



To: Public Works and Transportation Committee **Date:** July 9, 2018
From: Milton Chan, P.Eng.
Acting Director, Engineering **File:** 10-6060-01/2018-Vol
01
Re: **Fraser River Freshet and Flood Protection Update 2018**

Staff Recommendation

That the report titled “Fraser River Freshet and Flood Protection Update 2018” dated July 9, 2018 from the Acting Director, Engineering be received for information.

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

Att. 3

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

Staff Report

Origin

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

This annual report updates Council on 2017's rainfall, 2018's Fraser River freshet, ongoing works regarding the City's Flood Protection Management Strategy, incidents involving the City's flood protection system and completed or upcoming infrastructure improvement works.

This report also addresses the Public Works and Transportation Committee's request for information on the City's flood protection efforts and programs.

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

2017 Rainfall

Attachment 1 shows the total annual rainfall over the past 10 years. Rainfall highlights for 2017 include the following:

- Approximately 1,360 mm of rain fell on the City in 2017, which is 14% higher than the average annual rainfall and 2% less than 2016.
- March was the wettest month of the year with 237 mm of rainfall.
- The rainiest day in 2017 was December 19, with 47 mm of rain over a 24-hour period.
- The most intense storm of 2017 was February 9 when sensors at Richmond City Hall recorded a rainfall intensity of 23 mm/hr for a 1 hour period, which has a statistical return period exceeding 100 years.
- A total of five significant storm events with statistical return periods of two years or more were recorded in 2017.

The City experienced higher than average rainfalls in 2017. The drainage system performed well and no capacity-related flooding issues were identified. While the drainage system provides a high level of flood protection today, ongoing planning and upgrading are required to accommodate impacts of climate change and growth and to maintain current service levels.

2018 Fraser River Freshet

High snowpack in the Lower Fraser region, 125% of normal, combined with extreme spring temperatures led to high freshet flows in 2018. Flows in the Fraser River were approximately a ten year return period event, with a peak flow of 11,000 m³/s measured at Hope (peaks in 2016 and 2017 were 9,000 m³ and 9,800 m³, respectively). Fraser River water levels began receding on May 21, 2018 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 2018 freshet. The river's highest level remained at a minimum of 1.7 m below the dike crest at Boundary Road and 1.4 m below the dike crests at Bath Slough and No. 6 Road.

Drainage System Performance

355 service requests related to drainage issues were recorded by Public Works in 2017, approximately 10% below the annual average over the past 10 years, despite higher than average rainfalls in 2017. Attachment 2 shows the total number of service requests related to drainage over the past 10 years.

Drainage and Diking Utility

In 2003, Council endorsed the Drainage and Diking Utility and has annually increased funding levels from \$0.6 million to its current level of \$11.9 million. This dedicated source of funding is critical for supporting medium to long term drainage and diking infrastructure upgrades.

Flood Protection Strategy Update

The City's efforts in the continual upgrade and improvement of the City's flood protection system are guided by the 2008-2031 Richmond Flood Protection Strategy. Staff have commenced the Council approved comprehensive update of the Flood Protection Strategy and will bring forward a draft update for Council's consideration this fall.

A key action in this strategy is preparing and implementing a comprehensive perimeter dike improvement program. Phase 1 and Phase 2 of the Dike Master Plan have been completed and adopted by Council. Staff are currently working on the pre-design geotechnical investigation of Steveston Island for future dike construction. Additionally, Dike Master Plan Phases 3, 4 and 5 are scheduled for completion in early 2019.

Infrastructure Improvements

The City's drainage and flood protection system is currently valued at an estimated \$1.5 billion, comprising 581 km of drainage pipes, 61 km of culverts, 165 km of watercourses, 39 pump stations and 49 km 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 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. Staff are proactively managing the condition of box culverts by identifying and repairing deteriorating joints before they cause significant damage, including sink holes.

Since 2015, Council has supported a number of capital projects related to box culvert repairs. The most significant repairs include:

- 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 completed concurrently with the No. 2 Road Widening project. Repair work is expected to be completed by the end of this year.
- 2018: Council approved a \$1,500,000 budget for the repair of approximately 1600 m of deteriorated box culvert causing sink holes along No. 4 Road from Alderbridge Way to Granville Avenue. Repair work is expected to be completed by the end of 2019.

