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EVALUATION PROGRAM

IMAX Low Impact Development Feature Performance Assessment

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THE SUSTAINABLE TECHNOLOGIES EVALUATION PROGRAM

The water component of the Sustainable Technologies Evaluation Program (STEP) is a partnership between Toronto and Region Conservation Authority (TRCA), Credit Valley Conservation (CVC) and Lake Simcoe Region Conservation Authority (LSRCA). STEP supports broader implementation of sustainable technologies and practices within a Canadian context by:

- Carrying out research, monitoring and evaluation of clean water and low carbon technologies;
- Assessing technology implementation barriers and opportunities;
- Developing supporting tools, guidelines and policies;
- Delivering education and training programs;
- Advocating for effective sustainable technologies; and
- Collaborating with academic and industry partners through our Living Labs and other initiatives.

Technologies evaluated under STEP are not limited to physical devices or products; they may also include preventative measures, implementation protocols, alternative urban site designs, and other innovative practices that help create more sustainable and livable communities.

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LIST OF ACRONYMS AND ABBREVIATIONS

μg/L	Microgram per litre
CVC	Credit Valley Conservation
EMC	Event Mean Concentration
h	Hour
ha	Hectare
IPRA	Infrastructure Performance and Risk Assessment
LID	Low Impact Development
m	Metre
m3	Cubic metre
MECP	Ministry of Environment, Conservation, and Parks
mg/L	Milligram per litre
mm	Millimetre
mm/h	Millimetre per hour
STEP	Sustainable Technologies Evaluation Program

APPENDICES

Appendix A: Sampling Methodology
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1.0 BACKGROUND

The Credit River watershed in southern Ontario has experienced a 19% increase in urban land use from 1963 to 2017 (Credit Valley Conservation [CVC], 2019). Trend analysis on precipitation data in the watershed indicates an increasing amount of annual precipitation and an increase in winter precipitation in the form of rain (CVC, 2018a). The compounding effects of increased urbanization, changing climate, and shifts in seasonal water balance emphasize that the traditional approach to stormwater management is inadequate to maintain consistent levels of service and meet watershed targets.

In 2015, the Ontario Ministry of Environment and Climate Change (now Ministry of the Environment, Conservation and Parks [MECP]) identified that conventional (pipe and pond) stormwater management practices that focus on controlling peak flow rates and removal of total suspended solids are not fully achieving the desired protection of watershed ecosystems (MECP, 2015). Recent studies have shown that solely relying on conventional stormwater management pipe and pond configurations generally do not meet thermal (Sabouri et al., 2016), water quality (Liu et al., 2017), and water balance objectives (Ahiablame et al., 2012).

There has been a growing movement towards adopting green infrastructure and low impact development (LID) practices for stormwater management. LID is an integrated approach to stormwater management that functions to return development to more natural hydrologic conditions of pre-development and combines site planning with engineered retention and infiltration features designed to reduce runoff volume (Ahiablame et al., 2013), peak flows (Drake et al., 2013), extend discharge lag times, and lower pollutant loads (Liu et al., 2015) from source areas. Infiltration and retention-based features like permeable pavement and bioretention allow stormwater to percolate from the surface downward to restore groundwater and baseflows or allows it to be stored in the features' soil and vegetation (Eckart et al., 2017).

To achieve all stormwater management objectives, from flood control to maintaining the natural water balance and preserving water quality, stormwater management designs may use a treatment train approach that incorporates a combination of LID stormwater management practices. However, knowledge gaps remain for how LID practices work together, how to modify their design, and manage ongoing maintenance to meet performance objectives.

Stormwater management in the City of Mississauga is a responsibility of the municipality and was traditionally funded solely from property taxes and development charges. Due to ageing infrastructure and increased pressures because of climate change, this funding is no longer sufficient to maintain current levels of service. After a stormwater financing study and consultation with stakeholders and the general public, the city decided to implement a Stormwater Charge. This option was considered the more sustainable and equitable source of funding (AECOM, 2013). To encourage the use of innovative stormwater management practices, business and multi-residential properties can apply for a credit of up to 50% of the stormwater charge for the implementation of certain stormwater features.

To build confidence in sizing and long-term performance of stormwater infrastructure, CVC and its partners have implemented a series of demonstration sites within various land-use settings and are delivering a LID Infrastructure Performance and Risk Assessment (IPRA) program. The multi-year IPRA program will evaluate LID effectiveness in flood control, erosion protection, nutrient removal, and mimicking the pre-development water balance.

In 2012, the IMAX Corporation (IMAX) completed a parking lot retrofit incorporating permeable pavement, bioretention LID practices, and proprietary stormwater technologies to infiltrate, retain, and slow the release of stormwater runoff. In addition to treating stormwater, the parking lot is eligible for the City of Mississauga's stormwater credit program. In partnership with the Region of Peel, City of Mississauga, and IMAX, CVC is monitoring the hydrologic and water quality performance and maintenance needs of the LID features. Over seven years, the monitoring methodology has evolved to accommodate seasonality and fulfill the objectives of stakeholders.

1.1 Purpose

The goal of this study is to inform stormwater management design, implementation, and maintenance in areas with similar climate influences as southern Ontario. This report is intended to address several project questions on the performance of the stormwater management features at IMAX.

These are the main questions considered in this performance monitoring report:

1) What factors lead to stormwater overflow of bioretention swales, and what is the impact on water quality?
2) Are treatment trains more effective at providing water quality benefits compared to stand-alone LID features?
3) Do different permeable pavement designs reduce runoff volume and meet water quality targets?
4) Does infiltration from the LID features impact the quality of local soil and groundwater?
5) What are the operation and maintenance requirements of bioretention swales and permeable pavement in a commercial office parking lot over the long-term?
6) What are the overall water quantity and quality benefits to the receiver downstream of LID features?

