in the 'Water Demand' section that there is a significant water leakage based on well production and water usage data. CRD IWS Operations has attempted to reduce leakage by completing investigations via acoustic leak detection and hand digging without significant success (20230805 SH_to_DR email). Further investigations show that most of the system is in decent condition; however, the section of 150mm PVC pipe that connects to the tanks has been flagged as having multiple leaks and repairs are difficult due to the lack of access to the area.

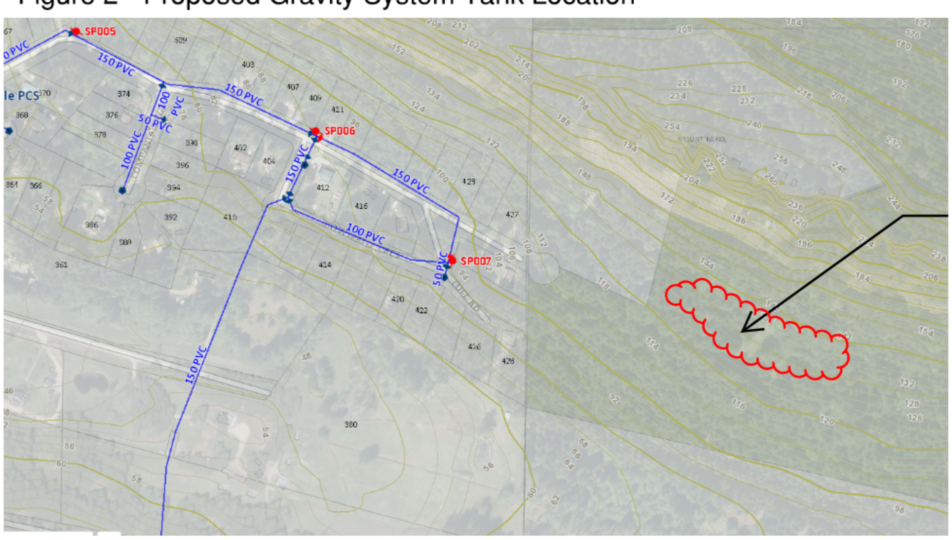
Options Analysis

The CRD has reviewed the current system and has selected the following two options for system upgrades. Both options require further review as part of the Consultant's option analysis.

1. Gravity System

   The system would continue to operate by gravity. This would likely require:
   - New tanks (2x45m^3) – possibly proprietary glass fused to steel flat panel tank with reinforced concrete pads and aluminum geodesic dome roof, polyethylene or other suitable recommended tanks.
   - New tank location proposed on Figure 2 (300m east of Wood Dale Drive, within Mount Parke, a CRD Regional Park) at an approximate elevation of 130m.
   - CRD Regional Parks have reviewed the location and confirmed that the tanks can be located in this area, but further review will be required as more detailed information becomes available.
   - Environmental Impact Assessment to be completed and reviewed by CRD Regional Parks.
   - Slope stability assessment for new tank location.
   - Approximately 300m of new watermain to new tank location (one tank fill/discharge line).
   - Decommissioning of existing pipe and tanks.

Figure 2 - Proposed Gravity System Tank Location

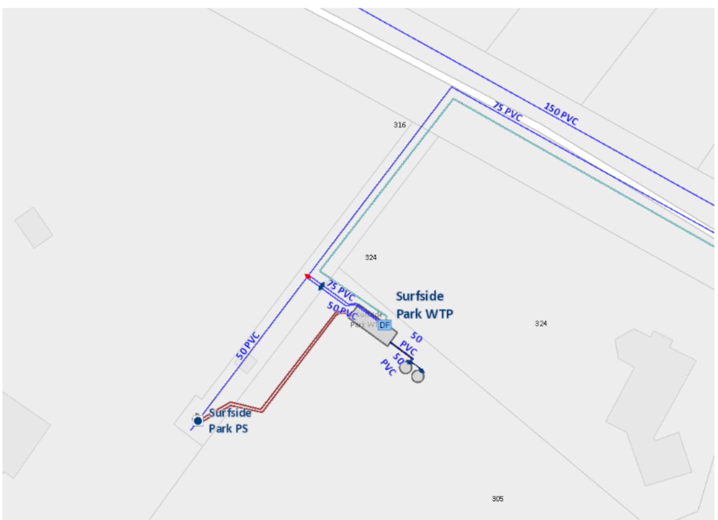


Some challenges of this option will include determining a suitable location based on slope stability and will likely require a geotechnical investigation of the potential CRD Park land where the new tanks can be situated.

2. Pumped System
   The system would operate as a pumped water distribution system. This would likely require:
   - New pump station to service the area (elevation range: 38m to 98m) at HGL 126m.
   - Potentially new piping depending on pressures and existing pipe pressure ratings.
   - New tanks (2x45m^3), proprietary glass fused to steel flat panel tank with reinforced concrete pads and aluminum geodesic dome roof, polyethylene or other suitable recommended tanks.
   - Decommissioning of existing pipe, tanks, and pumpstation.

   A challenge of this option include obtaining a new or expanded SRW for the required pump station and storage tanks. See Figure 3 for current well, treatment plant, and pump station location.

Figure 3 - Existing Well, Treatment Building, and Pump Station



Recommendation

The CRD has completed an in-house review of the Surfside System and has provided options for system upgrades. It is recommended to collaborate with a Consulting Engineer to further the options analysis and provide a report complete with a class D cost estimate for the possible system upgrades.

Yours truly,

Katarina Konicek

Katarina Konicek, P.Eng.
Project Engineer, Water Distribution Engineering and Planning
Infrastructure Engineering
CRD Integrated Water Services

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Attachments:

- Strategic Asset Management Plan for the Surfside Water System, December 2011
- Site Inspection by Operations, October 15, 2021
- Leak Detection Email August 5, 2022 (20230805 SH_to_DR email)
- Assessment of Skana Water System Tank, Mayne Island, BC, Stantec, February 2, 2016
- Conclusions and Recommendations for Skana Water System Tanks, Stantec, March 16, 2016

Appendix A

TECHNICAL MEMORANDUM

Capital Regional District
Mayne Island

Surfside Park Estate Water System
Tank Replacement Options Analysis

NOVEMBER 2023

Appendix A

TABLE OF CONTENTS

SECTION PAGE NO.

1 ISSUE

The Surfside Park Estates Water System is a small water system located on Mayne Island, operated by the Capital Regional District (CRD). The Surfside Park Estates Water System consists of a groundwater well, a treatment system to remove arsenic, booster pumps, a set of two gravity storage tanks to provide consistent pressure, and distribution pipe.

The existing cylindrical horizontal welded steel tanks have been identified as having significant corrosion and poor access for operation, and consideration of options for their replacement is required.

2 BACKGROUND

2.1 Existing system

The Surfside Park Estates Water System is located on Mayne Island, generally along Wood Dale Drive near the Village Bay Ferry Terminal which is the primary transportation link to the Island. The system serves approximately 70 homes, with an anticipated capacity at build-out of 107 homes.

In order to provide appropriate pressure to customers, the system is split into two pressure zones, operating at nominal hydraulic grade lines of 137 m and 100 m. The upper zone pressure is set by the twin storage tanks while the lower zone is served by a set of three pressure reducing valves. The water treatment plant supplies water to the upper pressure zone through a dedicated supply line tied into distribution mains immediately above the pressure reducing valves. The tanks are connected off of Bowsprite Crescent near the top end of the distribution system, and utilize a common fill/draw pipe with bidirectional flow depending on whether the tanks are filling or draining. Figure 2-2 on the following page provides an overview of the service area and key existing features.

