

To: Chief Administrative Officer
From: Brendan Schneeberger, Planning Engineer
Subject: **State of Dikes**

Date: June 6, 2022

Recommendation(s)

This report is provided for information. No staff recommendation accompanies this report and Council action is not required.

Purpose

This report provides background information and a status update for the Fraser River flood protection system under the City's jurisdiction, highlighting deficiencies and current levels of protection, recent weather events, the latest studies, as well as planning that is underway.

Executive Summary

The City governs two dikes totalling 7.6 km within its border. There are three City-owned drainage pump stations (DPS) and one privately owned DPS that form part of the dikes. The Hatzic Lake area has another dike and DPS which are not under City jurisdiction.

The above infrastructure protects approximately 480 ha (1180 ac) of land within the City from flooding, primarily when the Fraser River rises from snowmelt in late spring (the "freshet"). Most of the dike systems are deficient, with issues such as being lower than design flood levels, and pumps not having enough capacity. Emergency/temporary diking is required if an extreme freshet occurs.

There are draft plans in progress to rectify the above issues, such as the Waterfront area raising riverside land with new development, and a potential new drainage development cost charge (DCC) to help fund items like DPS replacements. No dike upgrades have taken place since 2011.

Some areas in Mission are not protected by dikes and/or have buildings below flood levels, where specific land use planning and restrictions are applied for new development through City bylaws. The flooding on Hatzic Lake from the November 2021 atmospheric river rainfall event was influenced but not entirely caused by high Fraser River water levels.

City staff developed documents to guide preparedness for and response to Fraser River floods, and are currently planning to draft one for extreme rainfall events. A Flood Risk Assessment was completed by a consultant in 2021. The Drainage Master Plan portion of the Utilities Master Plans has a flood protection component relating to the DPSs.

Background

The City of Mission is a diking authority under the provincial Dike Maintenance Act. Despite this, any changes or new construction affecting dikes requires approval from the provincial Inspector of Dikes or their Deputies. The City is responsible for managing two dikes within its municipal boundary: Mission City Dike (3.5 km long), and the Silverdale Dike (4.1 km long). The Dewdney Dike and Hatzic Slough drainage pump station (DPS) protecting the Hatzic Lake area are not

under City authority but are discussed later in this report. The dikes protect areas that lie within the Fraser River floodplain, which for Mission can generally be defined as areas with elevation below approximately 10 metres above sea level (MASL, hereinafter 'm').

The City operates three DPSs that form part of the dike system; they are needed when the Fraser River rises above a certain level, typically only during the annual freshet. When the River water becomes higher than the watercourses behind the dikes, pumps are needed to lift the water up to the Fraser via pipes through the dike. One-way flaps, a kind of check-valve, are mounted on the ends of pipes to prevent Fraser water from flowing the opposite direction into the land side of the dike. These are often called flood boxes or flood gates, and they prevent creeks, ditches, and connected storm sewers from backing up and flooding land that would otherwise be usable. Mission has several flood boxes.

On watercourses that have consistent/significant flows, such as a creek, permanent DPSs are usually sited with flood boxes. For areas with minimal base flows that can store rainfall for several days, such as a deep ditch, allowance is made to use portable/temporary pumps only when needed. The City has two trailer-mounted diesel pumps for sewage that can also be used for this purpose; otherwise, all other pumping equipment needs to be rented. When Fraser River levels drop below ditch water levels, the flap gates automatically open back up, causing rain water to no longer need pumping over – or storage behind – the dikes.

Mission City Dike has one public DPS (Lane Creek) and one private (Junction Mall), which protect mostly industrial and commercial properties. Silverdale Dike has two public DPSs at Chester Creek and Cooper Avenue, which protect mostly agricultural property and Highway 7. The Cooper station is very small and essentially only protects two farms.

UNPROTECTED AREAS

The Ruskin and Silvermere Lake areas are not protected by Fraser River dikes, however are much less vulnerable than Hatzic Lake given that all homes are above approximately 6 m, which is no more than about 1 m below the old 1894 flood level in that area.

