



To: General Purposes Committee

Date: June 9, 2023

From: Milton Chan, P.Eng
Director, Engineering

File: 10-6060-01/2023-Vol
01

Re: Fraser River Freshet and Flood Protection Update 2023

Staff Recommendation

That the staff report titled “Fraser River Freshet and Flood Protection Update 2023”, dated June 9, 2023, from the Director, Engineering be received for information.

Milton Chan, P.Eng
Director, Engineering
(604-276-4377)

Att. 2

REPORT CONCURRENCE		
ROUTED TO: Public Works	CONCURRENCE <input checked="" type="checkbox"/>	CONCURRENCE OF GENERAL MANAGER
SENIOR STAFF REPORT REVIEW	INITIALS: 	APPROVED BY CAO

Staff Report

Origin

As detailed in the Flood Protection Management Strategy 2019, the City of Richmond is situated approximately 1.0 metre above sea level and flood protection is integral to protecting the health, safety, and economic viability of the City. Richmond is protected from flooding by infrastructure that includes 49 kilometers of dikes, 595 kilometers of drainage pipes, 61 kilometers of box culverts, 155 kilometers of watercourses and 39 drainage pump stations.

This report provides Council with a summary of the 2023 Fraser River freshet, along with an update on 2022 rainfall statistics and ongoing works regarding the City's Flood Protection Program.

This report supports Council's Strategic Plan 2022-2026 Focus Area #3 A Safe and Prepared Community:

Community safety and preparedness through effective planning, strategic partnerships and proactive programs.

3.1 Advance proactive, sustainable, and accelerated flood protection in collaboration with other governments and agencies.

3.3 Ensure the community is collectively prepared for emergencies and potential disasters.

3.4 Ensure civic infrastructure, assets and resources are effectively maintained and continue to meet the needs of the community as it grows.

Analysis

2023 Fraser River Freshet

May 2023 was the hottest May on record for B.C. and generated extremely rapid melt of the provincial snow pack resulting in an early onset of the spring Freshet. The peak Fraser River flow measured at Hope was 9,130 m³/s, which is between a 2-year and a 5-year return period event (peaks in 2019, 2020, 2021, and 2022 were 7,200 m³/s, 10,800 m³/s, 9,800 m³/s, and 10,400 m³/s, respectively). Fraser River water levels began receding on May 21, 2023 and have attenuated since.

The City's diking system is built to withstand a 500-year return period freshet event and there was no danger of flooding in Richmond during the 2023 freshet. The City continues to be a leader in flood protection planning and mitigation through Council-endorsed capital projects and the annual dike maintenance program. Predicted climate change impacts, which include more extreme weather events, could result in an increased variability in freshet flows in the future, reinforcing the need for the City's continued flood protection upgrade program.

2022 Rainfall

Significant Rainfall Events

Attachment 1 identifies the total annual rainfall over the last 10 years. Rainfall highlights for 2022 include the following:

- The City received approximately 1,192 mm of rainfall in 2022, which is 5% lower than the average annual rainfall (over the last 10 years);
- January was the wettest month of the year, with 238 mm of rainfall at Hamilton Community Centre and 207 mm of rainfall at Fire Hall No. 7. This accounts for 18% and 26% of the total annual rainfall at Hamilton Community Centre and Fire Hall No. 7, respectively;
- A total of 14 significant events with statistical return periods of two years or more were recorded in 2022. Seven of these were a two year return period event. The total number of significant events in 2020 and 2021 were 11 and 8, respectively.

The City's drainage system is designed to withstand a 10 year return period rain event. The drainage system performed well during 2022 rainfall events.

November 2021 'Atmospheric River' Initiatives

Since the November 2021 'Atmospheric River Event', staff have undertaken a number of initiatives to assess and improve the City's drainage system based on observations from the event. Some of the completed initiatives include the following:

- Development and distribution of communications material to provide residents with information on how to better protect their property during extreme rain events and how to properly maintain private drainage infrastructure.
- Coordination with the Ministry of Transportation and Infrastructure (MoTI) to facilitate drainage infrastructure maintenance, including drainage canal cleaning and removal of beaver dam blockages along the Highway 99 corridor.

Some of the ongoing initiatives include the following:

- Assessment of the need for a new drainage pump station at Steveston Highway and Shell Road to further improve drainage in the Horseshoe Slough catchment. A temporary pump station is ready to be deployed ahead of future rainfall events, as necessary.
- Survey and assessment of the drainage infrastructure at the Highway 99/91 interchange to identify drainage patterns and potential capacity issues.
- Development of an operational work plan for future extreme rainfall events.

