



City of Richmond

Report to Committee



To: Public Works and Transportation Committee **Date:** June 23, 2017
From: John Irving, P.Eng. MPA **File:** 10-6060-03-01/2017-
Director, Engineering Vol 01
Re: Fraser River Freshet and Flood Protection Update 2017

Staff Recommendation

That the report titled "Fraser River Freshet and Flood Protection Update 2017" dated June 23, 2017 from the Director, Engineering be received for information.

John Irving, P.Eng. MPA
Director, Engineering
(604-276-4140)

Att. 3

REPORT CONCURRENCE		
ROUTED TO: Roads and Construction Sewerage and Drainage Parks Services	CONCURRENCE <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	CONCURRENCE OF GENERAL MANAGER 
	REVIEWED BY STAFF REPORT / AGENDA REVIEW SUBCOMMITTEE	INITIALS: 

Staff Report

Origin

The City of Richmond is approximately 1 m above sea level. The City is protected from the Fraser River and the Strait of Georgia by a system that includes 49 kilometers of dikes. Storm water is drained off Lulu Island through 581 kilometers of drainage pipes, 61 kilometers of culverts, 165 kilometers of watercourses and 39 storm drainage pump stations.

This annual report updates Council on 2016's rainfall, 2017's Fraser River freshet, ongoing works regarding the City's Flood Protection Strategy, incidents involving the City's flood protection system and completed or upcoming infrastructure improvement works.

This report supports Council's 2014-2018 Term Goal #6 Quality Infrastructure Networks:

Continue diligence towards the development of infrastructure networks that are safe, sustainable, and address the challenges associated with aging systems, population growth, and environmental impact.

Analysis

2016 Rainfall

Attachment 1 shows the total annual rainfall over the past 10 years. Rainfall highlights for 2016 include the following:

- Approximately 1,393 mm of rain fell on the City in 2016, which is 16% higher than the average annual rainfall and 21% higher than 2015.
- November was the wettest month of the year with 246 mm of rainfall.
- The rainiest day in 2016 was November 22, with 33 mm of rain over a 24-hour period.
- The most intense storm of 2016 was September 15 when sensors at Fire Hall #2 recorded a rainfall intensity of 35 mm/hr for a 30 minute period, which has a statistical return period exceeding 100 years.
- A total of ten significant storm events with statistical return periods of two years or more were recorded in 2016.

The City experienced higher than average rainfalls in 2016; however, the drainage system performed well and no capacity-related flooding issues were identified. While the drainage system was adequate for 2016, ongoing planning and upgrading are required to accommodate impacts of climate change and growth and to maintain current service levels.

2017 Fraser River Freshet

High snowpack in the Lower Fraser region, ranging from 120% to 150% of normal, combined with a wet and hot spring has led to high freshet flows in 2017. Flows in the Fraser River reached five-year return period levels, with a peak flow of 9,800 m³/s measured at Hope (peaks in 2015 and 2016 were 7,950 m³ and 9,000 m³ respectively). Fraser River water levels began receding as of June 15, 2017 and a return to high flows is unlikely based on forecasts by the River Forecast Centre.

The City's diking system is built to withstand a 500-year return period freshet event. Despite the significant freshet in 2017, river levels remained at a minimum of 1.5 m below dike crest elevations.

Drainage System Performance

273 service requests related to drainage issues were recorded by Public Works in 2016, approximately 25% below the annual average over the past 13 years, despite higher than average rainfalls in 2016. *Attachment 2* shows the total number of service requests related to drainage over the past 10 years.

Flood Protection Strategy Update

The City's efforts in the continuing upgrade and improvement of the City's flood protection system are guided by the 2008-2031 Richmond Flood Protection Strategy. Staff are commencing the Council approved comprehensive updating of the Flood Protection Strategy in 2017. A key action in this strategy involves preparing and implementing a comprehensive perimeter dike improvement program. The work is currently underway through various phases of a Dike Master Plan, each of which identifies a long-term upgrade strategy for a section of the City's dike.