The Surfside water service area does not include land of suitable elevation for gravity storage tanks, so these are located outside of the service area, across the valley to the south in a steeply sloped and heavily wooded area. The tanks were constructed in the 1970s and are constructed as horizontal steel cylinders, each supported on two concrete saddles. One of the tanks is shown in Figure 2-1 with the second tank out of view behind it.

Figure 2-1 Surfside Water Storage Tanks

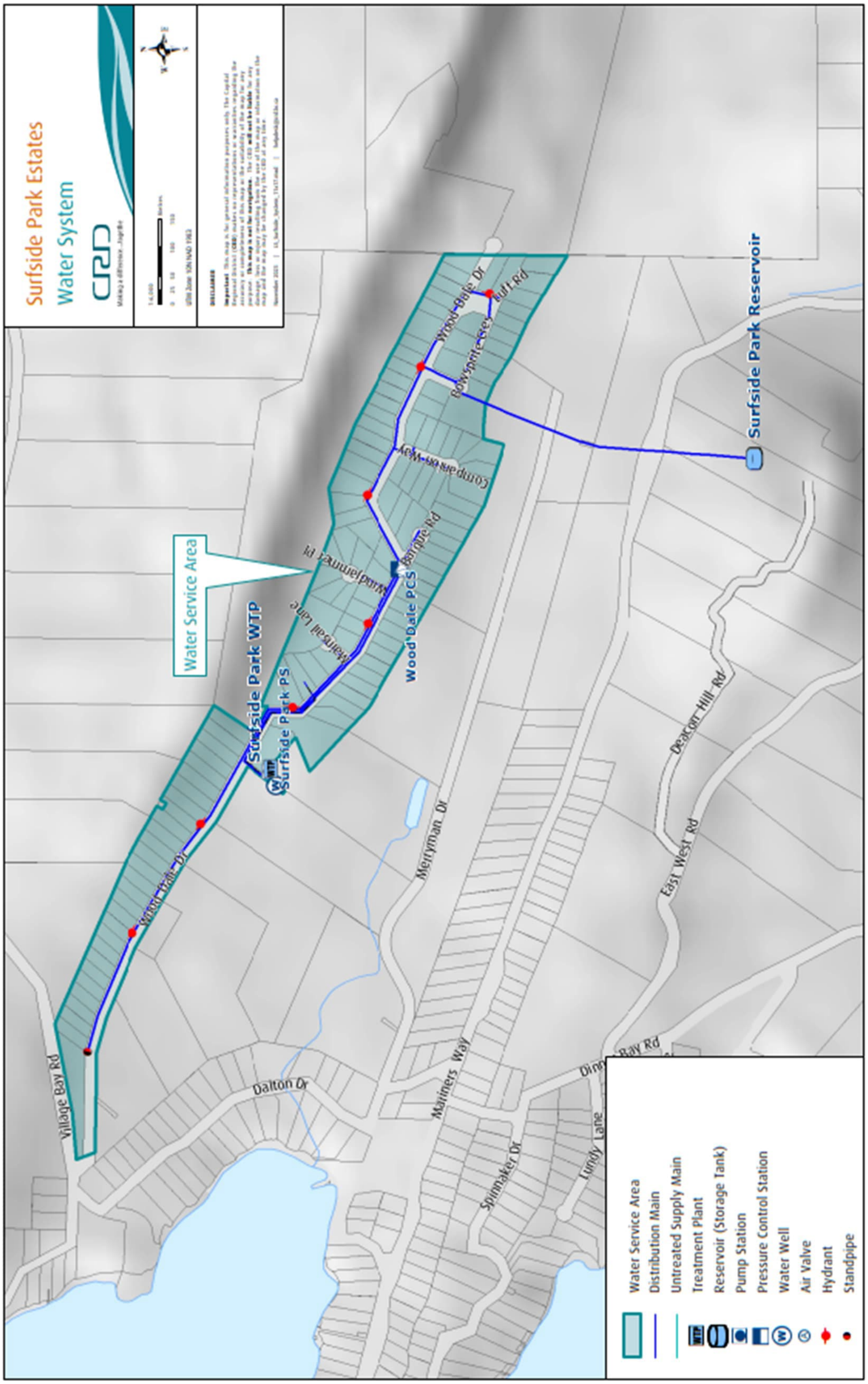


Figure 2-2 Surfside Water Service Area

In general, the available record information for the tanks is poor. The actual volume of the existing tanks is unknown, with recorded capacities between 45 and 57 m^3 per tank, but measurements on site suggesting a nominal capacity slightly over 60 m^3 per tank for a total nominal capacity of more than 120 m^3. Record drawings show a different foundation system to the one installed.

The tanks include a level measurement device mounted on the top of one of the tanks, which utilizes a radio link to convey this information back to the treatment plant and control the production of water. This system is powered by a solar panel. This equipment is visible atop the tank in Figure 2-1.

Access to the tanks is challenging due to the steep terrain and lack of an improved pathway. CRD Operators can access the tank from a point on Deacon Hill Road through an unimproved trail through the woods, though this access is across private property for which a right of way has not been established. Deacon Hill Road includes steep grades and extremely narrow sections where 2-way traffic is not possible. Due to its remote location, the road receives little or no winter maintenance. The unimproved trail access is generally adequate for operators on foot but is extremely challenging when equipment needs to be carried to the tanks for maintenance activities such as servicing the level transmitter or cleaning the tanks. The other access was from Mariners Way; however, this requires a steeper and longer hike compared to the upper access route off Deacon Hill Road. CRD Operations reports recent leak detection efforts in this area as extremely challenging.

To understand the operation of the system, relevant background information was collected from the CRD and a site visit was conducted on 21 September 2023. Background information reviewed included:

- Record drawings for Arbutus Water Co Ltd., the original system owner (various dates, mostly around 1976)
- Surfside Water System Strategic Asset Management Plan, CRD 2011
- Various documents related to tanks at Skana Water System (a nearby system with similar tanks)
- Surfside Reservoir Condition Assessment Report, CRD 2021

2.2 Potential Sites for Replacement Tanks

In addition to the background information reviewed, the CRD prepared a memorandum dated August 2023 entitled *System Review and Options Analysis for Tank Replacement & Relocation*. This memorandum provided a summary of recent water production and demand in the system, and outlined two potential options for siting of replacement tanks which could improve the site access. The two locations identified were:

- Option A: “Gravity System” – location of proposed tanks would be within the CRD Regional Park at Mount Parke, at an elevation similar to the existing tanks
- Option B: “Pumped System” – location of proposed tanks near the existing water treatment plant, with pressure raised to the upper pressure zone using pumps.

To supplement these information sources, a site visit was conducted by Associated Engineering staff on 21 September 2023 with support from CRD Engineering and Operations personnel. Photographs from the site visit are included as Appendix A to this memorandum. During the site visit it was observed that the existing tanks were in serviceable condition with localized surface rust only. Based on these observations, a third option was added for consideration:

- Option C: “Existing Tanks” – wherein refurbishment of the existing tanks could extend their lifespan.

Figure 2-3 Illustrates the three potential tank locations identified in relation to the existing system, while Table 2-1 compares some important considerations for the options.