This technical report includes the following sections: site description, methods, results and discussion, conclusion and next steps, and appendices.

2 SITE DESCRIPTION

2.1 IMAX Corporate Parking Lot

The IMAX corporate office is located at 2525 Speakman Drive, Mississauga at the headwaters of the Sheridan Creek subwatershed (Figure 1). The Sheridan Creek subwatershed is a long, narrow, fully urbanized watershed located on the west side of the City of Mississauga. The subwatershed drains an area of approximately 1,035 hectares (ha) and outlets to Rattray Marsh, a Provincially Significant Wetland and Provincial Area of Natural and Scientific Interest, then flows into Lake Ontario. The subwatershed is dominated by urban landuse and was largely developed without any stormwater management, leading to altered hydrology, declining water quality, and concerns about aquatic health (Credit Valley Conservation, 2011).

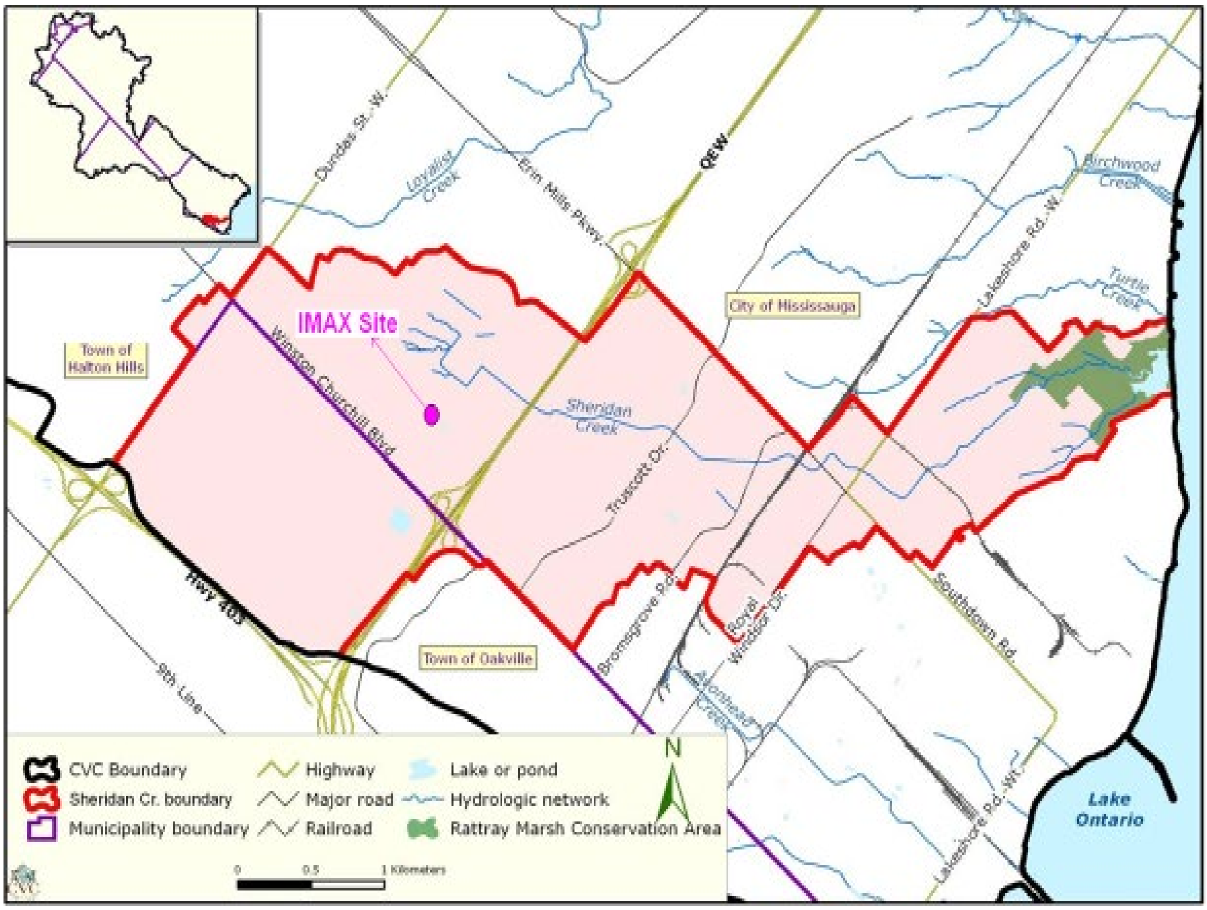

Figure 1: Location of study area inside the Sheridan Creek watershed located within the larger Credit River watershed.

The pre-retrofit parking lot surface was in poor condition with signs of severe cracking, rutting, and spalling throughout the facility. Wet weather events caused sustained standing water within potholes and large cracks. Before flowing overland to the nearest catch basins, groundwater from the high elevation areas surrounding the parking lot pooled between the existing curb and asphalt surface. Poorly draining subsoils created saturated conditions that quickly degraded the asphalt surface, causing frequent ice build-up during winter months. This build-up resulted in increased salt application during de-icing operations, adversely impacting the quality of stormwater runoff leaving the site.

To alleviate these issues, and to provide water quality benefits to the Sheridan Creek subwatershed, in 2012- 2013 the parking lot was expanded and retrofitted with LID features including bioretention swales, permeable pavement, and proprietary stormwater technologies. The range of features on the site allowed it to effectively be used to compare these technologies.