Phase 1 of the Dike Master Plan addresses Steveston and the southern portion of the West Dike to Williams Road and was completed in 2013. Staff are currently engaging consultants to perform survey and geotechnical investigations to confirm the preferred alignment of the Steveston Dike along Steveston Island. In addition, the Phase 1 plan identified the potential to utilize sea berms as a breakwater fronting Sturgeon Banks to dissipate wave energy and reduce wave run-up. Staff will bring forward a feasibility assessment project as part of the 2018 capital planning process for Council's consideration to identify implementation costs and environmental and stakeholder concerns.

Phase 2 of the Dike Master Plan addresses part of the West Dike between Williams Road and Terra Nova Rural Park and part of the North Dike between Terra Nova Rural Park and No. 6 Road. Council adopted the recommendation for staff to consult with the public and key stakeholders at the regular Council Meeting on January 23, 2017. Public consultation is in progress and a finalized plan based on the feedback collected will be presented to Council in a subsequent report.

Phase 3 of the Dike Master Plan addresses the South Dike from London Heritage Farm to Boundary Road. Work on Phase 3 of the plan is ongoing and staff will update Council with findings of the Dike Master Plan – Phase 3 in 2018.

Infrastructure Improvements

The City's drainage and flood protection system is currently valued at an estimated \$1,451 million, comprising 581 kilometers of drainage pipes, 61 kilometers of culverts, 165 kilometers of watercourses, 39 pump stations and 49 kilometers of dikes. Staff are continuously upgrading and improving the City's flood protection system to accommodate the impacts of infrastructure age, growth and climate change.

Box Culvert Repair and Preventative Maintenance

The City has approximately 61 kilometers of large concrete box culverts, the majority of which are 40 to 50 years in age. Although the concrete culverts have a design life of 100 years, premature failure of some joints has been observed in recent years. Staff are proactively managing the condition of box culverts by identifying and repairing deteriorating joints early on.

In recent years, Council has supported a number of capital projects related to box culvert repairs:

- 2015: \$2,150,000 for the rehabilitation of a section of box culvert along No. 1 Road between Westminster Highway and River Road using a Glass Reinforced Plastic liner. The project was successfully completed in October 2016 and the lining effectively sealed all detached joints and maintained the structural integrity of the box culvert.
- 2016: \$2,000,000 for the replacement of approximately 50 m of settled box culvert at No. 2 Road near Walton Road that caused ground settlement in the vehicle lanes along No. 2 Road. Replacement of the damaged section of culvert was completed in February 2017.
- 2017: Inspection work conducted through 2016 and 2017 identified deterioration of the box culvert under No. 2 Road south of Steveston Highway. Council approved a \$3,700,000 budget for the City to undertake these repairs which will be done concurrently with the No. 2 Road Widening project. Repair work is expected to be completed in 2018.

As part of the 2017 Utility Budgets and Rates, Council supported the implementation of a box culvert preventative maintenance program to inspect the condition of the box culverts and identify sections that require significant repair or replacement. Maintaining a well-managed preventative maintenance program will enable more efficient repairs, fewer service and public disruptions, lower life cycle costs, and extension of the box culverts' life span. Staff have developed a plan to inspect the City's culvert network on a 3-year cycle. The program includes both structural and service condition inspection of the culverts and completion of minor repair work identified. Repair of significant defects identified through the program will be presented to Council for consideration as part of future capital programs.

Inspection work commenced in May 2017 in the Horseshoe Slough drainage catchment area. Results of each inspection are documented through written reports, photographs and video records, allowing staff to monitor changes to the condition of the culverts which will better inform long-term decision making. Minor defects have been identified and remediated, with no significant defects encountered to date. The Green Slough drainage catchment area is scheduled next for inspection.

Pump Station Upgrades

Significant progress has been made in upgrading the City's drainage pump stations to meet the ten-year return period storm and to accommodate growth and climate change. **Attachment 3** shows the total capacity of the City's drainage pump stations over the past 10 years. Over the last fifteen years, since the City introduced a dedicated utility funding, the City has rebuilt ten of its thirty nine drainage pump stations and has performed significant upgrades on a further four. Ageing infrastructure and capacity issues require that major upgrades be completed on six pump stations and minor upgrades be completed on twelve pump stations over the next ten years in order to meet the City's needs and mitigate flood risks. Re-construction of the Bath Slough Drainage Pump Station was completed in 2016 and re-construction of the No. 2 Road North Drainage Pump Station upgrade will be complete in the Summer of 2017. In 2016, the City received a \$16.6 million grant from the Province of British Columbia towards the \$25 million dike upgrades and the re-construction and upgrade of the following pump stations as part of the Flood Protection Program:

- Horseshoe Slough Drainage Pump Station
- No. 7 Road South Drainage Pump Station
- Shell Road North Drainage Pump Station
- No. 2 Road South Drainage Pump Station

Design of all four stations is underway and construction is scheduled for completion by the end of 2018.