Silver Creek Industrial Park on Gill Avenue is not protected by dikes either, however the area still underwent substantial raising in preparation for when roads and servicing were brought in and completed around 2005. This met the standard at the time, which was to have building pads just above the old (measured) 1894 flood level, with no freeboard. Today it is still standard to let industrial buildings forego freeboard, but the new (modeled) 1894 flood is approximately 1 m higher than the old. The new level came into full force in 2008, less than two years after the first building started. To legally “grandfather” the in-stream development to the old flood level, a Local Exemption Area was established in the Floodplain Management Bylaw. This avoided challenges such as steep driveways that would have been required to meet building pads 1 m higher than originally planned.

Exemptions are only granted on a case-by-case basis, meaning that City staff encourage new buildings to meet the current flood levels if at all practical, and Council can deny exemptions. An example is a new building (JBS Equipment) on Fraserview Place finished in 2021, being about 1 m higher than an older building (CrossFit/Nu-Tea/Technaflora) on River Place finished in 2008. Exemptions require certain conditions per the Bylaw, such as an engineer’s certification, a restrictive covenant on title, as well as mechanical/electrical components being raised above the new flood level plus 0.6 m freeboard – the current Flood Construction Level (FCL).

There is another floodplain exemption area that includes Junction Mall, Mission Hills Mall, parts of Haig/Park/Wardrop Street, as well as all of Mission Way, Beatty Drive, and London Avenue west of Herman S Braich Boulevard. This area is different from Silver Creek Industrial Park in that it is inside the protection area of Mission City Dike and the associated two pump stations.

Some buildings are close to the FCL like Cineplex and Dairy Queen, while others are 3 to 4 m below it such as VIP Soap and Atlanta Flooring. Attachment A shows the Local Exemption Areas, as well as locates all DPSs.

Discussion and Analysis

DESIGN FLOOD LEVEL HISTORY

The highest Fraser River water levels on record reached approximately:

Year	Day	Level*
1894	June 5	7.92 m**
1948	May 31	7.61 m
1950	June 20	7.45 m
1972	June 17	7.15 m

* Unless otherwise indicated, elevations in the above table and the report hereinafter are at the Mission Gauge reference point, on the west side of the CP Rail bridge near Harbour Avenue. In high flow conditions, water elevations on the river are approximately 0.5 m higher than this point at Hatzic Slough, and 1 m lower at Stave River.

** Estimated with modeling to be 8.89 m if same flow event occurred today with current dikes and channel conditions

The highest level in recent past was 6.3 m on June 23, 2012. It is typical to see levels near 5 m during every year's freshet. Modeling done for the Province by NHC laid in a report dated December 2006 and titled '*Lower Fraser River Hydraulic Model*', as well as the City's Floodplain Management Bylaw adopted in 2008, considered the 1894 event to have a return period close to 200 years, so was referred to as the "200-year flood". A follow-up study completed by NHC for the Province, dated March 2008 and titled '*Fraser River Hydraulic Model Update*', determined it is more likely that the 1894 record freshet is approximately a "500-year flood", meaning that it has a 1 in 500 (or 0.2%) chance of occurring in any given year.

The current top of dike design elevation is 9.5 m, which was increased by ~1 m in 2007 from the old elevation of 8.5 m established in 1969. This was a direct result of the aforementioned 2006 NHC report. The old design elevation was based on the actual recorded water level in 1894, whereas the new is based on computer modeling of the same event but with changes to the floodplain since 1894, such as channel width constrictions due to constructed dikes. Both design elevations include 0.6 m of freeboard, defined as extra height to account for uncertainties in the modeling and other events such as waves and floating debris.

The City's Floodplain Management Bylaw 4027-2007 (Attachment A) was adopted in 2008 and mandates the above design flood protection level established by the Province in 2007, as its FCL. The corresponding profile published by the Province has also been used to establish the FCLs upstream and downstream of the Mission Gauge. Attachments E and F also show these FCLs.

DIKE CLASSIFICATIONS AND CONDITION

The Province classifies dikes by consequence of their failure economic impacts and threats to life safety. The last update was by Northwest Hydraulics Consultants (NHC) dated May 2019 titled '*BC Dike Consequence Classification Study*' which caused the Province to "downgrade" Mission City's dike by one point. The current ratings are as follows:

Classification	Dike
1 - Insignificant	
2 - Minor	
3 - Moderate	Silverdale

4 - Major	Mission City, Dewdney
5 - High	

In the future it is likely that Mission City Dike's classification will be upgraded back to '5 - High' when the Waterfront area undergoes significant redevelopment. If and when this dyke is classified as High, any new dike construction will have to meet additional seismic standards. The Waterfront Revitalization Master Plan (WRMP) has already assumed this in its preliminary dike design and cost estimates.