The total drainage area for the site is 1.0 ha (9,978 m^2) based on 2014 as-built survey results. The IMAX parking lot retrofit applies LID features which were customized to suit local hydrological and geological conditions. The layout of the parking lot, and locations of different LID features, is shown in Figure 2. The main source of runoff to the LID features is from the parking lot and entrance driveways. Permeable pavement was installed in the northern portion of the parking lot, however due to a low depth to bedrock, bioretention systems were installed along the southern and eastern edges to receive runoff from asphalt in the southern portion.

Figure 2: IMAX retrofit design concept.

2.2 Bioretention Swales

Bioretention swales are engineered soil/media filter systems that temporarily store and filter stormwater runoff. Three side-by-side bioretention practices were integrated into the front of the parking lot retrofit to improve runoff water quality; each system has its own perforated underdrain and outlet monitoring location (Figure 3).

Figure 3: Bioretention swale at IMAX looking downstream.

The bioretention swales accept overland sheet flow from their designated parking lot drainage area. Inlets to each of the three swales consist of a simple curb cut (Figure 4).

Figure 4: Inlets to one bioretention swale, and an overflow drain circled in red.

Incoming runoff velocities are reduced by round stone channels which dissipate energy as runoff enters the bioretention swales before being filtered by the engineered media and collecting in the perforated pipe and gravel underdrain system. Runoff volumes that exceed the bioretention swales' capacity are conveyed through an overflow drain directly to the outlet. All three swales drain to the local municipal stormwater system.

- **The first swale:** is a stand-alone bioretention swale (Figure 3 above),
- **The second swale:** contains an Imbrium Systems Sorbtive Media Vault to further treat nutrients (Figure 5). The Sorbtive Vault is an engineered stormwater quality treatment technology which filters stormwater through Imbrium Systems Sorbtive Media as an additional form of water quality treatment after it has been filtered through the bioretention swale (Imbrium Systems, 2014). Sorbtive Media is an oxide-coated high surface area reactive engineered media that absorbs and retains phosphorus and does not leach pollutants into infiltrated stormwater.
- **The third swale:** has an Imbrium Systems Jellyfish Filter pre-treatment to filter out a variety of stormwater pollutants including oil, grease, and suspended solids from runoff before entering the bioretention swale (Figure 6). Flows from the parking lot area enter a curb cut, flow down a concrete channel, and into the sump of the Jellyfish Filter unit. The Jellyfish Filter has been designed to treat storm events up to 25 mm with four hi-flow cartridges and two draindown cartridges. For more information on the function of the Jellyfish Filter, see the Jellyfish Filter Technical Manual (Imbrium Systems, 2020).

Figure 5: Looking inside the Sorbtive Media Vault.

Figure 6: The Jellyfish Filter unit shown both closed and open.

A bypass channel has been constructed in the event the filter is clogged or flow capacity is exceeded, which allows excess flows to bypass the feature and enter the swale (Figure 6). After the stormwater exits the Jellyfish Filter, or if it bypasses due to insufficient capacity, it is then filtered by the bioretention media.

An As-Built Survey completed in 2014 indicated that some of the drainage areas for the three bioretention sites are substantially different from the design phase (Table 1), with the largest increase (+68%) for the catchment with only bioretention. This is suspected to be due to improper grading of the parking lot.

Table 1: Difference between designed and actual drainage areas for the bioretention sites.

Site	Designed drainage area (m^3)	Actual drainage area (m^3)	Percent change
Only bioretention	1566	2637	+68%
Bioretention with Sorbtive media	1125	1128	+0%
Bioretention with Jellyfish filter	1350	1394	+3%

2.3 Permeable Pavement

Permeable pavement is another alternative to traditional stormwater management. It uses interlocking concrete pavers with an opening between to allow drainage into an aggregate base. Stormwater that enters the base will either infiltrate into the native soils or enter an underdrain system.

Three side-by-side permeable pavement systems were built at the back of the IMAX parking lot retrofit (Figure 7). The systems were hydraulically separated with an impermeable liner and each one has its own underdrain. All three systems used the same permeable pavers. Two different types of aggregates were used for the base layer of the systems, with one using granular ‘O’ and two using 20 mm clearstone (Figure 8). The underdrain system for the feature using granular ‘O’ included three lateral pipes perpendicular to the main pipe. All three permeable pavement systems discharge to a constructed wetland.

Clearstone is recommended for permeable pavement systems because it does not include fine material and has large void spaces that provide storage for infiltrating stormwater. Without fine material, greater aggregate depth is required to meet structural requirements for traffic loadings. In contrast to clearstone, granular ‘O’ is readily available in southern Ontario and requires less depth to meet structural requirements, however it contains more fine particles.

Figure 7: Permeable pavement parking lot at IMAX**.**

Figure 8: Granular ‘O’ (left) and 20 mm clearstone (right).

As the permeable pavement system was designed with monitoring in mind, a portion of the 20 mm clearstone permeable lot was installed with an impermeable liner at the bottom to prohibit infiltration (Figure 9). This was included to evaluate the potential to provide some of the benefits of LID without posing a risk to groundwater quality. The rest of the permeable pavement lot systems have a geotextile liner at the bottom to allow for infiltration.

Figure 9: Impermeable geosynthetic clay liner.

2.4 Stormwater Design Criteria

The design criteria and objectives for the IMAX parking lot include water quantity for all LID features and water quality for the bioretention swales. The criteria listed in Table 2 below are summarized from the design memo (Aquafor Beech, 2012) and Imbrium Systems performance testing (Imbrium Systems, 2012).