Diking Improvements

Climate change scientists estimate that sea level will rise approximately 1.0 m by 2100 and 0.2 meters of subsidence is expected in that same time period. The 2008-2031 Richmond Flood Protection Strategy guides the City to raise dike crest elevations to 4.7 m geodetic (approximately 1.2 m above the current dike height) with the ability to further increase to 5.5 m geodetic to combat climate change induced sea level rise and ground subsidence over the next 100 years. As identified in the report to Council titled "Ageing Utility and Road Infrastructure Planning – 2017 Update", dike raising efforts should be completed within the next 75 years to stay ahead of sea level rise.

The City is actively completing dike upgrades through capital programs and is partnering with developments adjacent to the dike in completing dike upgrade works. **Figure 1** shows completed and upcoming dike improvement work for 2017 and 2018. Further dike improvements will be included in future capital plans for Council's consideration.

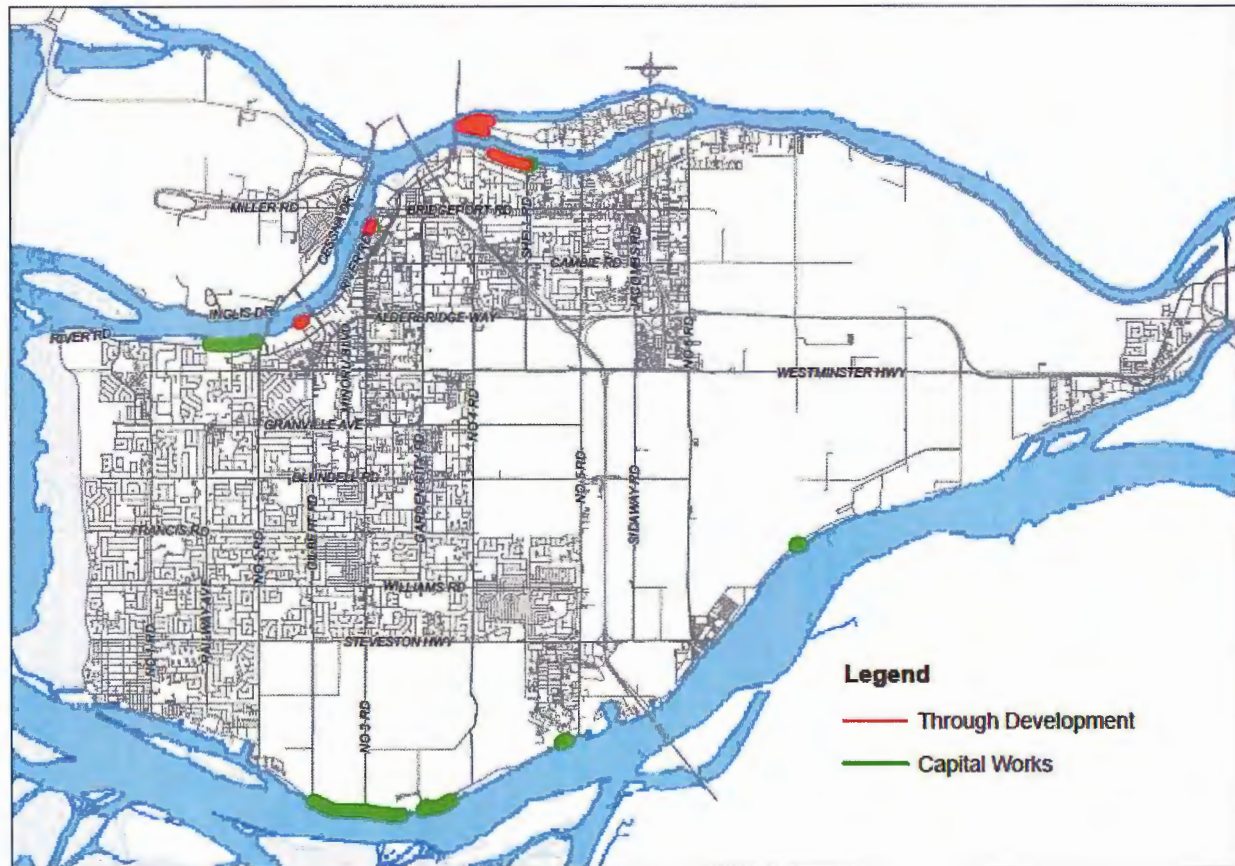


Figure 1 - Current and Upcoming Dike Improvements

The following dike improvement projects are underway through the capital program:

- South Dike between Gilbert Road and No. 3 Road – Design is underway and construction is expected to be complete by the end of 2018;
- Sections of dike adjacent to Horseshoe Slough Drainage Pump Station, No. 7 Road South Drainage Pump Station, and Shell Road North Drainage Pump Station – Design is underway and construction is expected to be complete by the end of 2018;
- South Dike between No. 3 Road and approximately 410 m east of the Woodward Slough South Drainage Pump Station – Design will commence in 2017 with construction to follow; and
- North Dike between 50 m east of the McCallan Road North Drainage Pump Station and 50 m west of the No. 2 Road North Drainage Pump Station – Design will commence in 2017 with construction to follow.

In addition to dike upgrades through the capital program, the City collaborates actively with developments adjacent to the dikes to synergize dike improvement work with development activities. 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. Construction of a section of superdike east of the Richmond Olympic Oval is underway, and a section of superdike will be constructed through development between Capstan Way and Sea Island Way.