The Province also commissioned a study completed by NHC dated July 2015 and titled '*Lower Mainland Dike Assessment*'. Results indicate that all of Mission's dikes are sub-standard. Attachments B and C are mapping excerpts from that study, and are summarized below.

In terms of crest elevation (height of dike top in comparison to design flood level), the entire length of Silverdale Dike, as well as the eastern end of Mission City Dike, were rated as "Unacceptable"; the lowest score. This includes the recently (2011) upgraded 150 m section along Harbour Avenue which by itself is up to standard, but would still require nearly 1 km of emergency diking around it to actually achieve its full protection level. The other portions of Mission City Dike west of CPR were rated as "Fair"; a 3 out of 4 score.

In terms of average dike rating (a combined score with additional criteria regarding resistance to breaches such as width, erosion protection, and core material), all dikes within the City were deemed "Fair to Poor"; a 2-3 out of 4 score. Silverdale Dike does not have an impermeable core, nor is composed of engineered fill, resulting in a high risk of seepage and instability respectively during high freshets. Further, there is no erosion protection against the Fraser River, and one section is much too close to the bank. The dike is generally built to a lower agricultural standard, being too narrow and steep in many sections.

DEWDNEY DIKE AND HATZIC LAKE AREA

The Dewdney Dike is under authority of the Dewdney Area Improvement District (DAID). It is 12.2 km long total, only 1.5 km of which lies inside the City of Mission boundary, while the rest is within the FVRD Electoral Area G. The Mission portion runs southeast from the intersection of Dewdney Trunk Road and Highway 7, to the Hatzic Slough where a DPS and the municipal boundary is located. This DPS is also operated by DAID. The rest of protected land covers a much larger area in FVRD Area G and F.

The total usable (above ~3 m elevation) area within the City that is protected by this dike and DPS is approximately 126 ha (310 ac), broken down roughly as 85% ALR, 7% residential, and 8% railway/provincial highway right-of-way. Most of the homes are concentrated in the 51-lot residential subdivision of Benbow Street, Shook Road, Moore Avenue, and McKenzie Street, which was the area most affected by the record rainfall event of November 2021. DAID collects tax separately on all properties within the floodplain, including those within the City boundary, to fund flood protection activities such as dike and pump maintenance. For example, this levy is in the range of \$800 per year for a property on Benbow Street.

NOVEMBER 2021 ATMOSPHERIC RIVER

An atmospheric river event hit southwest BC in late fall 2021, causing 185 mm of rain to fall over Mission in two days; November 14 and 15. The event caused the Fraser to peak at ~5.5 m on November 15, 2021 (Attachment D). This was especially rare in that it caused river levels to rise to those only typical of the annual freshet occurring during May, June, or July largely caused by snowmelt. Usually the DPSs are not required to operate during fall/winter outside of freshet, but this time they had to, with pumps running at full bore. A second but less severe event hit less than two weeks later, causing 270 mm to fall over six days from November 25 to 30.

Although there was damage to property and infrastructure, the City of Mission fared relatively well compared to other areas, primarily due to the size of its creek watersheds that pass near development being smaller than required to create worst-case conditions for that specific event, and the size of the Fraser River watershed being much larger than the storm's coverage. Although statistically low probability, if an atmospheric river like this were to happen concurrently with a May/June Fraser River freshet, the results could be catastrophic. The snowmelt-induced freshet remains the event governing Fraser River dike design elevations, rather than an event like November 2021 which is unlikely (but not impossible) to occur near the summer.

Hatzic Lake Area Flooding

The area within the City's floodplain most affected by the 2021 atmospheric river was the Shook/Benbow Street residential subdivision on Hatzic Lake. Houses here are as much as 6 m (20 ft) below FCL, the lowest of which had approximately 1 m of water submerging the at-grade level. At least one dozen homes here had severe damage from floodwaters submerging their lower interiors.