Table 2: IMAX design criteria (Aquafor Beech, 2012 and Imbrium Systems, 2012).

Parameter / Criteria
Bioretention Swales
Each bioretention swale is sized to treat: • Runoff volumes during the 25 mm event (water quality event) • The 1-in-10-year storm event (51.7 mm) per the City of Mississauga minor system design criteria from their respective drainage areas • Each swale also has a maximum drawdown time of 24 hours
Sorbtive Media Vault: • Effluent total phosphorus benchmark: 0.03 mg/L • 95% removal of dissolved phosphorus was assumed based on an influent concentration of 0.5 mg/L and annual media replacement
Jellyfish Filter: • Provide water quality control for all events up to 25 mm • Expected pollutant load reductions from performance testing (Imbrium Systems, 2012): o Total suspended solids 89% o Total phosphorus 59% o Total nitrogen 51% o Copper >80% o Zinc >50%
Permeable Pavement
A maximum drawdown time of 24 hours

3 STORMWATER MONITORING METHODS

The monitoring program included water quantity and quality monitoring for seven independent catchment areas, groundwater monitoring, and a meteorological station located just north of the parking lot. The catchment areas include the three bioretention swales, three permeable pavement areas, and a control site. A map of the catchment areas and monitoring stations is shown in Figure 10. Areas 2, 3, and 4 drain to the bioretention swales and correspond to monitoring sites IX-2, IX-3, and IX-4, respectively (see Table 3). Areas 5, 6, and 7 are the permeable pavement areas and correspond to monitoring sites IX-5, IX-6, and IX-7, respectively. Area 1 drains to the control site (IX-1). The drainage areas shown are based on as-built surveys and are the ones used for the report. Four groundwater wells were also installed near the four corners of the site, labelled MW-05, MW-06, MW-07, and MW-08. Table 4 summarizes the monitoring at IMAX.

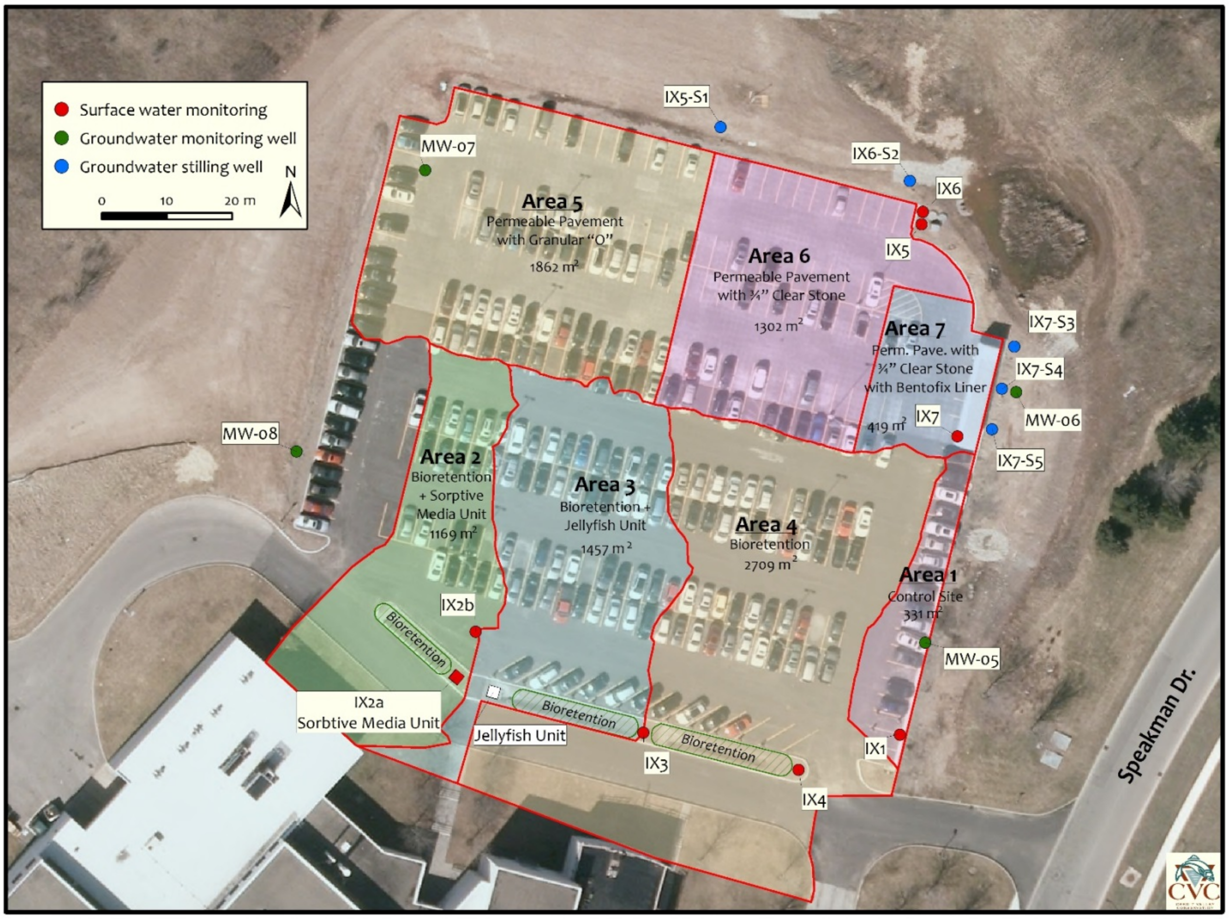

Figure 10: Catchment areas and monitoring stations.

