



City of Richmond

Report to Committee

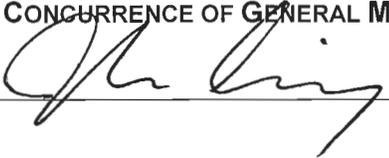
To: Public Works and Transportation Committee **Date:** June 25, 2019
From: Milton Chan, P.Eng.
Acting Director, Engineering **File:** 10-6060-01/2019-Vol 01
Re: **Fraser River Freshet and Flood Protection Update 2019**

Staff Recommendation

That the report titled, "Fraser River Freshet and Flood Protection Update 2019", dated June 25, 2019, from the Acting Director, Engineering be received for information.



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

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

Staff Report

Origin

The City of Richmond is situated approximately one metre above sea level and protected from the Fraser River and Strait of Georgia by infrastructure that includes 49 km of dikes. Storm water is drained from Lulu Island, Mitchell Island, and Sea Island through 585 km of drainage mains, 61 km of culverts, 165 km of watercourses, and 39 drainage pump stations.

This annual report updates Council on 2018 rainfall statistics, the 2019 Fraser River freshet, on-going works with respect to the City's Flood Protection Management Strategy, incidents involving the City's flood protection system, as well as completed or upcoming infrastructure improvement works.

Analysis

2018 Rainfall

Attachment 1 identifies the total annual rainfall over the past 10 years. Rainfall highlights for 2018 include the following:

- The City received approximately 1433 mm of rainfall in 2018, which is 16% higher than the average annual rainfall and 5% higher than 2017.
- January was the wettest month of the year, with 265 mm of rainfall.
- The rainiest day of 2018 was December 13, with 61 mm of rain over a 24-hour period.
- The most intense storm of 2018 occurred on October 28, when sensors at Richmond City Hall recorded a rainfall intensity of 18 mm/hr for a 1-hour period, which has a statistical return period exceeding 10 years.
- A total of 36 significant events with statistical return periods of two years or more were recorded in 2018.

In 2018, the City experienced the highest level of total rainfall since 2007, with 36 rainfall events that equaled or exceeded the 2-year return period. The frequency and intensity of rainfall events have been increasing in recent years, with multiple storms exceeding a 10-year return period intensity. This is consistent with predicted climate change impacts on local weather patterns and reinforces the need for the City's continued flood protection upgrade program.

Staff analysis of these storms and recent trends has led to an update of the Storm Intensity-Duration-Frequency criteria used for the drainage system design in Richmond. This will provide Richmond with more robust infrastructure to meet future needs.

Drainage System Performance

536 service requests related to drainage issues were recorded by Public Works in 2018, which is approximately 30% above the annual average over the past 10 years. This was primarily due to the near record high rainfall in 2018 and the 10-year storm on December 13, which caused localized surface ponding in the Shell Road North and Bath Slough catchments but no reported property damage. Public Works performed additional maintenance activities to clear the drainage system in response to this event, and the measures were effective and no localized flooding was recorded in the area for subsequent storm events.

Rain water is pumped off of Lulu Island, Mitchell Island, and Sea Island through 39 drainage pump stations throughout the City. To date, 11 pump stations have been re-built to modern standards with higher capacity and reliability. During the December storm event, a number of the older pump stations were operating 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 programs or will be brought forward for Council's consideration as part of future capital programs.

Attachment 2 identifies the total number of service requests related to drainage over the past 10 years.

2019 Fraser River Freshet

Low snowpack in the Lower Fraser region (68% of normal) led to low freshet flows in 2019. The peak flow in the Fraser River was 7,200 m³/s, measured at Hope. Peaks in 2017 and 2018 were 9,800 m³/s and 11,000 m³/s, respectively. Fraser River water levels began receding on June 3, 2019, 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 2019 freshet.

Drainage and Diking Utility

In 2003, Council adopted the Drainage and Diking Utility and has annually increased funding levels from \$0.6 million to its current level of \$12.1 million. This dedicated funding source is critical for supporting medium- to long- term drainage and diking infrastructure upgrades. Ongoing growth of the Drainage and Diking Utility will be critical to support the funding of future capital projects.