The Council supported box culvert preventative maintenance program that began in 2017 and received increased funding in 2018, inspects the condition of the box culverts and identifies sections that require significant repair or replacement. Maintaining a well-managed preventative maintenance program enables more efficient repairs, fewer service and public disruptions, lower life cycle costs, and extension of the box culverts' life span. The program inspects the City's culvert network on a 7-year cycle and identifies and repairs minor defects. 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 2017 in the Horseshoe Slough, No. 1 Road North and No. 1 Road South drainage catchment areas. 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 No. 4 Road North and McCallan Road North drainage catchment areas are scheduled next for inspection.

Pump Station Upgrades

Significant progress has been made upgrading the City's drainage pump stations to accommodate growth and climate change. Attachment 3 identifies the total capacity of the City's drainage pump stations over the last 10 years which has increased by 22% since 2008. Over the last eighteen years, since the City introduced the Drainage and Diking Utility, the City has rebuilt eleven of its thirty nine drainage pump stations and has performed significant upgrades on a further four.

Re-construction of the No. 2 Road North Drainage Pump Station upgrade was completed earlier this year. Re-construction of Horseshoe Slough Pump Station has commenced. No. 7 Road South, Shell Road North and No. 2 Road South will all begin construction late 2018.

Based on ageing infrastructure and capacity analysis, major upgrades on six pump stations and minor upgrades on twelve pump stations are recommended over the next ten years to improve the City's high level of flood protection. Pump station upgrades will be included in the 5 Year Capital Plan for Council's consideration.

Diking Improvements

Climate change scientists estimate that sea level will rise approximately 1.0 m by 2100 and 0.2 metres 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 in the future. 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 development for additional dike upgrades. Figure 1 identifies current and upcoming dike improvement work for 2018 and 2019. Additional dike improvements will be included in the 5 Year Capital Plan for Council's consideration.