Table 3: Name of LID feature monitoring location.

LID Features	Area	Monitoring Location
Bioretention and Sorbtive Media Vault	Area 2	IX-2
Bioretention and Jellyfish Filter	Area 3	IX-3
Bioretention	Area 4	IX-4
Permeable pavement with granular ‘O’ base	Area 5	IX-5
Permeable pavement with clearstone base	Area 6	IX-6
Permeable pavement with clearstone base and liner	Area 7	IX-7

Table 4: Summary of monitoring activities at IMAX.

Type of monitoring	Sites monitored	Relevant research questions	Equipment used	Time period monitored
Precipitation and air temperature	Climate station several metres north of parking lot	1, 2, 3, 4, and 6	Hydrological Services TB3 Rain Gauge (Heated)	2013 to 2019
Total volume of water leaving the site	IX-2, IX-3, IX-4, IX-5, IX-6, and IX-7	1, 2, 3, and 6	ISCO 2150 or ISCO 4150 area velocity flow and level meter, and weir	2014 to 2019
Stormwater event water quality sampling	IX-2, IX-3, IX-4, IX-5, IX-6, and IX-7	1, 2, 3, and 6	ISCO 6712 automatic sampler and sent to outside lab for analysis	2014 to 2018
Height of ponded water	IX-2, IX-3, and IX-4	1	HOBO Model U20 level loggers	2014 to 2019 (no winter data)
Water level in the Sorbtive Vault and Jellyfish Filter	IX-2 and IX-3	1	HOBO Model U20 level loggers	2014 to 2019
Soil moisture and temperature	IX-2 and IX-4	Future research	HOBO Soil Moisture Smart Sensor, HOBO Temperature Smart Sensor, and HOBO USB Micro Station	2017 to 2019
Soil quality	IX-2, IX-3, and IX-4	4	Samples collected manually and sent to outside lab for analysis	2015, 2017, 2019
Continuous conductivity	IX-5 and IX-7	Future research	HOBO Model U24-001/002	2014 to 2019
Water level downstream of permeable pavement	IX-7	4	HOBO Model U20 level loggers	2014 to 2017
Continuous groundwater levels and temperature	MW-05, MW-06, MW-07, and MW-08	4	HOBO Model U20 level loggers	2013 to 2019
Groundwater chemistry	MW-05, MW-06, MW-07, and MW-08	4	Waterra inertial pump and sent to outside lab for analysis	2012 to 2018
Site inspections	Entire parking lot	5	Data collected using checklists	2014 to 2019

Area 1 in Figure 10 was designated as control site IX-1, with total outflow and water chemistry being monitored from a portion of the parking lot not being treated by LID. However, there were a number of challenges with the monitoring infrastructure at this location. There were consistent leaks in both the concrete structure and weir, leading to issues with the flow data. In addition, changes from the designed drainage area and the as-built drainage area meant that the area was smaller than expected, and consisted of mainly lightly used parking stalls, as they were either portioned off for monitoring access or designated visitor stalls. As a result, this meant that this monitoring location was not representative as a control site. Due to these concerns, data from this site was not used to estimate the chemistry of untreated water at IMAX. Instead, results were used from a similar study using similar methods at the Toronto and Region Conservation Authority (TRCA) Kortright Centre located about 35 km away in Vaughan, Ontario (Van Seters and Drake, 2015).

Dataloggers and automatic samplers were stored either in manholes (e.g. Figure 11) or in above-ground storage boxes. For further details on the sampling methodology and data analysis for both the stormwater and groundwater, see Appendix A.

Figure 11: Data logger located within monitoring manhole, the automatic sampler normally sits on the metal basket (left); data logger and automatic sampler removed from monitoring manhole (right).

4 RESULTS AND DISCUSSION

The LID monitoring at IMAX produced a large amount of data. For the purposes of this report, the results and discussion were focused on the key project questions regarding the performance of the stormwater management features at IMAX. These questions are:

1) What factors lead to stormwater overflow of bioretention swales, and what is the impact on water quality?
2) Are treatment trains more effective at providing water quality benefits compared to stand-alone LID features?
3) Do different permeable pavement designs reduce runoff volume and meet water quality targets?
4) Does infiltration from the LID features impact the quality of local soil and groundwater?
5) What are the operation and maintenance requirements of bioretention swales and permeable pavement in a commercial office parking lot over the long-term?
6) What are the overall water quantity and quality benefits to the receiver downstream of LID features?

Analysis of the climate station data can be found in Appendix B, and other data not relevant to these key questions will be presented in future fact sheets and case studies and posted on the STEP website.

4.1 What factors lead to stormwater overflow of bioretention swales, and what is the impact on water quality?

Many bioretention sites are designed with an overflow, which allows water to bypass the system and drain directly to the local stormwater system when the capacity of the feature is exceeded. Features should be designed to minimize overflow events while still restricting water from backing up onto roads and parking lots. Overflows are often situated at heights that allow some water to pond and slowly infiltrate, but low enough to prevent stormwater backing up from the feature onto the road or parking lot it is intended to drain. However, when stormwater does enter the overflow, it bypasses the water quality treatment of the system. Understanding the factors that cause overflow in bioretention swales, and the water quality and quantity implications, is important to inform future LID design.

This question was answered by comparing the proportion of events that produced overflow between the three different sites, comparing precipitation depth and intensity of events that had overflow with ones that did not, and comparing the sampled water quality of overflow events and non-overflow events. Each of the three bioretention swales at IMAX contain an overflow and a water level data logger to measure the height of water ponding on the swale. Events where the water level reached the level of the overflow were identified as overflow events, allowing the frequency of overflow events to be determined.