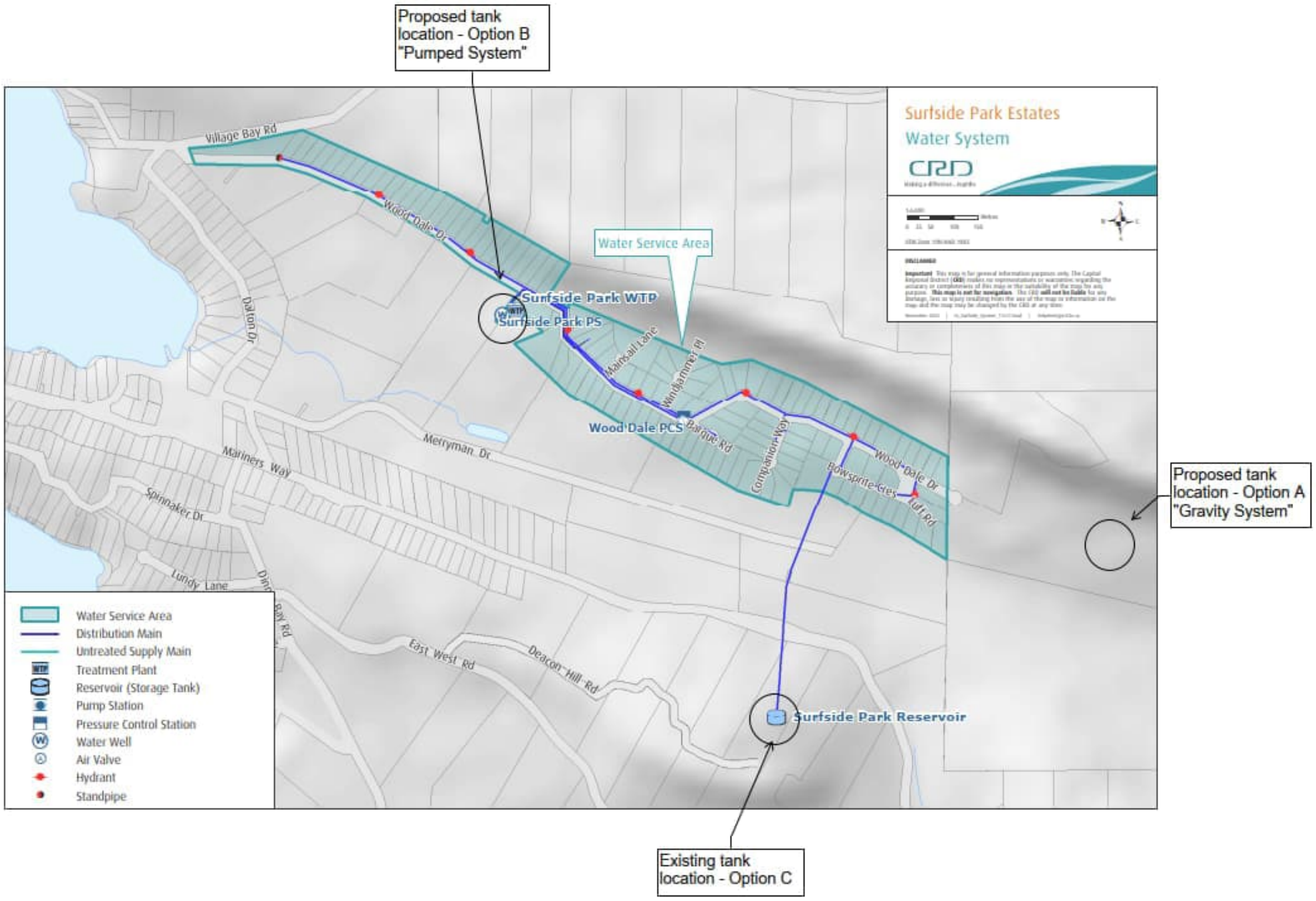


Figure 2-3: Potential Tank Locations Identified

Table 2-1: Key Considerations for Potential Tank Locations

	Option A Gravity System	Option B Pumped System	Option C Existing Tanks
Site location	Flat clearing in park	Flat areas near treatment plant	Steep terrain
Elevation	Allows for gravity system	Requires pumping	Allows for gravity system
Access	Existing gravel road in park.	Shared driveway at existing plant	Very challenging
Land Use	CRD Parks has indicated location is feasible.	Private property	Existing
Electrical & Controls	Require new electrical supply and radio communication	Existing electrical supply and controls	Existing solar panel and radio

The water consumption was reviewed to understand what size of tanks are appropriate for this system. The average water production in the system over the 5 years from 2018 to 2022 was 31.7 m^3/day and average metered usage of 13.7 m^3/d. This metered usage equates to 196 L/d per household, a low number which may indicate that some of the homes are not occupied on a full time basis. Depending on whether production or metered usage is considered, the tank turnover is likely at least 2 to 4 days at average flow. The usage numbers also indicate 57% of the water is non-revenue. The long section of pipe connecting the reservoirs to the system was identified by the CRD as a significant contributor to the non-revenue water in the system, and leak detection and repair work conducted by the CRD in May & June of 2022 is likely not reflected in these figures. No water quality issues were reported within the system.

3 STAKEHOLDERS

The primary stakeholders for the tank replacement are the customers whose potable water is supplied from the system. Other stakeholders include the Capital Regional District Integrated Water Services (IWS) who operates the system, and for Option A CRD Parks and other park users.

4 OBJECTIVE

The objective of this memorandum is to review available information and recommend next steps for the future water storage needs of the Surfside Estates system.

5 TECHNICAL REVIEW OF SYSTEM

This memorandum is primarily aimed at determining a preferred location for new water storage tanks for the Surfside Park Estates Water System. This section of the memorandum begins with a review of tank sizing and material considerations for replacement tanks, followed by detailed discussion regarding each of the location options identified earlier in the memorandum and illustrated in Figure 2-3.

5.1 Tank Sizing

Replacement tanks for the Surfside Estates Water System should be designed in accordance with the BC Ministry of Health's 2023 Design Guidelines for Drinking Water Systems in British Columbia. Other relevant regulations were considered including the Mayne Island Trust Land Use Bylaw No.146, but the provincial guidelines provide the most comprehensive direction for reservoir design. Use of these guidelines will be beneficial for obtaining the required Permit to Construct Waterworks at the completion of design.

Two sizing options are provided within the provincial guidelines, depending upon whether water is stored for fire protection or not. If fire storage is not provided, the guidelines indicate that storage equal to maximum day demand should be provided. Using the peaking factor of 2.75 from the guidelines together with the average water production rate of 31.7 m^3/d this equates to a recommended 87 m^3 of storage, or approximately ¾ of the volume available in the existing tanks. If fire storage is to be provided, the simplified method within the Fire Underwriters Survey (FUS) guideline Water Supply for Public Fire Protection indicates a flow rate of 4,000 L/min for a duration of 90 minutes, based on floor areas under 450 m^2 (4,800 ft^2) and separation between structures of at least 3 metres. The provincial guidelines indicate that equalization and emergency storage should be added to this, resulting in a total required volume of 478 m^3. Table 5-1 summarizes the calculated volumes. This is approximately four times as much storage as the current system has.

Table 5-1 Fire Storage Reservoir Volume

Component	Volume (m^3)
Fire Storage *(4,000 L/min x 90 minutes)*	360
Equalization Storage (0.25 x 87 m^3)	22
Emergency storage (0.25 x 360 m^3 + 0.25 x 22 m^3)	96
Total	478

The maximum day demand noted above is based on current water production including significant non-revenue water. If the CRD is successful in reducing non-revenue water in the system and lower total production can be demonstrated, then lower numbers and smaller tanks could be justified. The maximum day demand and recommended tank capacity derived from it should be reviewed again in detail as design progresses.