Where a lot existed (subdivision was registered) before adoption of the Floodplain Management Bylaw in 2008 and is protected by a dyke, a new single-family dwelling can be constructed or added onto if:

- the underside of the floor system or any area used for habitation, business, or storage of goods damageable by floodwaters, is at least 2.5 metres above the surrounding ground elevation
- the owner enters into a Restrictive Covenant

Garages less than 110 m², foyers less than 12 m², as well as crawlspaces less than 1.5 m tall, do not have to meet the 2.5 m above grade requirement. This requirement has been implemented on all newer homes in the lake area, those of which were high enough to avoid flood damage in 2021.

Large areas from the City drain into the Hatzic Lake, including Draper Creek whose catchment extends nearly to the eastern boundary of Cedar Valley. The Hatzic Slough is the outlet of the Lake and has a DPS before its mouth into the Fraser River. This DPS forms part of the Dewdney Dike and was upgraded in 2014 with three pumps being added. There were several factors potentially contributing to the flooding, including inadequate capacity of the DPS and upstream culverts under the CPR, as well as issues with pump on/off settings and flood box efficiency. City staff have initiated contact with DAID regarding the event, but more investigation and collaboration is needed. Staff will keep lines of communication open with DAID and participate in meetings where appropriate, possibly including FVRD and CPR.

Silverdale Flats Flooding

The agricultural areas on either side of Highway 7, between Silverdale Avenue and the dike, were partially flooded during the November 2021 storm. Although it is known that the Chester station's pumps could not keep up with the flow, there were likely other factors that contributed to the pooling water, such as:

- MoTI/CPR-owned culverts and ditches being too small and/or inadequately cleaned of debris/sediment,
- the private land being too flat and saturated to drain efficiently, as well as
- the Fraser River being higher than the ground on the land side of the dike, resulting in differential pressure to cause the groundwater table to rise near or above the surface.

EXISTING AND POTENTIAL FUNDING SOURCES

A diking levy is collected on properties that are protected by the Mission City and Silverdale dikes, per the following table:

Dike providing protection	Approx. area protected	No. of indiv. owners taxed for diking	Total diking tax (2021 levy) collected	Approx. revenue per hectare	2021 budget	Actual cost (2021) incl. DPSs & flood boxes
Silverdale	230 ha (570 ac)	11	\$1,325.00	\$6	\$55,475.33	\$74,516.03
Mission City	150 ha (370 ac)	143	\$120,564.85	\$804	\$79,624.82	\$85,287.08

Totals= **\$121,889.85** **\$135,100.15** **\$159,803.11**

As per above, tax collected for diking has been insufficient to cover actual costs, and the financial burden is dramatically lopsided against Mission City. Further, no surplus is being accumulated for future projects that go beyond regular operation/maintenance/repairs. The last noteworthy increase to a diking levy was when rates were approximately doubled for the Mission City diking area only, raising the total amount collected from approximately \$60,000 in 2006, to ~\$120,000 in 2007.

Potential funding from provincial/federal government such as grant opportunities will continue to be monitored by City staff, and where possible, pursued.

The Province's Development Cost Charges (DCC) Best Practices Guide states that lowland drainage improvements including diking and pump stations can be part of storm drainage DCC programs. Unlike other municipalities in BC, the City of Mission does not currently have a Citywide drainage DCC; rather, just one for Cedar Valley.

CURRENT PROCEDURES

City staff from Public Works conduct annual inspections of the dikes and flood boxes, while operators conduct tests and maintenance on the pump stations more frequently. A document prepared by City staff for monitoring and responding to emergency conditions arising from freshet high water levels, the Fraser River Flood Preparedness and Response Plan (Flood Response Plan), is updated internally every year. This Plan includes things like an emergency contact list, locations and specifications for temporary diking and pumping, timing of certain tasks based on river levels, and other procedures.

Staff from Mission Fire Rescue are currently drafting an Atmospheric River Emergency Plan in response to the November 2021 event.

RECENT DIKE IMPROVEMENTS

The latest major improvement to any Mission flood protection structure was in 2011 when a 150 m-long portion of the Mission City DiKe along Harbour Avenue was upgraded to meet current provincial standards, as well as provide a park and pathway. It was widened and raised to FCL, complete with an impermeable core and erosion protection. The cost of this project was approximately \$900,000, split between the City (32.1%), Province (30.6%), Federal Government (30.6%), and FVRD (6.7%). With the construction industry experiencing dramatic inflation since then, it is estimated the same project would be at least double the cost today.