4.1.1 Influence of Site Design

Over the monitoring period, IX-4 had a much higher percentage of overflow events compared to IX-2 and IX-3 (Table 5). This is likely due to the fact that IX-4 has a much larger drainage area than designed (+68%), which would increase the volume of stormwater during events and more quickly saturate the soil in the bioretention swale, leading to ponding and overflow. These results show the importance of ensuring actual drainage areas are as close as possible to design drainage areas, as small differences in grading could lead to a large reduction in stormwater feature performance. Full event-by-event hydrology data is shown in Appendix C.

Table 5: Percentage of overflow events by site and drainage area.

Site	Monitored events for overflow	Number of overflow events	Percentage of overflow events	Designed drainage area (m^3)	Actual drainage area (m^3)	Percent change
IX-2	188	14	7%	1125	1128	+0%
IX-3	190	9	5%	1350	1394	+3%
IX-4	174	62	36%	1566	2637	+68%

4.1.2 Influence of Precipitation Depth and Intensity

Increasing magnitude of precipitation depth and intensity can lead to overflow events. As the bioretention swales were designed to treat events up to 25 mm, it is expected that there should be no overflow for events 25 mm and under. Overflow and non-overflow events are plotted on a precipitation depth vs intensity graph for the three sites in Figure 12 through Figure 14. For all three sites, overflow events are more likely to happen with increasing precipitation depth and intensity (towards the upper left of the graphs). All events with a precipitation intensity over 60 mm/h produced overflow at each of the three sites.

Key observations include:

<u>IX-2 and IX-3</u>

- The vast majority of events under 25 mm for IX-2 (98%) and IX-3 (97%) produced no overflow.
- The overflow events with a precipitation depth under 25 mm at both sites had peak precipitation intensities of at least 37 mm/h.
- Most events over 25 mm at these sites produced no overflow, indicating that they are able to treat events beyond their design standard.

<u>IX-4</u>

- 29% of events under 25 mm produced overflow at IX-4, meaning it is not meeting the design standard for these events.
- This is very likely due to the site being undersized relative to its drainage area (see Section 4.1.1).

- Precipitation intensity was an important driver for overflow at IX-4, as all the events with an intensity over 25 mm/h produced overflow.

An LID design that manages to successfully treat these more intense storms will allow for even better water quality benefits to be realized.

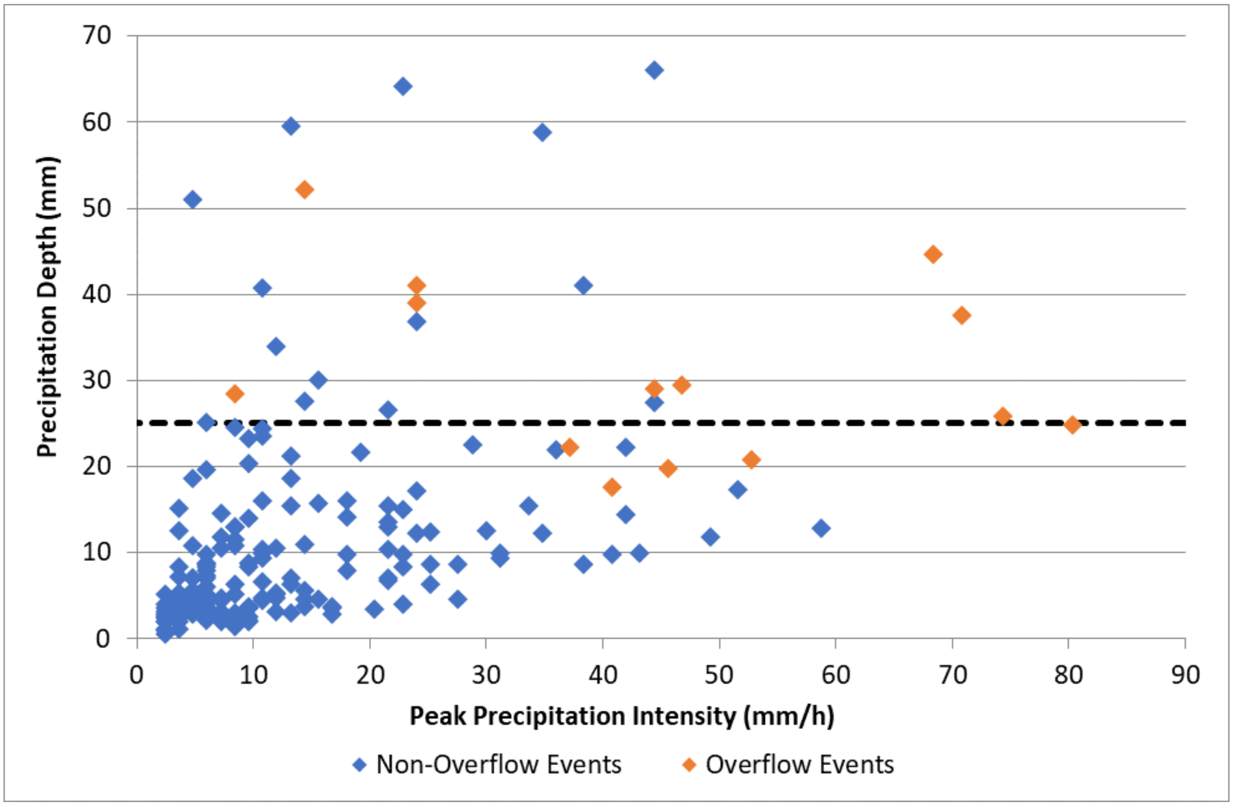

Figure 12: IX-2 overflow and non-overflow events plotted on a precipitation depth vs intensity graph. The dashed line represents 25 mm precipitation depth.