- Continued coordination with MoTI on preventative maintenance of the interconnected City-MoTI drainage infrastructure and identifying opportunities for drainage upgrades as part of the Fraser River Tunnel Project.

Continuing to invest in upgrades to the drainage and flood protection system will help ensure that the City can withstand these future storms.

Drainage System Performance

361 service requests related to drainage issues were recorded by Public Works in 2022. The requests are consistent with the average annual number of service requests received over the past 10 years, as identified in Attachment 2.

2022/2023 Winter Storm Events

December 2022 King Tide Event

On December 27, 2022, water levels surrounding Richmond reached close to record high levels as a result of a king tide combined with a significant storm surge event. The City also received over 25 mm of rain on that day. Water levels measured by the Steveston tide gauge that day came within 30 mm of the highest recorded water level in this location from December 1982.

Lulu Island

Overall, Lulu Island's flood protection system performed well. However, some localized flooding occurred in low lying areas located outside of the City's dike, including London Landing, marinas near the Moray Channel Bridge, and waterfront properties along 17000 and 18000 block River Road. Water levels remained below the City's dike elevation throughout the event and emergency flood protection measures were not required on Lulu Island or Sea Island.

Mitchell Island

On Mitchell Island, a section of Mitchell Road and several low-lying properties flooded during the event. The peak tide elevations were higher than the land elevations of some of the low-lying private properties to the east of the north/south segment of Mitchell Road, resulting in water flowing onto the island through these private properties. The southern end of Mitchell Road and the City's drainage pump station remained above river levels and the pump station was not impacted.

Staff were deployed to clear the impacted area and sandbags were set up along the Mitchell Road as a temporary measure to prevent any future instances of flooding during the storm season. Subsequently, a survey of Mitchell Road and perimeter of the impacted properties was completed by the City to better understand the ground elevations and prepare for flood protection measures. The City also installed a camera overlooking the Fraser River to monitor the river levels. Staff are also working directly with the property owners impacted by this incident to identify solutions and encourage construction of private flood protection infrastructure on low-lying properties.

The perimeter of Mitchell Island is primarily private property. There is no perimeter dike and the City does not have access rights to construct a dike or similar flood protection measures around the island perimeter. The City's Dike Master Plan Phase 5, endorsed by Council in 2019, identifies raising roadways to a 4.7 metre dike elevation to provide an emergency egress, acquiring rights-of-ways along the river bank through redevelopment, and establishing policies to require land raising and construction of a superdike on Mitchell Island through development as a part of the long term flood protection program for Mitchell Island. Long-term flood protection upgrades, including road raising across Mitchell Island, will be assessed and implemented through future capital and development-related projects.

Infrastructure Improvements

The City's flood protection system has a replacement value of \$2.2 billion, comprised of an extensive drainage network and 49 kilometers of perimeter dike. Staff are continuously upgrading and improving the system to address the impacts of infrastructure age and growth, and climate change.

Capital Dike Upgrades

Current climate change science estimates that sea level will rise approximately 1.0 m by the year 2100 and 0.2 m of land subsidence is forecasted over the same time period. The City's Flood Protection Management Strategy is the guiding framework for continual upgrades and improvements to the City's flood protection system. A key action identified in the City's Flood Protection Management Strategy involves continuing to raise the City's perimeter dike to 4.7 m in order to stay ahead of climate change induced sea level rise.

Currently approved dike improvement projects include the following:

- Design of North dike upgrades between Lynas Lane and No. 2 Road.
- Design of South dike upgrade between No. 4 Road and No. 5 Road.
- Design of South dike upgrade between No. 2 Road and Gilbert Road.

Funding to construct these dike upgrades will be secured through future capital projects which will be brought forward for Council consideration as part of the annual budget process.

Additionally, the preliminary design for the Steveston Island Dike was endorsed by Council for public and stakeholder engagement at the Regular Council Meeting on March 27, 2023 through the staff report titled "Steveston Island Dike Preliminary Design - Public and Stakeholder Engagement," dated February 8, 2023, from the Director, Engineering.

Dike Rehabilitation

Staff maintain annual inspection and maintenance programs to ensure that the City's dikes are well-protected against issues such as erosion and seepage. Notable inspection and maintenance work completed this year include the following:

- Enhancement of the flood patrol system with better defined thresholds for High Water Events and improved reporting processes in alignment with the Canadian Incident Command System (ICS).
- Responded to 11 high water events totalling 29 days of patrols during the winter storm and spring freshet seasons.
- Improved emergency accessibility to the dike by upgrading surface materials.
- Installed new steel gates at dike access points that were previously obstructed by concrete barricades and worn out wooden bollards, improving access to the dike during routine maintenance, dike patrols and emergency situations.
- Conducted vegetation removal along the dike slope in order to prevent unwanted growth which would otherwise compromise the structural integrity of the diking system.
- Acquired and stockpiled 3000 tonnes of emergency rip rap.
- Resurfaced 1000 meters of dike crest, improving usability and accessibility of the dike trails for residents.