A volume of 478 m^3 would be a significant change to the system, with more than two weeks of water stored at average day demand. If non-revenue water was decreased substantially, the storage duration would see an inversely proportional increase. These long water ages could result in degraded water quality within the system. Additional work would be required to determine what flowrate could be delivered to the existing hydrants within the Surfside Estates System, since a larger tank needs to be paired with appropriately sized piping and hydrants in order to deliver water for fire protection.

5.2 Tank Material

Tanks suitable for potable water service may be manufactured from a wide variety of materials. For field-erected tanks away from large population centres, bolted steel tank construction is common. Shop fabricated tanks are available in a wider range or materials, including various polymers, coated steel or stainless steel.

Cross-linked Polyethylene

Cross-linked polyethylene is a polymer with excellent mechanical properties that can be manufactured into tanks within a manufacturing facility. The material is suitable for storage of potable water, and can be procured with NSF 61 certification. A carbon black additive can be added to the polymer during manufacturing to reduce the effects of UV exposure which can cause the material to become brittle over time. The mechanical properties of cross-linked polyethylene allow it to provide adequate performance even under seismic loading. A polyethylene tank would be expected to last at least 20 years, and due to this relatively short life expectancy this option was not considered further.

Stainless Steel

Stainless steel is another candidate material which offers many of the benefits of steel while being more resistant to environmental corrosion. Stainless steels are generally still susceptible to corrosion in the presence of chloride (salt), including the sodium hypochlorite which is added to the Surfside water for disinfection. When tank size becomes small and the relative cost of applying coatings is more significant, this can be a good option. Stainless steel can be passivated, rapidly forming a thin layer of oxide which prevents more significant corrosion. A stainless steel tank with proper maintenance would be expected to last more than 50 years if chloride levels are carefully managed. Stainless steel was not considered further due to the additional care required for management of chlorides.

Steel

Bolted steel tanks have been used for many years for many applications including reservoir and other liquid storage purposes. This type of tank can provide an economical way to combine shop coating of panels with field erection for a robust tank. Historically, depending on the corrosiveness of the stored liquid, epoxy coated steel tanks have performed satisfactorily with service life of the epoxy coating lasting at least 30 years. Glass-fused steel tanks have also been used in many similar applications where the estimated maintenance life can extend beyond 50 years. Cathodic protection is often used as an additional measure to protect these tanks and prolong the overall service life. These tanks can be assembled on site using relatively lightweight equipment.

When the required tank size is small enough to facilitate shipping of a complete tank, it is also practical to fabricate a steel tank off site, apply factory coatings to the entire fabrication, and deliver a complete tank to site. This is likely how the existing tanks were constructed. Epoxy coated steel would be a likely choice, and coating life of at least 30 years could be expected. A shop fabricated tank requires relatively little field work and can provide better quality control compared to a field-fabricated tank. A cathodic protection system could also be provided for such tanks. A large crane would be required to lift a shop fabricated tank.

Corrosion within a steel tank often takes place above the water line within the tank where excessive moisture exchanges with oxygen and create corrosion when metal is exposed. Therefore, regular maintenance and monitoring programs to inspect for corrosion will help extend the overall service life of any metallic tank. Such programs can be performed through observation at the rooftop hatch of the tank where a maintenance crew would access by using a ladder mounted on the side of the tank. For larger tanks, two access manways should be installed at the bottom of the tank at opposite sides. This will improve the safety access from a confined space perspective and improved ventilation. A vertical caged ladder with a vertical safety lifeline should be provided to access to the roof top.

At this stage, it has been assumed that glass-fused bolted steel tanks would be used if fire storage is provided, and shop-fabricated epoxy-coated carbon steel tanks otherwise. These options can be considered in more detail as the work progresses, and it is also possible to procure a tank in such a way that a contractor will propose the tank that provides the best value to the Surfside system from more than one acceptable solution.

5.3 Option A – Gravity System

Construction of new tanks within Mount Parke would result in a water system that operates in the same way as the existing system but provides greatly improved access to the storage tanks for operations and maintenance and eliminates the section of piping which is believed to be causing much of the non-revenue water loss. This would require the construction of new tanks complete with foundations, piping from the existing end of line off Wood Dale Drive, and instrumentation complete with power supply and communication system. Since tanks at this location would be hydraulically similar to the existing tanks, no modifications to the treatment plant or PRV would likely be required. Figure 5-1 illustrates the required upgrades.

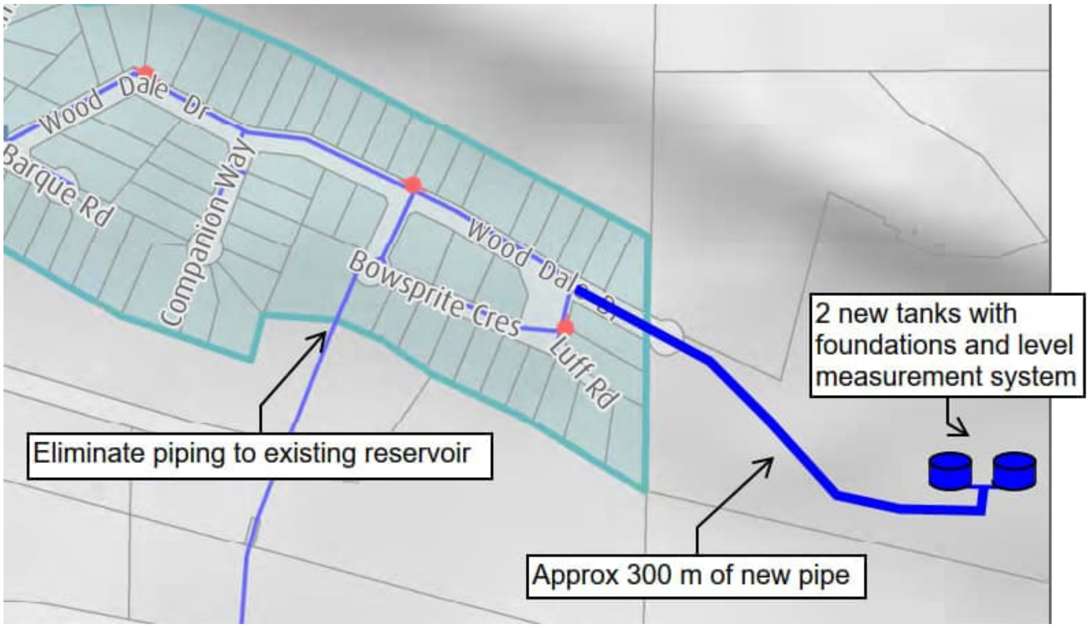


Figure 5-1 – Option A Gravity System Upgrade Concept

The ability to construct and maintain piping and tanks within a park is relatively unusual and the ability to do this should be confirmed, with a formal agreement for land use put in place. Approximately 300 metres of new pipe would be required to be installed along the existing gravel roadway. The existing clearing appears to be of suitable size and at the appropriate elevation for construction of new tanks. A desktop review was conducted by Thurber Engineering Ltd. which suggests that a soil or rock berm or other method could be used to mitigate a slope stability concern at this location.

It may be economical to provide utility power to the site if the power wiring is installed at the same time as the piping, and this would eliminate the maintenance required for the current solar power system. If a radio is to be used for communicating tank level to the water treatment plant, a radio path study will be required.

Archaeological and environmental constraints should be evaluated before confirming the preferred site.