Staff maintains annual inspection and maintenance programs to ensure that the City's dikes are well protected against issues such as bank erosion and seepage. Two issues were identified and addressed as part of this year's dike inspections:

- During pre-freshet dike inspections, staff identified an area at 19740 River Road where the North Arm of the Fraser River undermined trees fronting the dike. In May 2017, 69 cottonwood trees along the dike were removed and ground stabilization and erosion protection works were implemented to reinforce and protect the dike at this location.
- A dike inspection completed in early 2017 identified sloughing on the river side in a section of the south dike between the No. 9 Road right-of-way and the No. 9 Road Drainage Pump Station. Investigations identified that scour by the Fraser River is a likely cause for the sloughing. Staff are actively coordinating repairs and improvements to this section of dike, and will continue to monitor the conditions of this section of dike until the construction of improvement works are complete. Improvement works, including improved access for inspection and maintenance, removal of vegetation and improved scour protection, is scheduled for completion by the end of 2017.

Britannia Flood Protection System Improvement

The Britannia Shipyards National Historic Site is located outside of the City's diking system and is not protected by Richmond's dikes. The site is surrounded by an ageing timber bulkhead built below high water levels created by king tides combined with storm surge events, making it susceptible to occasional flooding. Flooding of the site occurred on March 10, 2016 when water levels at the Fraser River reached 2.4 m. Various options for improving the site's flood protection system were presented to the Steveston Historic Sites Building Committee in 2016. The recommended option includes construction of a plastic sheet pile flood wall built to an elevation of 2.9 m. Design work has been finalized and construction of the improvement works is scheduled to begin later in 2017 with completion in early 2018.


Financial Impact

None. Through the City's Drainage and Diking Utility, an annual amount of \$11.6 million is currently dedicated towards related infrastructure improvements.