Pump Station Upgrades

Significant progress has been made in upgrading the City's drainage pump stations to accommodate growth and climate change. The total capacity of the City's drainage pump stations has increased by 30% since 2005.

Over the last 20 years, since the City introduced the Drainage and Diking Utility, now the Flood Protection Utility, the City has rebuilt or upgraded 19 of its 39 drainage pump stations. The upcoming drainage pump station upgrade projects include No. 6 Road South, No. 9 Road, and Ewen Road pump stations.

During extreme events, a number of older pump stations operate near full capacity. These stations have been identified to require upgrades through capacity analysis. Projects to upgrade or replace these stations are either included in current capital program or will be brought forward for Council consideration as part of future capital program.

Box Culvert Repair and Preventative Maintenance

The City has approximately 61 km of box culverts, the majority of which are 40 to 50 years in age. Although the box culverts have a design life of 100 years, premature failure of some joints has been observed in recent years.

The City has a box culvert preventative maintenance program to inspect the condition of box culverts and identify sections that require repair or replacement executed in a 7-year cycle. Staff are proactively managing the condition of box culverts by identifying and repairing deteriorating joints before they cause significant damage. Repair of significant defects identified through the program are presented to Council for consideration as part of the capital program.

Staff inspected 5.0 km of box culvert within 12 drainage catchments in 2022. Results of each inspection are documented through written reports as well as images and video records, allowing staff to monitor changes to the condition of the box culverts, better informing long-term decision making. In 2022, no significant defects were encountered. Minor defects have been identified and remediated.

The City is currently working on the design and procurement for the rehabilitation of the No. 4 Road box culvert from Granville Avenue to Alderbridge Way. The rehabilitation will use conventional methods along with injection grouting to stop infiltration into the box and fill potential voids along the outside of the culvert.

The Gilbert Road North, Cambie Road, Shell Road North, and No. 2 Road South drainage catchment areas are scheduled for inspection in 2023.

Flood Protection Improvement Financing

Improvements to the City's flood protection system to address the needs of ageing infrastructure and climate change are funded through three main funding sources: Drainage and Diking Utility, Senior Government Grant Funding, and Development.

Flood Protection Utility

The Flood Protection Utility was established by Council in 2000 and currently generates \$18.0 million annually to maintain and upgrade Richmond's flood protection infrastructure. Staff are continuously monitoring regional and global climate change science to inform the City's Flood Protection Program.

At the April 12, 2021 Regular Council meeting, Council endorsed a target annual revenue level of \$30 million by 2031 for the Flood Protection Utility in order to support a 50 year implementation period to improve the City's flood protection infrastructure well in advance of anticipated climate change impacts.

To support this target, implementation of the new utility rates were included in the 2023 Utility Budgets and Rates report and endorsed by Council as a part of the annual budget process. The annual utility rate will continue to increase gradually until the target annual revenue is reached by 2031.

Senior Government Grant Funding

The City's Flood Protection Management Strategy aims to acquire senior government funding for a wide range of flood prevention and protection research, monitoring, studies, planning and improvements. As a result of proactive flood protection planning efforts, the City has been successful in securing approximately \$42 million in senior government grants since 2010 that helped fund over \$72 million of dike upgrades, pump station improvements and master planning updates. Since 2010, the City has completed approximately \$130 million in flood protection works.

Development

The City has successfully partnered with developers to secure dike upgrades through development. In particular, the City is actively pursuing opportunities to construct superdikes, where land supporting development behind the dike is filled to the same elevation as the dike crest. This eliminates visual impacts of a raised dike structure on waterfront views while providing an enhanced flood protection structure for the City.

Superdikes constructed through development to date include sections near the Richmond Olympic Oval, along the north dike near No. 4 Road, along the south dike at Riverport Way, and in Steveston. Superdike construction is underway by Western-Citimark and Vancouver Airport Fuel Facility Corporation.

Financial Impact

None.

Conclusion

The City observed the seventh highest annual rainfall over the last 10 years in 2022 and average freshet flows in the spring of 2023. The drainage and flood protection system performed well, with negligible freshet flood risk and an average number of drainage-related service requests.

Demands on the drainage and flood protection system will continue to increase as a result of climate change and development. The Flood Protection Management Strategy guides the City to proactively forecast, plan, and improve the City's flood protection system to meet long-term requirements. Through capital improvements and investment in preventative maintenance programs, the City is able to manage flooding risks and maintain a high level of service to Richmond's residents. Significant progress continues to be made in advancing the City's dike planning efforts and implementing infrastructure improvements to the City's flood protection system.