The likely costs of Option A are provided in Table 5-2 below:

Table 5-2 Gravity System Class D Opinion of Probable Cost

Description	Cost without fire storage	Cost with fire storage
Piping connection	$180,000	$180,000
Tanks complete with foundations	$500,000	$1,000,000
Electrical & Instrumentation	$170,000	$170,000
Contractor Overhead and Profit (10%)	$85,000	$135,000
Escalation Contingency (40%)	$340,000	$540,000
Construction Contingency (30%)	$255,000	$405,000
Total Anticipated Project Cost	$1.5M	$2.4M

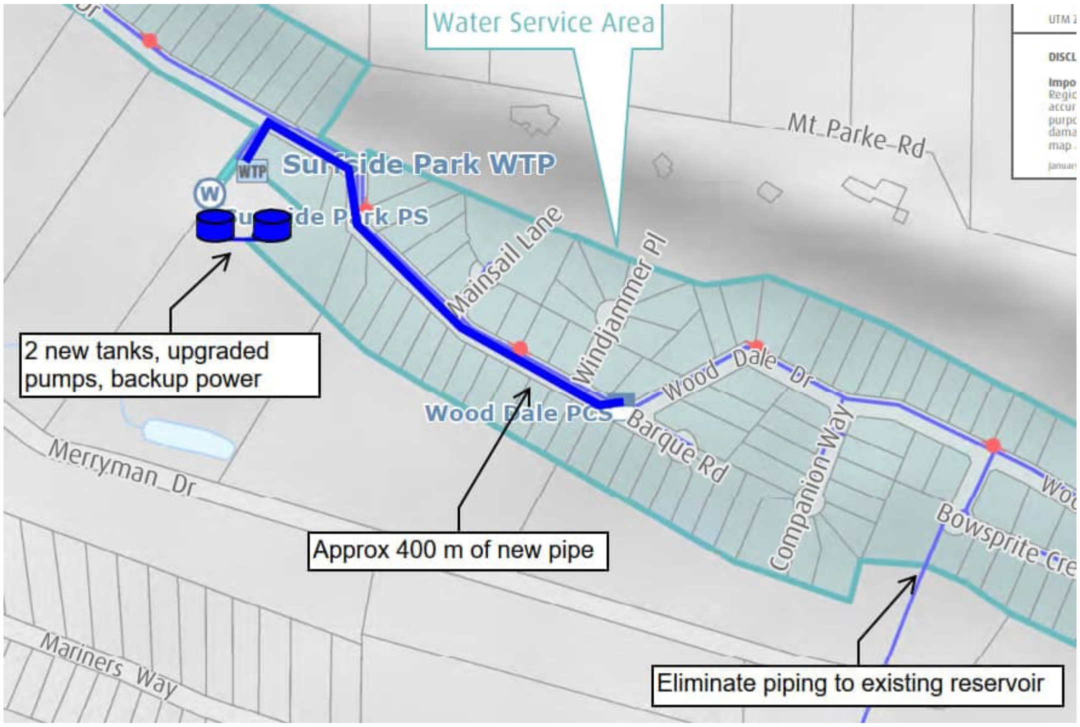
5.4 Option B – Pumped System

Construction of new tanks adjacent to the existing water treatment plant will require a reconfiguration of the water system since system pressure will be provided by pumps rather than by gravity as in the existing system. This option would require construction of new tanks complete with foundations, upgraded piping from the water treatment plant to the tie-in point, construction of new pumps with a pressure tank, and addition of backup power to the treatment plant. Adding tanks at this location would eliminate the need for communication to remote sites within the Surfside Estates System. No changes to the PRV station would be anticipated. Figure 5-2 Illustrates the required upgrades for this option.

The existing land at the treatment plant does not include adequate space to accommodate new tanks, so additional land would need to be acquired at this location. Discussion with adjacent landowners should be undertaken.

Although all of the work is to be done is located at a site with existing power supply, it is likely that the single phase power would be a significant constraint for the larger pumps required. This would require careful consideration during design but could likely be overcome. Since the system would have increased reliance on continuous power, a diesel backup power generator would be required.

Geological, archaeological and environmental constraints should be evaluated before confirming the preferred site.



The likely costs of Option B are provided in Table 5-3 below:

Table 5-3 Pumped System Class D Opinion of Probable Cost

Description	Cost without Fire Storage	Cost with Fire Storage
Piping connection	$400,000	$400,000
Tanks complete with foundations	$500,000	$1,000,000
Electrical & Instrumentation	$250,000	$300,000
Pump & Mechanical Upgrades	$50,000	$150,000
Contractor Overhead and Profit (10%)	$120,000	$180,000
Escalation Contingency (40%)	$480,000	$720,000
Construction Contingency (30%)	$360,000	$540,000
Total Anticipated Project Cost	$2.2M	$3.2M

5.5 Option C – Existing Tanks

Based on a visual inspection of the exterior and the operator's description of the interior condition, the existing tanks appeared to have some remaining useful life. This could likely be further extended by renewing the coatings. Retrofitting the foundation system to provide seismic capacity might also be feasible. Creating a reliable all-weather access to the tanks would be more expensive than the other options considered, due to the steep slopes and need to obtain additional property rights. Renewal of the piping which supplies the reservoir would also add expense. As such, this option was not considered further.

5.6 Option Comparison and Next Steps

Any of the three options described above could be viable upgrades for addressing the concerns with the existing tanks. The lowest cost option is Option A, a gravity system with tanks located in Mount Parke Regional Park. Option B, a pumped system with new tanks near the existing water treatment plant, could also be viable but is expected to have higher costs. Option C, correcting the issues with the existing tanks, is expected to be the most expensive option primarily because of the difficulties in improving access to the tanks. Based on these considerations, Option A is the preferred option to consider.

In order to move forward the tank replacement, a review of archaeological, geotechnical, and environmental constraints should be undertaken. A detailed review of available information should be conducted and/or daily usage monitored during peak demands to determine an appropriate design maximum day demand which can be used for tank sizing.

Should the anticipated costs of at least $1.5 million depending on the preferred option exceed available funding, the CRD could consider deferring this work since an external visual inspection suggests that the existing tanks may have useful life remaining. In this case, a detailed tank condition assessment should be conducted, and options to renew coatings evaluated. Options for improving capacity and resilience of the existing foundation system should also be conducted by qualified structural and geotechnical specialists. If this option is pursued, higher operation and maintenance costs will be incurred due to the access constraints and water leakage until such time as the tanks are replaced.

6 SUMMARY

The existing potable water storage tanks for the Surfside system have some corrosion, are very difficult to access for maintenance, are likely unable to resist seismic forces in case of an earthquake, and are connected to the customer base by pipes that are believed to have significant leakage. Two feasible upgrade options were considered, and it is expected that Option A for locating new tanks within Mount Parke Regional Park will provide the best value to the stakeholders. The anticipated costs for Option A are approximately $1.5 Million to install new shop fabricated steel tanks of similar size to the existing, or $2.4 Million to install new bolted steel tanks which would be capable of storing adequate water for firefighting.

7 RECOMMENDATIONS

It is recommended that the CRD pursue siting of replacement tanks within Mount Parke Regional Park. If it is desired to defer this work, upgrades to the coatings and foundations of existing tanks should be considered.

The effectiveness of recent distribution pipe repairs should be reviewed by comparing water production with invoicing.

This report presents our findings regarding the Mayne Island Surfside Tanks Replacement Options.