In 2007 and 2009, three sections of the Mission City DiKe totalling approximately 1.8 km were upgraded, primarily by widening and raising the crest elevations ~1 m to meet the new FCL:

- 140 m just west of Mission Hills Mall (FreshCo) between Highway 7 and CPR
- 220 m just west of Junction Mall (Cineplex and Staples) between CPR and Highway 11
- 1450 m from the Raceway driveway (Dyke Road / Highway 11 offramp) across the Braich lands to the CPR train bridge

The two short sections west of the shopping malls were completed in 2007 by City crews, but did not include an impermeable core. The longer east-west section was completed in 2009 with funding from the provincial and federal governments, and included engineered features such as an impermeable core, as well as “toe blankets” to alleviate water pressure and control seepage.

REMAINING DIKE DEFICIENCIES

Attachment E and F show some of the major deficiencies remaining in the Mission City and Silverdale Dike systems respectively, including low points/gaps, narrow portions, and sections without proper ownership/right-of-way. For Mission City, the most significant inadequacies are the complete absence of a dike structure east of Horne Street, stretching nearly 0.8 km, as well as Lane Creek DPS being under capacity with its electrical equipment below flood level. For Silverdale, Chester Creek DPS has the same issues. Both dikes have long sections over private property without legal right-of-way.

The lowest gap in the Mission City Dike is at the foot of Horne Street on the south side of Harbour Avenue where the ground elevation where a dike should be is as much as 2.2 m below FCL. Installing a temporary flood wall here, consisting of lock blocks, gabion bags, poly sheeting, and sandbags, is part of the City’s current Flood Response Plan. In 2007 and 2012, this was done as a precaution when river levels were projected to crest above 6 m.

The Silverdale Dike has a crest elevation significantly lower than the current FCL, with most of it being at ~8 m elevation, or approximately 1 m below the current FCL. In addition, there are several gaps lower than this that would need to be temporarily diked to achieve even that level of protection. The most notable gaps are on either end of the dike where it meets Highway 7 and CP Railway; two temporary flood walls would be required to cross all 4 travel lanes and the 2 side-by-side train tracks, blocking and thereby closing a 3 km stretch of these key corridors.

FUTURE PLANS AND RECENT/UNDERWAY STUDIES

Waterfront Superdike

The WRMP project team and consultants have planned a “superdike” that would essentially raise all developable land south of Highway 11 between the Dyke Road offramp in the west, and the CPR tracks in the east, to at least the FCL. This would be complete with erosion protection and a full replacement of Lane Creek DPS. If accomplished, these future projects would bring the vast majority Mission City Dike up to standard, with the exception of some areas that will require temporary diking (e.g. sandbags) regardless but can be achieved quickly in an emergency, such as the railway crossing low point at the southwest corner of FreshCo. The WRMP team is currently investigating possible funding sources and exploring potential strategies for phased construction of the above-mentioned superdike and related components.

Waterfront North Area – Proposed Floodplain Exemption

The WRMP is recommending future extension of the London Avenue floodplain exemption area (previously described) to the east from approximately Bridge Street to Thompson Avenue, covering the areas north of Highway 11 and south of CPR that will not be comprehensively filled as part of the superdike. This area totals approximately 16 ha (40 ac) and would still have a strong level of protection especially resistant to breaches due to the significant width of the future superdike, which is planned to include the future replacement of Lane Creek DPS.

It is not the intention of the WRMP to implement the above-mentioned future exemption area without first completing improvements to the flood protection system. Once the improvements are made, the restrictions of the new exemption area could be tailored to allow delivery of the WRMP land use plan, such as allowing more fulsome commercial use on the ground level below FCL, but still preventing uses/items that are especially damageable by floodwater to be below FCL, such as dwelling units, electrical switchgear, and furnaces. All of this would require amendment to the Floodplain Management Bylaw, and is subject to legal review.