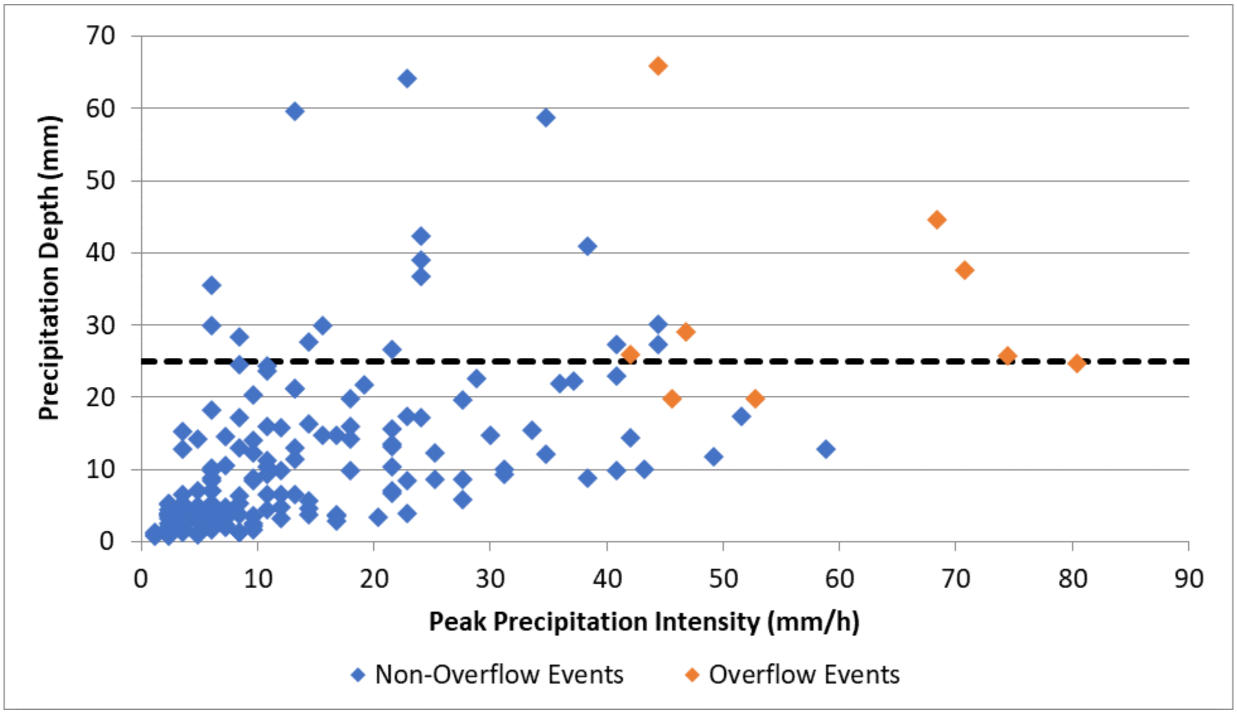

Figure 13: IX-3 overflow and non-overflow events plotted on a precipitation depth vs intensity graph. The dashed line represents 25 mm precipitation depth.