Senior Government Funding

In recent years, the City has been successful in receiving senior government grants, which include:

- Public Safety Canada National Disaster Mitigation Program (NDMP) – Flood Protection Strategy Update (\$500,000)
- Public Safety Canada NDMP – Steveston Island Flood Mitigation Planning (\$1.2M)

- UBCM Community Emergency Preparedness Fund – Dike Master Plan Phase 5 (\$150,000)
- Infrastructure Canada Disaster Mitigation Adaptation Fund – Dike Upgrades / Pump Station Replacements (\$13.8M)
- BC Flood Protection Program – Pump Station Upgrades (\$16.6M)
- Emergency Management BC NDMP – No. 3 Road / Steveston Highway Drainage Pump Station (\$1M)

Staff will continue to pursue grants from the above sources as well as explore other grant funding opportunities to supplement the Drainage and Diking Utility, as the City works towards implementing the initiatives of the Flood Protection Management Strategy, which includes increasing drainage system capacity and raising dikes.

Flood Protection Strategy Update

The City's efforts in the continual upgrade and improvement of the flood protection system are guided by the Richmond Flood Protection Management Strategy 2019, which was adopted by Council in June.

A key action in this strategy is preparing and implementing a comprehensive perimeter dike improvement program. Dike Master Plan Phases 1, 2, 3, and 5 have been completed and adopted by Council. Dike Master Plan Phase 4, which addresses the north dike east of No. 6 Road, is scheduled for completion by the end of 2019.

Infrastructure Improvements

The City's drainage and flood protection system is currently valued at an estimated \$2.5 billion, comprising 585 km of drainage mains, 61 km of box culverts, 165 km of watercourses, 39 drainage pump stations, and 49 km of dikes. Staff are continuously upgrading and improving the City's flood protection system to address 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.

In recent years, 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 were completed in 2018.
- 2018: Council approved a \$1,500,000 budget for the repair of approximately 1,600 m of deteriorated box culvert that caused sinkholes along No. 4 Road, from Alderbridge Way to Granville Avenue. Repair work is expected to be completed by the end of 2020.

The City has a box culverts preventative maintenance program to inspect the condition of box culverts and identify sections that required repair or replacement. Maintaining a well-managed preventative maintenance program enables more efficient repairs, fewer public disruptions, lower lifecycle costs, and extension of infrastructure lifespan. Inspection and remediation of the City's culvert network are currently performed on a 7-year cycle. Repair of significant defects identified through the program will be presented to Council for consideration as part of future capital programs.

City staff inspected 16.1 km of box culverts within 12 drainage catchments in 2018. Results of each inspection are documented through written reports, image and video records, allowing staff to monitor changes to the condition of the culverts, better informing long-term decision making. Minor defects have been identified and remediated. Significant defects were encountered within the No. 4 Road North catchment and staff are currently determining the scope of repairs. The No. 3 Road South drainage catchment area is scheduled next for inspection.

Pump Station Upgrades

Significant progress has been made upgrading the City's drainage pump stations to address growth and climate change. The total capacity of the City's drainage pump stations has increased by 22% over the last 10 years, as identified in Attachment 3. Since the Drainage and Diking Utility was introduced in 2003, the City has rebuilt 11 of its 39 drainage pump stations and performed significant upgrades on 4 others.

Re-construction of the No. 2 Road North Drainage Pump Station was completed in 2018; re-construction of the Horseshoe Slough Pump Station is expected to be completed by the end of this year. Construction for the No. 7 Road South, Shell Road North, and No. 2 Road South pump stations is expected to begin late 2019.