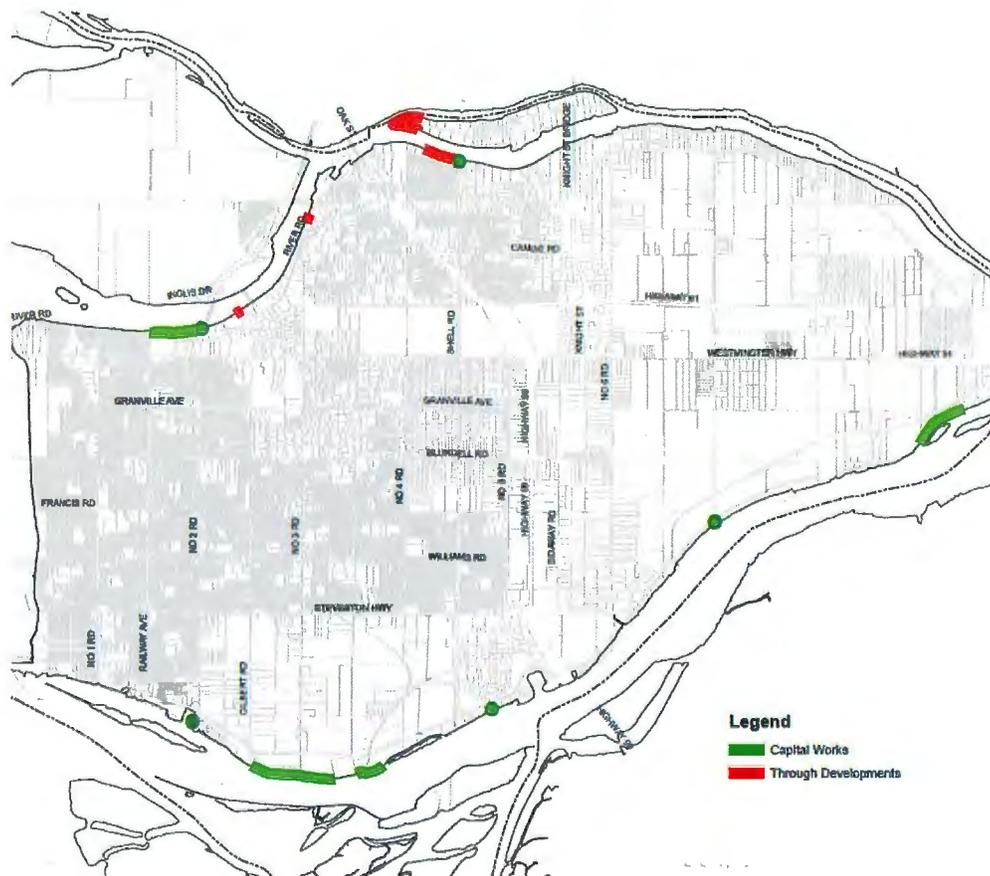


Figure 1 - Current and Upcoming Dike Improvements

The currently funded dike improvement projects include over 2.5 km and \$11 million in upgrades. These projects include:

- North Dike Upgrade from No. 2 Road to McCallan Road – Design is underway and construction is expected to be complete by the end of 2019.
- South Dike Upgrade between Gilbert Road and No. 3 Road – Design is nearly complete and construction is expected to begin late 2018 or early 2019.
- South Dike Upgrade between No. 3 Road and Finn Slough – Design is underway and construction is expected to be complete by the end of 2019.
- South Dike Upgrade between No. 9 Road and west of McMillian Way – Design is underway and construction is expected to be complete by the end of 2019.
- Horseshoe Slough Drainage Pump Station and sections of dike adjacent – Design is complete, construction began in Spring 2018 and is expected to be completed by Fall 2019.
- Shell Road North Drainage Pump Station and sections of dike adjacent to – Design complete and construction is expected to begin by the end of this year.
- No. 7 Road South Drainage Pump Station and sections of dike adjacent - Design is expected to be complete by fall of this year and construction to begin late 2018 or early 2019.

In addition to dike upgrades through the capital program, the City actively partners with developments adjacent to the dike 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 was recently completed, and a section of superdike will be constructed through development by 2021 between Capstan Way and Sea Island Way.

Staff maintain annual inspection and maintenance programs to ensure that the City's dikes are well protected against issues such as erosion and seepage. Significant maintenance issues addressed in 2017/2018 include:

- Staff identified sloughing in a section of south dike between the No. 9 Road right-of-way and the Ewen Road Drainage Pump Station. Vegetation removal, dike re-armouring and improved scour protection was implemented to reinforce and protect the dike at this location.
- Staff identified sloughing in a section of north dike between No. 4 Road North drainage pump station to 330 metres west. Dike re-armouring was implemented to reinforce and protect the dike at this location.
- Staff identified minor sloughing in a section of north dike near Terra Nova for 130 metres. Dike re-armouring was implemented to reinforce and protect the dike at this location.

- Staff identified minor sloughing in a section of south dike from Shell Road to 30m west. Dike re-armouring was implemented to reinforce and protect the dike at this location.
- Staff identified sloughing and deterioration of rip rap in a section of north dike for 500 metres in the 22,000 blk of River Road. Dike re-armouring was implemented to reinforce and protect the dike at this location.

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 was surrounded by an ageing timber bulkhead built below high water levels created by king tides combined with storm surge events, which made it susceptible to occasional flooding. The City constructed a plastic sheet pile flood wall clad in wood to match the existing timber bulkhead to preserve the important historic character of Britannia. The new wall was built to an elevation of 2.9 m earlier this year to protect the area from flooding.

Financial Impact

None.

Conclusion

The City experienced higher than average rainfalls in 2017 and high freshet flows in the early spring of 2018. The City's drainage and flood protection system performed well, with a below average number of drainage-related service requests and river levels remained at a minimum of 1.7 m below the dike crest at Boundary Road and 1.4 m below the dike crests at Bath Slough and No. 6 Road under freshet flows.