Eric Sparolin, P.Eng.
Manager, Engineering Planning
(604-247-4915)



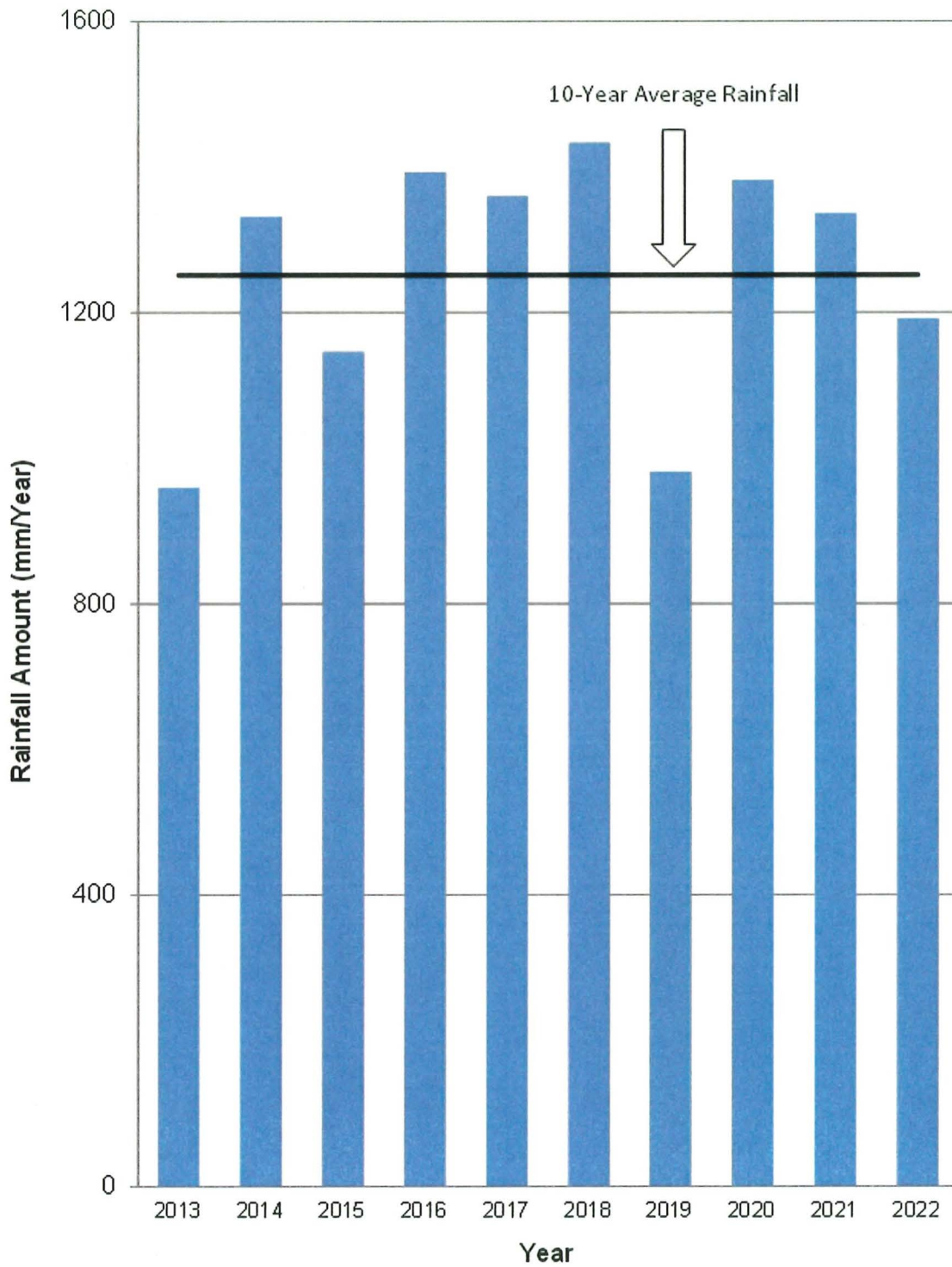
Angelica Quiring, EIT
Project Manager, Engineering Planning
(604-276-4026)



Ridhi Dalla, EIT
Project Manager, Engineering Planning
(604-204-8521)

- Att. 1: Annual Rainfall Data 2013 – 2022
2: Annual Drainage Service Requests 2013 – 2022

Annual Rainfall Data 2013-2022



Annual Drainage Service Requests 2013-2022