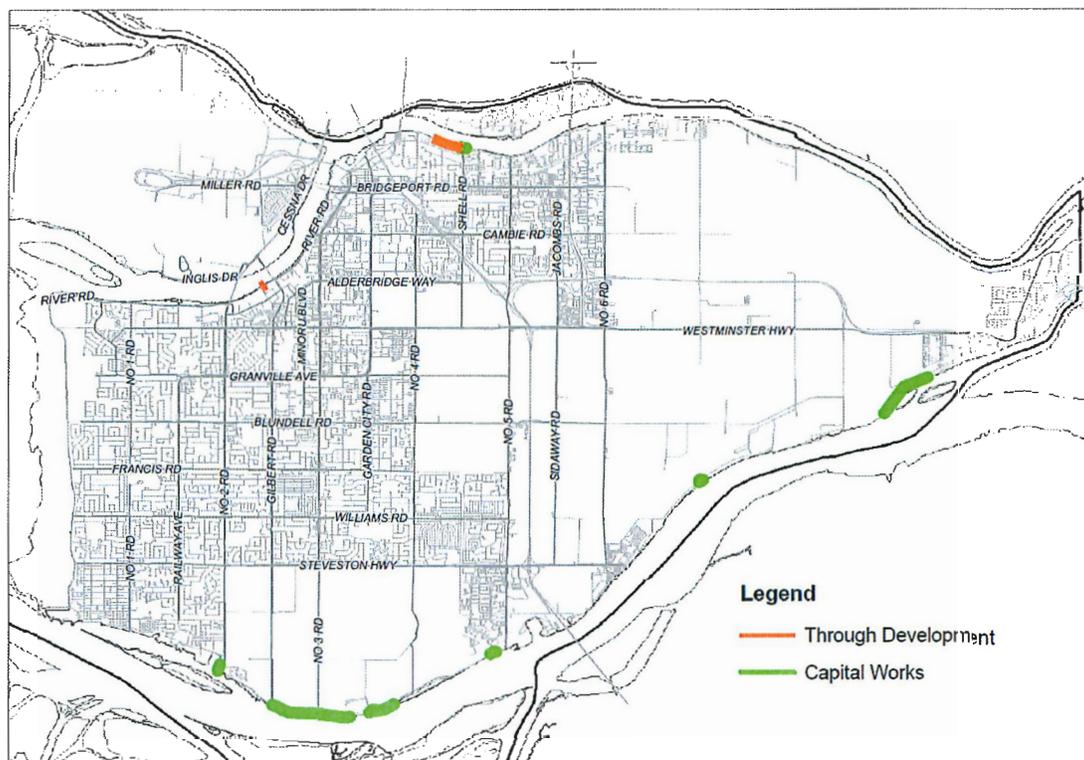
Based on ageing infrastructure and capacity analysis, major upgrades on 6 pump stations and minor upgrades on 12 pump stations are recommended over the next 10 years to improve the City's high level of flood protection. Pump station upgrades will be included in the 5-Year Capital Plan for Council's consideration.

Diking Improvements

Current climate change science estimates that sea levels will rise by approximately 1.0 m by 2100 and 0.2 m of subsidence is expected over that same time period. The Richmond Flood Protection Management 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. In order to stay ahead of sea level rise, dike raising efforts should be completed approximately within the next 75 years.

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 2019 and 2020. Additional dike improvements will be included in the 5-Year Capital Plan for Council’s consideration.

Figure 1. Current and Upcoming Dike Improvements for 2019 and 2020



The currently funded dike improvement projects include over 2.4 km and \$17.3 million in upgrades. These projects include:

- South Dike upgrade between Gilbert Road and No. 3 Road. Construction is in progress and expected to be completed by the end of 2019.
- South Dike upgrade between No. 3 Road and Finn Slough. Construction is expected to be completed by the end of 2020.

- South Dike upgrade between No. 9 Road and west of McMillan Way. Design has been completed and construction is expected to be completed by the end of 2020.
- Horseshoe Slough Drainage Pump Station and sections of adjacent dike. Construction is in progress and expected to be completed by the end of 2019.
- Shell Road North Drainage Pump Station and sections of adjacent dike. Construction is expected to be completed by the end of 2020.
- No. 7 Road South Drainage Pump Station and sections of adjacent dike. Construction is expected to be completed by the end of 2020.
- No. 2 Road South Drainage Pump Station and sections of adjacent dike. Construction is expected to be completed by 2021.

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 completed in 2018, and a section of superdike will be constructed through development in the next few years 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. Notable maintenance issues identified and addressed through dike inspections over the past year include:

- Sloughing and deterioration of rip rap in a 390 m section of the south dike by 9611 No. 9 Road. Dike re-armouring was implemented to reinforce and protect the dike at this location.
- Sloughing and deterioration of rip rap as a result of a significant winter storm along the south dike at 6000, 7000, 8000 and 9000 Dyke Road. Over 4000 tonnes of rip rap was used, totaling 860 metres of re-armouring to reinforce and protect the dike at these locations.
- Sloughing at a section of the north dike in the 20000 River Road block. Dike re-armouring was implemented to reinforce a 285 m section to protect the dike at this location.
- Land-side damage to the west dike fronting 11000 7th Ave as a result of rodent incursion into the dike. 300 m of land-side dike was stripped, reinforced and repaired to protect the dike at this location.