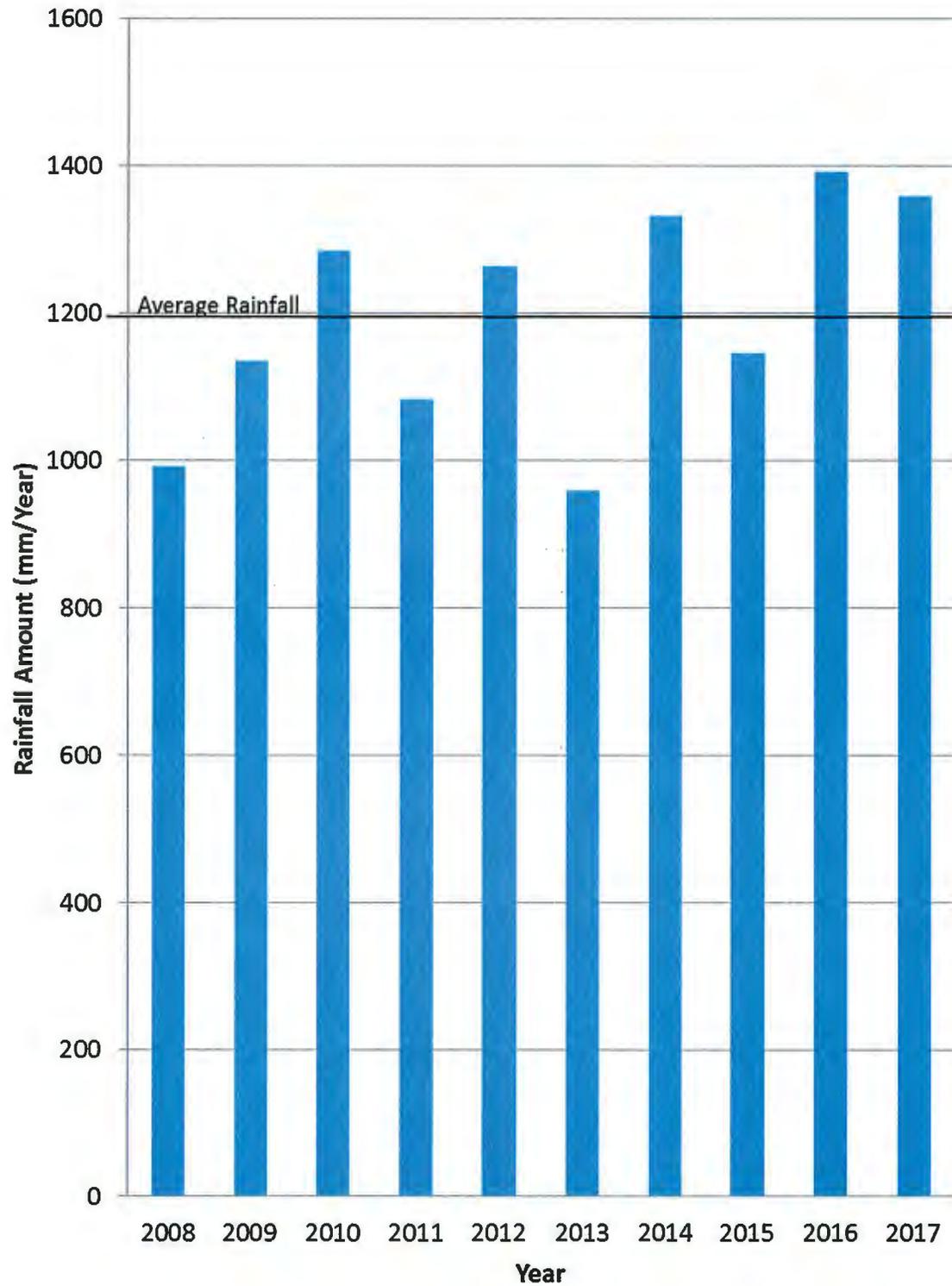
Demands on the City's flood protection system will continue to increase with pressures from climate change and development. The Flood Protection Strategy Update proactively guides the City to forecast, plan and improve the City's flood protection system to meet long-term requirements. Richmond's drainage 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 the last few years in progressing the City's dike planning efforts and implementing infrastructure improvements to the City's flood protection system.