Associated Engineering (B.C.) Ltd. Permit to Practice 1000163

Prepared by:

Shane Duggan
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Reviewed by:

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Mechanical Engineer

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Project Manager

SD/JM/ia

Attachments:

- Appendix A – Site Photos

APPENDIX A – SITE PHOTOS

Figure A-1 WTP Pumps

Figure A-2 WTP Clearwell

Figure A-3 Pressure Control Station

Figure A-4 Fire Hydrant

Figure A-5 Existing Reservoir

Figure A-6 WTP Backwash Tanks

Figure A-7 WTP PRV

Figure A-8 WTP Valves

Figure A-9 Existing Reservoir #2

Figure A-20 Reservoir Fill/Discharge

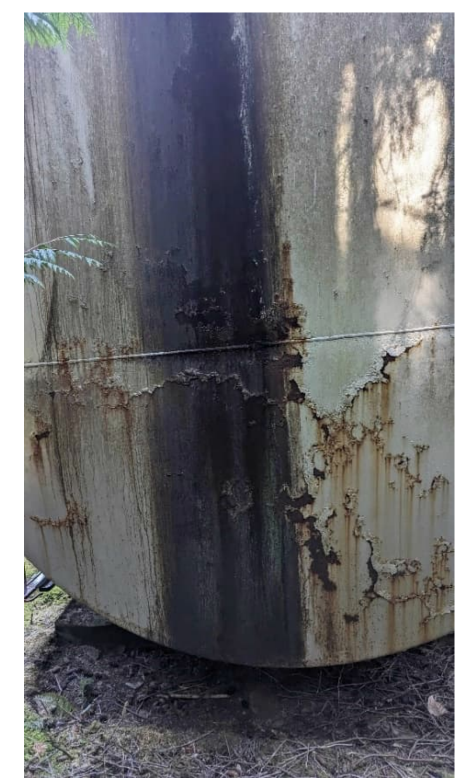

Figure A-31 Reservoir #2 Corrosion

Figure A-12 Existing Reservoir Antenna/Transmitter

Figure A-13 Existing Reservoir Concrete Saddles

Figure A-14 WTP Arsenic Removal Process

Figure A-15 Existing Reservoir Side Profile

Figure A-16 Existing Reservoirs

Figure A-17 Existing Wellhouse

Figure A-18 Existing WTP

Figure A-19 Existing WTP Pump Control Panel

THURBER ENGINEERING LTD.

November 9, 2023 File No.: 41872

Capital Regional District
479 Island Highway
Victoria, B.C.
V9B 1H7

Attention: Katarina Konicek, PMP, P.Eng.

SURFSIDE PARK ESTATES WATER SYSTEM, MAYNE ISLAND, B.C.
ROCKFALL HAZARD ASSESSMENT – REVISION 1

Dear Katarina,

At the request of the Capital Regional District (CRD), Thurber Engineering Ltd. (Thurber) has completed a desktop study to review the rockfall hazard to a proposed water storage location on Mayne Island, B.C. This letter provides the results of our desktop study and provides a discussion of the rock fall hazard and some potential protection measures. This revision supersedes our letter issued November 8, 2023.

It is a condition of this letter that the performance of Thurber's professional services is subject to the attached Statement of Limitations and Conditions.

1. BACKGROUND

We understand that the CRD is looking to present water system upgrade options to the Local Service Committee for their water storage within the Surfside Park Estates Water System on Mayne Island, B.C. A potential water storage tank location has been identified approximately 230 m east of the end of Wood Dale Drive within Mount Parke Regional Park. The site is located at the base of a talus slope and steep bedrock cliff, which are about 40 m and 85 m tall, respectively.

Golder completed a rockfall hazard study in 1999, which addressed the rockfall hazard presented by the steep rock cliff above Wood Dale Drive, west of the project site. The Golder study indicated that there are potentially unstable blocks of rock on the crest and face of the cliff, which are likely to fall in the future due to natural processes. This is verified by the presence of talus at the base of the cliff. The report provided a hazard area map and recommended a series of potential protection measures that could be constructed to protect the lots along Wood Dale Drive. This same cliff band extends eastward above the proposed project site.

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2. DESKTOP STUDY

The elements reviewed as part of the desktop study are summarized in the following subsections. As requested, a site reconnaissance has not been conducted by Thurber at this time.

2.1 Geology

The bedrock geology of Mayne Island is characterized by the Nanaimo Group, a conglomerate unit comprising boulders, cobbles and pebbles. The project site is bound to the north by a 50 m to 85 m tall cliff band with a 40 m tall talus slope at its base. The talus extends linearly about 90 m from the base of the cliff. Photographs of the site provided by CRD and Associated Engineering (AE) indicate that the proposed water storage site is relatively flat, with an excavation face into the conglomerate bedrock at the north end of the site. Talus is visible in the forest north of the site, including large, moss covered boulders that appear to be up to about 3 m in diameter.

2.2 LiDAR Analysis

The report titled "The Assessment of Rockfall Hazard at the Base of Talus Slopes, 1993" by S.G. Evans and O. Hungr, indicates that talus slopes generally form between 32° and 38° below the apex (i.e., the base of the rockfall source) with small debris accumulated near the apex and large debris accumulating near the toe of the talus slope. Evans and Hungr defined the rockfall shadow as a zone where large boulders come to rest beyond the toe of the talus slope. The report indicated that an empirical minimum shadow angle of 27.5° is suggested from rockfall vulnerability studies (i.e., a 27.5° or 1.9H:1V line projected downward from the bottom of the bedrock outcrops).

The rockfall hazard at the proposed site was assessed using publicly available LiDAR data, obtained from the B.C. online LiDAR database. Representative cross sections were cut through the project site and on either side of the site to assess whether the proposed location is within the talus zone or the rockfall shadow of the cliff band.

3. HAZARD ASSESSMENT AND DISCUSSION

Based on the results of our desktop study, the proposed water tank location is within the rockfall shadow of the cliff band. Figures 1, 2 and 3 show the location of the project site with respect to the cliff, talus zone and rockfall shadow. It should be noted that these preliminary lines are based on a desktop study only and could possibly be refined after a site reconnaissance and rockfall trajectory analyses.

Generally, geotechnical approaches to geohazard problems such as rockfall include avoiding the hazard, protection measures, and/or mitigation measures. Protection measures are implemented to protect structures from a rockfall that will occur. Examples of protection measures include soil or rock berms, walls and rockfall fences. Mitigation measures are implemented to reduce the probability of a rockfall event occurring. Examples of mitigation measures include rock scaling and rock bolting. In general at this location, avoidance would be the more practical measure. Avoiding the rockfall hazard would mean establishing sufficient setbacks from the hazard zone such that the risk to the water tanks and individuals would be sufficiently low and considered acceptable. The tanks should be located at least on the south side of the road, which delineates the rockfall shadow zone as shown in Figures 1 and 2.

If the water tanks are to be located within the rockfall shadow zone, rockfall protection measures would be the most practical and economic option. The following sections discuss some potential different protection options.

3.1 Rockfall Protection Options

The selection of the most suitable rockfall protection measure would depend on the size and impact velocity of the boulders, the available space and the construction and installation costs. Periodic maintenance will be required for all rockfall protection systems, which include clearing the catchment area of rockfalls and fallen trees and repairs to the structures.

High level estimates of costs are provided for comparison options only. Cost estimates assume that the water storage structure will comprise two 4 m tall and 4 m diameter tanks. Detailed design of the rockfall protection measure is required to determine more accurate costs. This includes a site reconnaissance to estimate the size and frequency of rockfall events and a rockfall analysis. This information is crucial in determining the geometry of the protection measure, and in turn the cost.

3.1.1 Soil or Rock Berm

A soil or rock berm is an effective rockfall protection measure, provided the required space is available. Soil berms are typically constructed from granular materials, which can be sourced on- or off-site. The height and width of the barrier depends on the size and trajectory of the boulders it is designed to retain. The drawback to berms as a rockfall protection measure is the amount of space required. Berms require a width of two to three times the height of the berm and a catchment area of at least several metres.