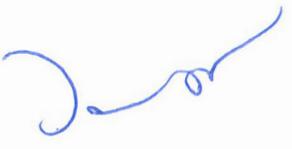
Financial Impact

None.

Conclusion

The City experienced near record high total rainfall in 2018 and low freshet flows in the spring of 2019. The drainage and flood protection system performed well, with an above average number of drainage-related service requests and negligible freshet flood risk.

Demands on the drainage and flood protection system will continue to increase with pressures from climate change and development. The Flood Protection Management Strategy 2019 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 is addressed through on-going Dike Master Planning efforts. Through 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 towards the City’s dike planning efforts and implementing infrastructure improvements to the City’s flood protection system.

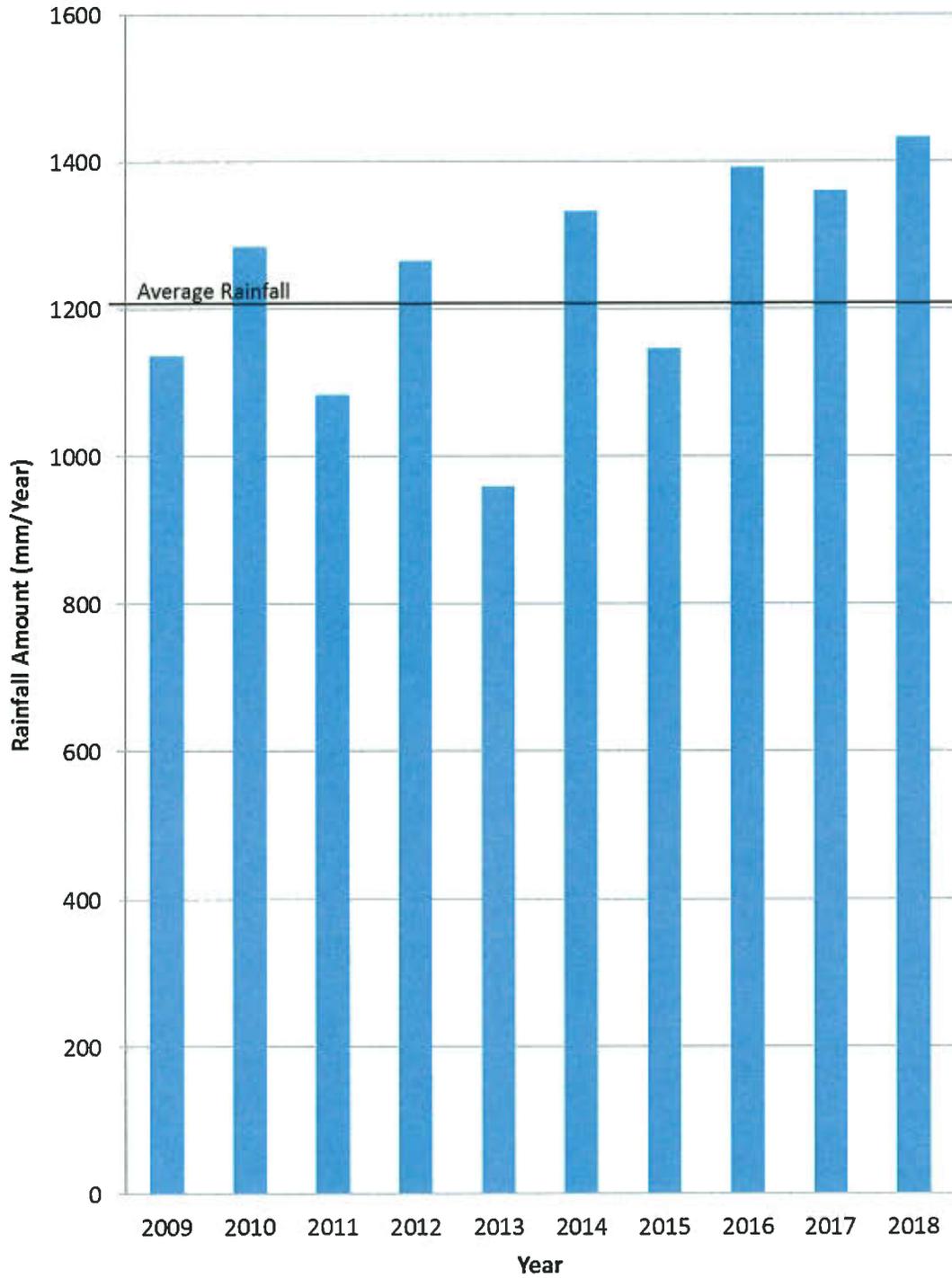


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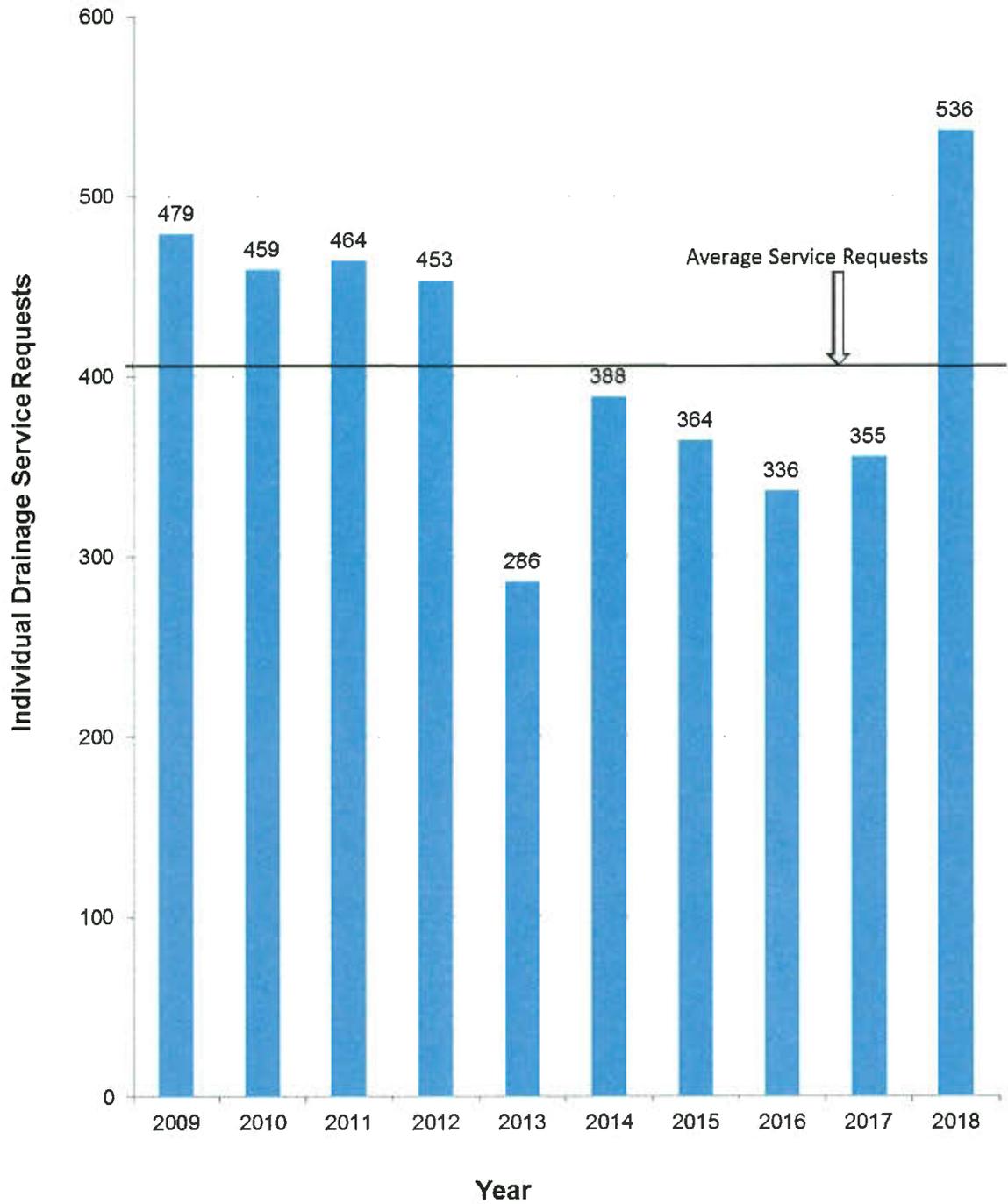
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- Att. 1: Annual Rainfall Data
- 2: Annual Drainage Service Requests
- 3: Drainage Pump Station Capacity

Annual Rainfall Data



Annual Drainage Service Requests



Total Drainage Pump Station Pumping Capacity 2009-2018