Conclusion

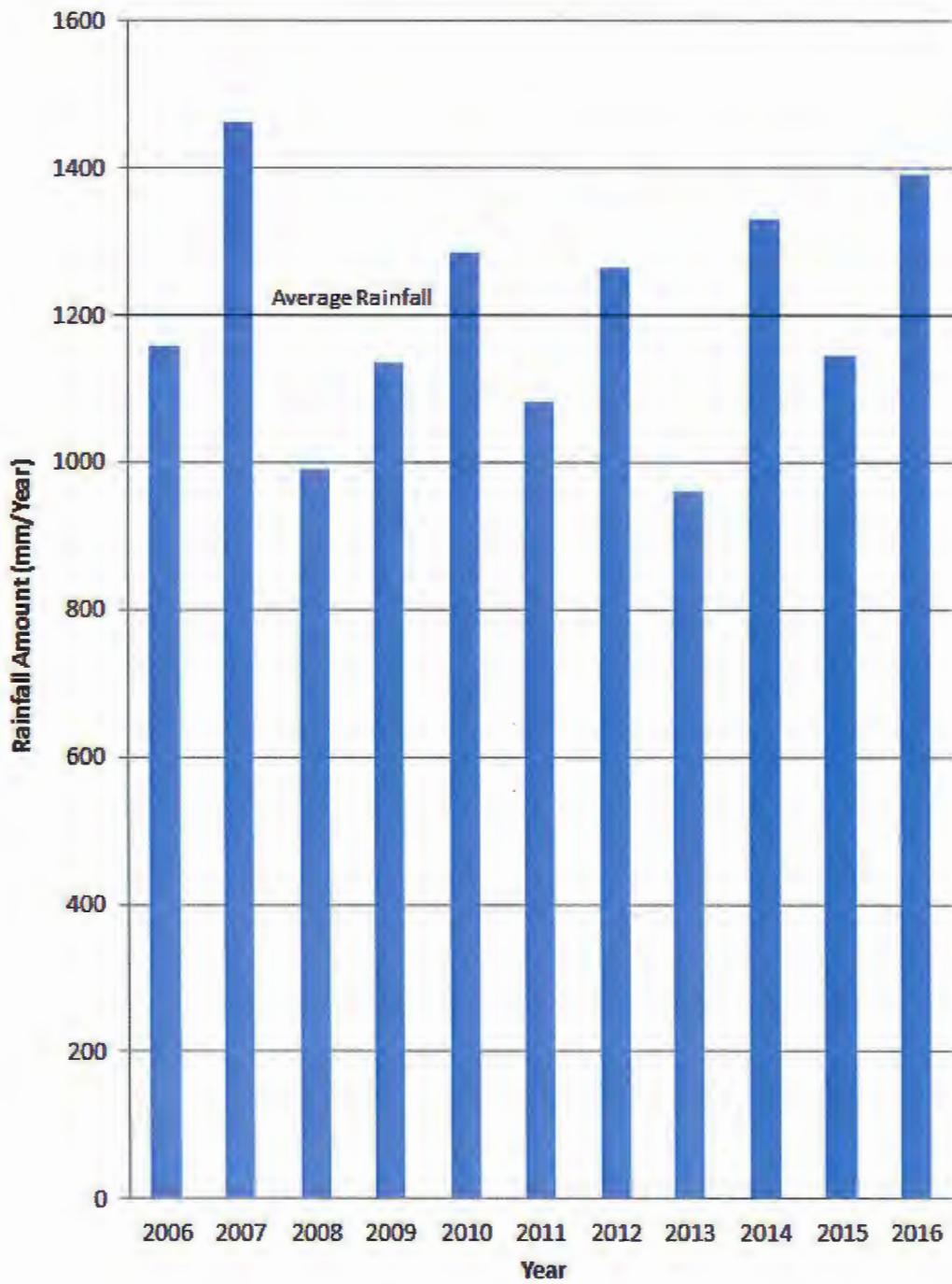
The City experienced higher than average rainfalls in 2016 and high freshet flows in the spring of 2017. Despite this, the City's drainage and flood protection system performed well, with a below average number of drainage-related service requests and a minimum 1.5 m freeboard maintained along the dike under freshet flows.

Demands on the City's drainage and flood protection system will continue to increase with pressures from climate change and development within the City. As such, proactive measures must be taken to forecast, plan and improve the system for long-term requirements. Richmond's drainage infrastructure is well developed, with computer based hydraulic models to forecast future capacity requirements. Long-range planning of the City's diking needs are addressed through the ongoing Dike Master Planning efforts. Through the capital improvements and investment in preventative maintenance programs, the City has developed the ability to proactively prepare and respond to flood related concerns. Significant progress has been made in 2016 and 2017 in progressing the City's dike planning efforts and implementing infrastructure improvements to the City's flood protection system.