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Depending on the actual size and specific location of the water storage structure it may also be possible to design a rockfall deflection berm to direct rockfall around the structure.

Based on experience with recent projects, the cost to build a soil or rock berm is in the order of $60 per cubic meter. For a 4 m tall and 20 m long berm, the estimated cost is in the order of $60,000. It may be possible to use the local talus material to construct the berm, if the existing material is a suitable size, which would help to reduce the construction costs.

3.1.2 Modular Block Wall

A modular block or gabion basket wall is an effective rockfall protection measure, with a smaller footprint and cross-sectional area than a berm. Depending on the size and velocity of the anticipated boulders it is expected to retain, the modular block wall may be reinforced or unreinforced. Where rockfall is expected to have a kinetic energy of less than about 500 kJ, the modular block wall could possibly be unreinforced. Reinforcement comprising of a high tensile strength cable or back to back walls with geogrid is typically required for rockfall with a kinetic energy above about 500 kJ. A modular block or gabion basket wall would require a catchment width of at least several metres. The height of the barrier would depend on the size of the rockfall it is designed to retain.

A single modular block wall could cost in the order of $1,000 per square meter of wall face. For a 4 m tall modular block wall, the estimated cost is in the order of $110,000. We estimate that cable reinforcement could increase the cost by about 10% to 20% and back to back walls would be about double the cost.

3.1.3 Rockfall Fence

Rockfall fences could be designed for rockfall with kinetic energies in the range of 650 kJ to 3,000 kJ. Rockfall fences are designed to contain falling rock by significantly deforming to dissipate the rock's energy. The fence comprises a net that is suspended from posts and cables which are anchored into the ground and requires a minimum length of about 25 m for installation. The technical specifications of the fence components depend on the size and velocity of the expected rockfall.

The cost of the fence materials is estimated to be about $600 to $800 per linear meter. Installation costs would be in the order of $2,500 per linear meter. The estimated cost for a 4 m tall rock fall fence is in the order of $110,000. There are several local suppliers that could be contacted for high level pricing and to assess the feasibility of installing the systems.

- Geobrugg
- Trumer Schutzbauten
- Macafferri

4. FURTHER WORK

If moving the location of the water storage structure is not considered practical, it is recommended that a rockfall assessment be completed as part of the design phase. The assessment would determine a more reliable required setback distance if the water tank location could be adjusted and provide design options for appropriate protection measures. The work would include completing a site reconnaissance to determine the size of pre-existing rockfall on site and the frequency of occurrence and a detailed rockfall trajectory analysis using commercial software programs such as Rocfall2 or similar. This analysis would estimate the rockfall energy at impact and would allow the preliminary design of potential rockfall protection options.

5. CLOSURE

We trust this information meets your present needs. If you have any questions, please contact the undersigned.

Yours truly,
Thurber Engineering Ltd.
Stephen Bean, M.Eng., P.Eng.
Review Engineer

PROFESSIONAL
PROVINCE OF
D. M. AUSTIN
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BRITISH COLUMBIA
ENGINEER
2023-11-09

Thurber Engineering Ltd.
Permit to Practice #1001319

Dominique Austin, P.Eng.
Geotechnical Engineer

Attachment

- Statement of Limitations and Conditions
- Figure 1 – Plan View - Ortho imagery
- Figure 2 – Plan View – LiDAR
- Figure 3 – Cross Sections

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STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

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The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

Appendix A

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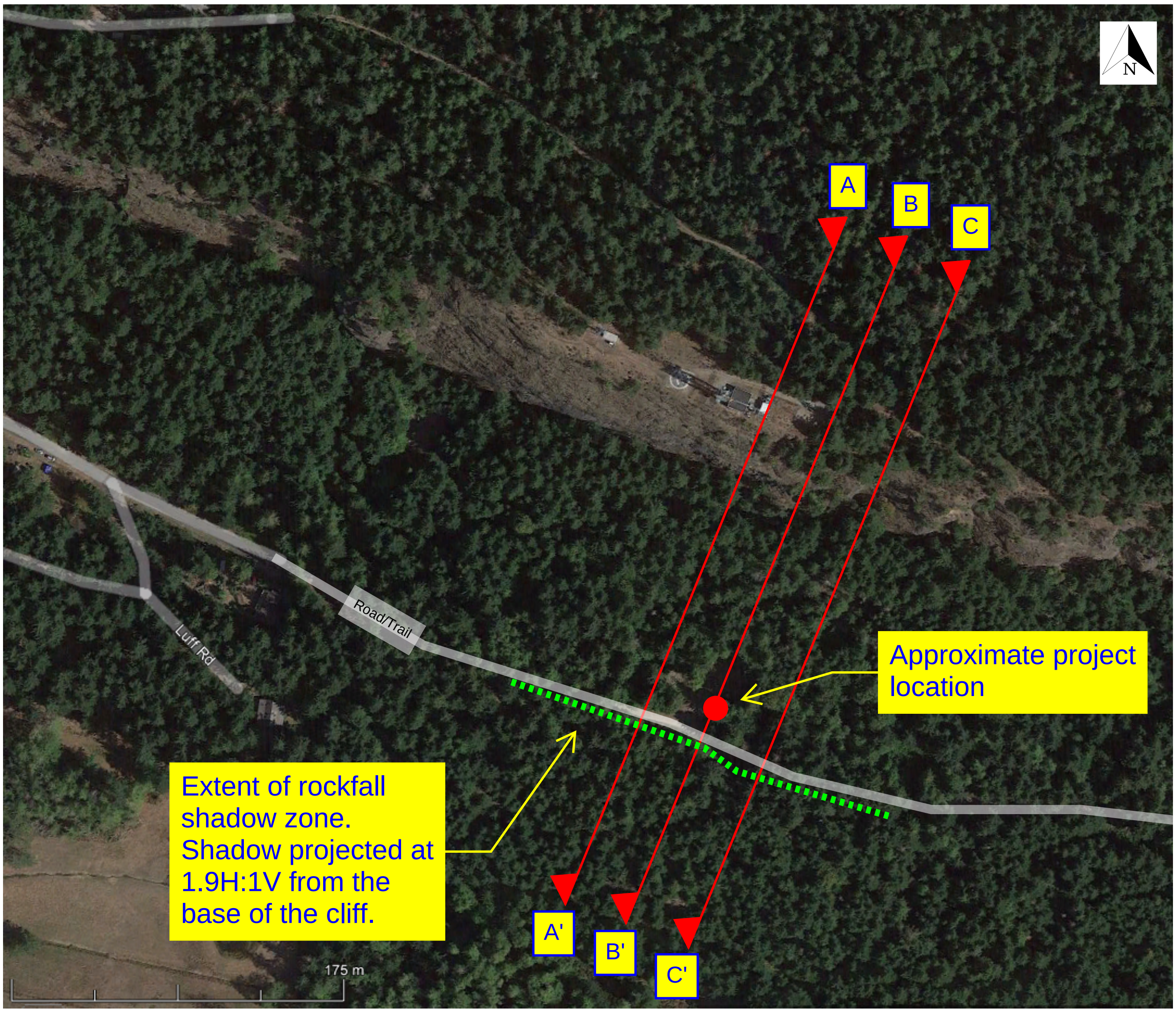

Figure 1 - Site Plan View - Orthoimagery

Section lines correspond to cross sections shown in Figure 3.