NHC 2021 Report: 'Flood Risk Assessment and Mitigation'

The City retained NHC in 2020 to prepare a Flood Risk Assessment, delivered in late 2021. This was funded entirely by a successful grant application from UBCM. Aspects of the project included but were not limited to:

- technical review of the proposed Waterfront superdike and floodplain exemption area
- legal review of the Floodplain Bylaw with recommended possible amendments
- results for different flood scenarios/events (e.g. ponding depths in Attachment G)
- damage quantification (e.g. number of buildings flooded, dollar value damage estimates)
- recommended flood mitigation methods for different areas (e.g. structural measures vs. land use restrictions, list of temporary diking products), and
- a summary of studies to date (e.g. potential effects of climate change on the freshet).

Silverdale Agricultural Area

NHC recommends in the above-mentioned report that for the Silverdale agricultural area, “flood risk is managed in this area through non-structural measures such as land use planning . . . and emergency preparedness for existing occupants”. They also state that “more extensive raising of the [Silverdale] dike is low priority based on the limited development protected by the dikes and high cost”. Extensive raising of the dike to FCL would not solve the problem of the CPR and Highway 7 being the low points on either end; 3 km of Highway 7 would still have to be closed to achieve this higher level of protection, via temporary dikes on either end. The dike is currently at a level that can still provide protection against events that are relatively rare (e.g. 50-year return period), such as the 1972 freshet. However, at this level or higher, dike failure is likely. This dike should not be considered reliable for protection against events greater than the 50-year flood.

Drainage Master Plan

The drainage portion of the Utilities Master Plans, puts forward a potential strategy to at least retrofit all three public DPSs. Order-of-magnitude cost estimates have also been completed for potential full replacement of them. The stations are currently under-capacity, below dike/highway levels, and their pumps are not fish-friendly. Chester and Lane DPS have the most benefit of full replacement and raising to FCL, and Cooper does not require fish-friendly pumps. It appears that upgrading the Chester station would provide good value in terms of flood protection for the Silverdale Dike protection area, more so than comprehensive raising/widening of the dike berm. An example of this is on the east side of Nelson Street at its intersection with Highway 7, where a 20-acre industrial park and 9-acre auto mall are proposed. These developments are being filled to levels above the current dike, so will not rely on it for protection of their buildings, but will still rely on the pump station to drain storm sewers in their roads during the typical freshet.

The WRMP is carrying out a conceptual design for a new Lane Creek DPS complete with an order-of-magnitude cost estimate and is anticipated to recommend it be a DCC project delivered through a new Citywide drainage DCC program.

NEXT STEPS

City staff plan to continue to work on this issue and will update Council in the near future to provide more information on and develop plans, options and/or recommendations for:

- A potential workshop with Council regarding diking and flood protection;
- Funding requests for engineering study and cost estimation;
- Grant application recommendations or approvals for improvements such as local dike gap filling, purchasing of portable pumping equipment and temporary dam materials;
- Areas not protected by dikes such as Ruskin, Silvermere Lake, Sun Valley Trout/Trailer Park;
- Hatzic Lake after more discussion with DAID/FVRD/CPR;
- Options and recommendations regarding diking levy/tax;
- Amendments to the Floodplain Management Bylaw; and
- Updates of the Flood Response Plan.

Once all damages from the November 2021 storm are repaired (e.g. Wren Street road rebuild), staff plan to bring a report to Council summarizing the damages and total costs from that specific event. An attempt will be made to gather the same information for private property as well, and pair the report with the previously mentioned Atmospheric River Emergency Plan.

Council Goals/Objectives

This report aligns with Council objectives for a safe community and to secure finances, assets, and infrastructure.

Financial Implications

There are no financial implications associated with this report.

Communication

No communication action is required.

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Reviewed by:	Allen Xu, Manager of Engineering Planning and Assets
Reviewed by:	Tracy Kyle, Director of Engineering and Public Works
Approved for Inclusion:	Mike Younie, Chief Administrative Officer

Attachments

Attachment A:	Floodplain Management Bylaw - Schedule A
Attachment B:	2015 Dike Assessment Rating - Crest Elevation
Attachment C:	2015 Dike Assessment Rating - Average
Attachment D:	2021 Mission Gauge Levels
Attachment E:	Dike Deficiencies - Mission City
Attachment F:	Dike Deficiencies - Silverdale
Attachment G:	2021 Flood Risk Assessment - Ponding Depths