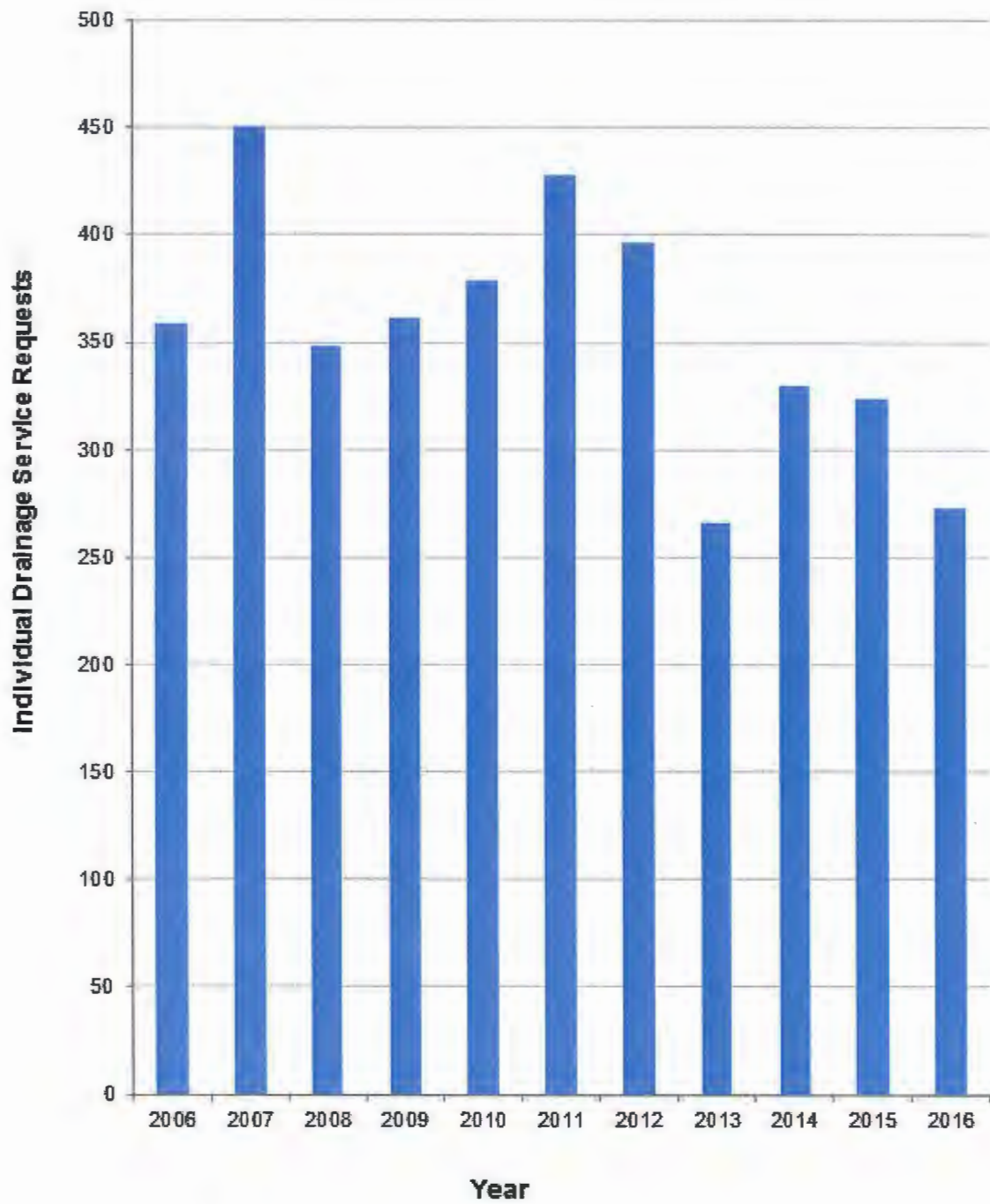

For Lloyd Bie, P.Eng.
Manager, Engineering Planning
(4075)

- Att. 1: Annual Rainfall Data
- Att. 2: Annual Drainage Service Requests
- Att. 3: Drainage Pump Station Capacity

Annual Rainfall Data



Annual Drainage Service Requests



Total Drainage Pump Station Pumping Capacity 2006-2016