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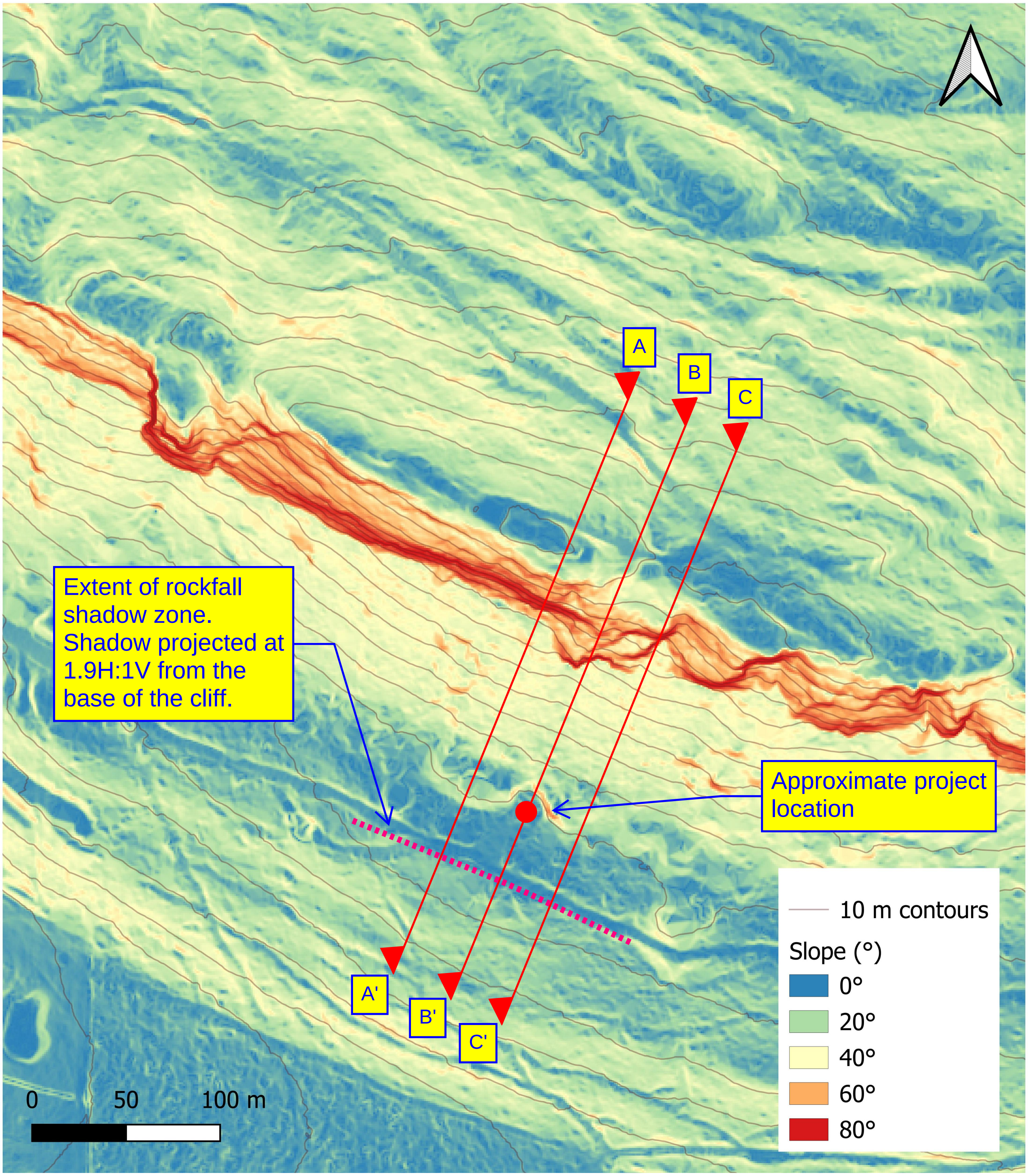

Figure 2 - Site Plan View - LiDAR

Section lines correspond to cross sections shown in Figure 3.

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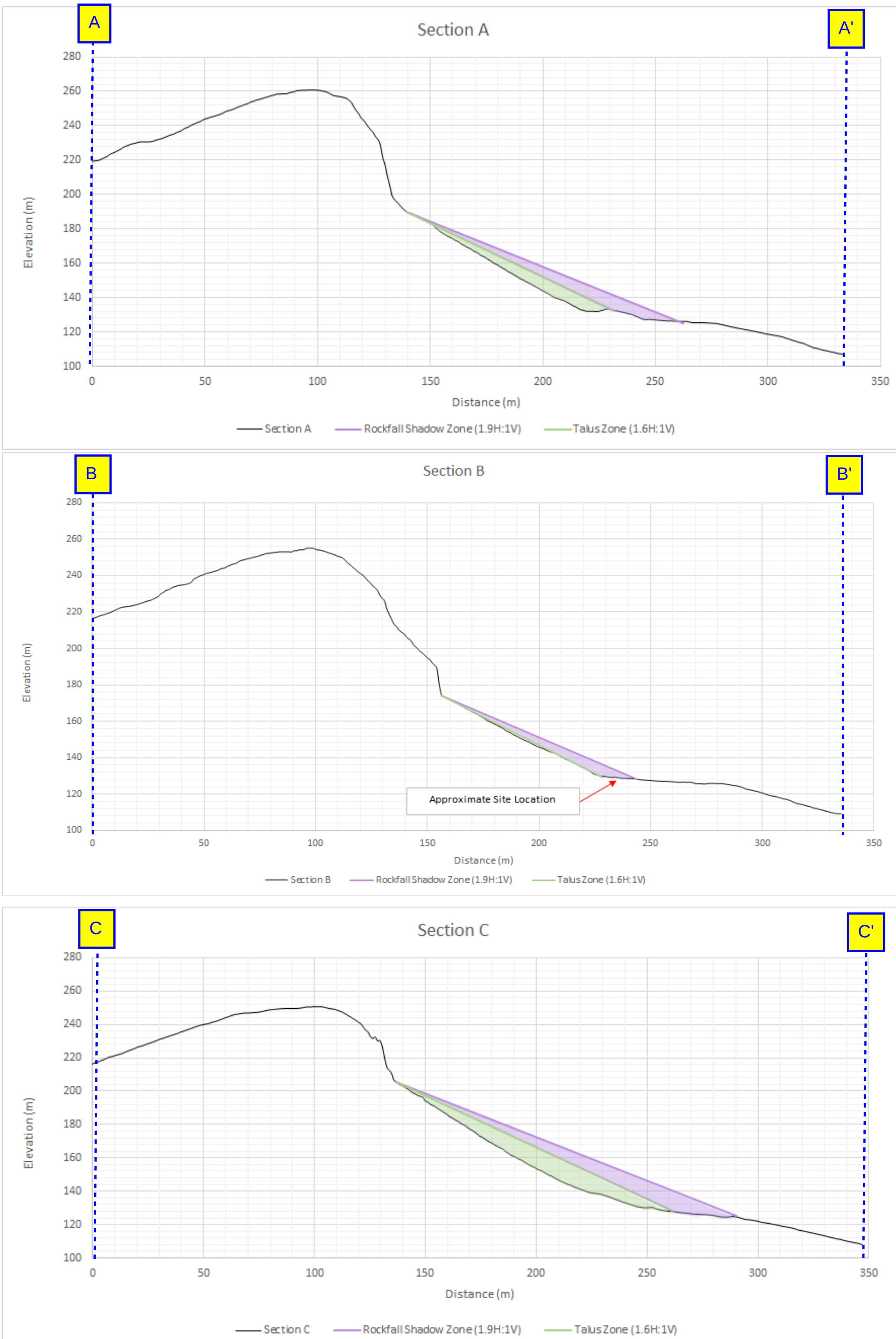

Figure 3 - Talus and Rock Fall Shadow Zones