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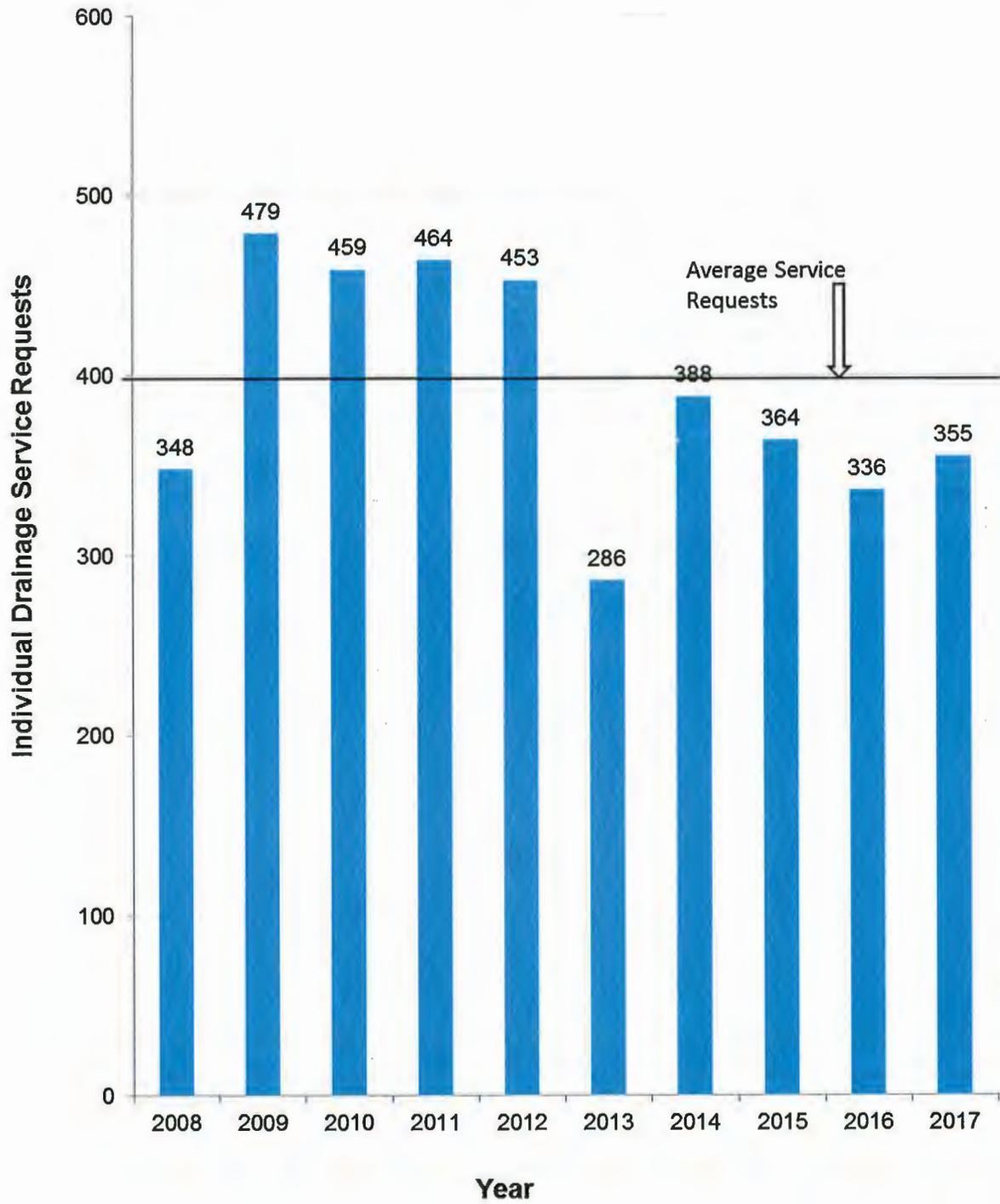
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- Att. 1: Annual Rainfall Data
- Att. 2: Annual Drainage Service Requests
- Att. 3: Drainage Pump Station Capacity

Annual Rainfall Data



Annual Drainage Service Requests



Total Drainage Pump Station Pumping Capacity 2008-2017