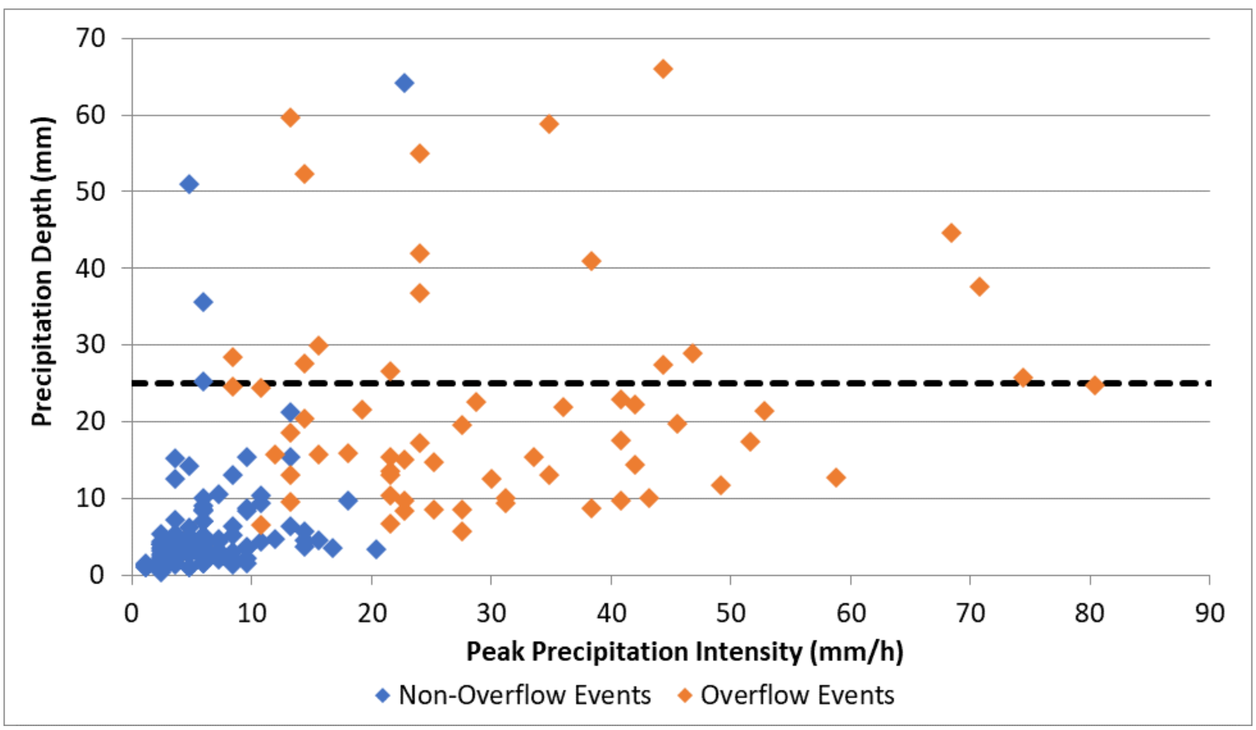

Figure 14: IX-4 overflow and non-overflow events plotted on a precipitation depth vs intensity graph. The dashed line represents 25 mm precipitation depth.

4.1.3 Influence of Overflows on Water Quality

As water entering the overflow is not treated by the bioretention feature, overflow events may have higher levels of stormwater contaminants. To test this, the water quality of events that did have flow were compared to the ones which did not.

As IX-4 had the largest number of overflow events, it also had the largest number of sampled overflow events (17). No overflow events were sampled at IX-2 during the outflow monitoring period, and two were collected for IX-3. Box plots for effluent total suspended solids concentrations for overflow and non-overflow events at IX-4 are shown in Figure 15. Event mean concentrations (EMCs), which are flow weighted composite samples, are used for this analysis. The mean and median total suspended solids concentrations are notably higher for the overflow events.

The median EMC for parameters of interest for overflow and non-overflow events are shown in Table 6. For most parameters, the median EMC for overflow events is higher. The exceptions are nitrogen compounds (nitrate + nitrite, total ammonia, and total Kjeldahl nitrogen) and nickel. Full event by event water quality data is shown in Appendix D.

These results demonstrate that the water quality impact of overflow events can clearly be seen, as even though much of the effluent water is still treated, the overall concentrations of contaminants are still higher. As water entering the overflow is directed to the stormwater system and not infiltrated, these events may also have less infiltration and volume reduction. This would lower the pollutant load reduction, causing the stormwater feature to be less effective at reducing the total mass of the pollutants.

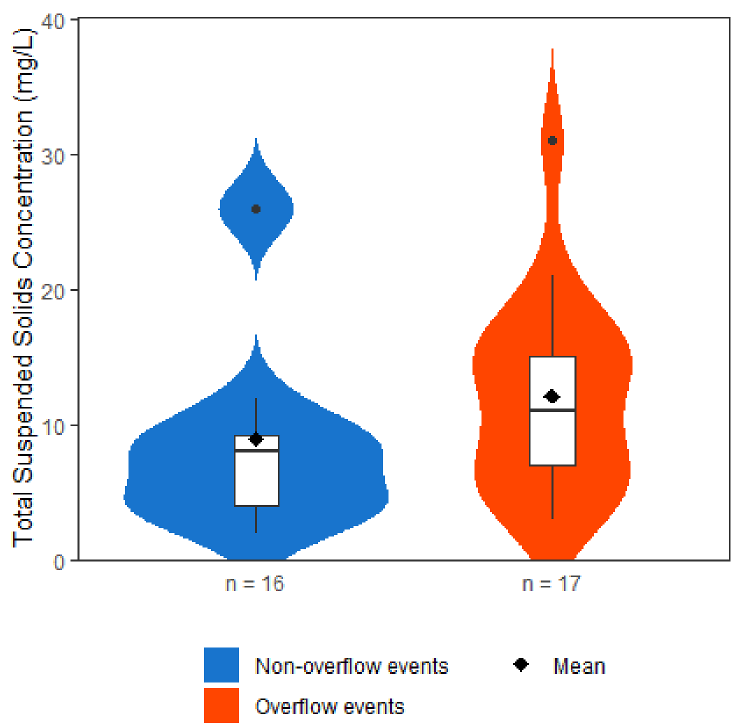

Figure 15: Violin plot of effluent total suspended solids concentrations between overflow and non-overflow events at IX-4.

Table 6: IX-4 median EMCs for non-overflow and overflow events. The highest result for each parameter is in bold.

Parameter	Median EMC for non-overflow events	Median EMC for overflow events
Count	16	17
Aluminum (µg/L)	78.65	**91.3**
Copper (µg/L)	6.4	**8.8**
Iron (µg/L)	109	**117**
Lead (µg/L)	3.42	**4.46**
Nickel (µg/L)	**1.3**	1.2
Nitrate + nitrite (mg/L)	**0.87**	0.46
Orthophosphate (mg/L)	0.08	**0.1**
Total ammonia nitrogen (mg/L)	**0.07**	0.05
Total Kjeldahl nitrogen (mg/L)	**0.69**	0.54
Total phosphorus (mg/L)	0.12	**0.13**
Total suspended solids (mg/L)	8	**11**
Zinc (µg/L)	9.15	**12.2**

4.2 Are treatment trains more effective at providing water quality benefits compared to stand-alone LID features?

Installing stormwater quality control is important to help ensure development or urbanization does not degrade the water quality of receiving water bodies. As two of the bioretention swales at IMAX have additional treatment (see Section 2.2), water quality samples were collected during storm events to compare performance between these sites and technologies.

To provide estimated influent concentrations, values were used from a study conducted by the Toronto and Region Conservation Authority (TRCA) at the Kortright facility in Vaughan, located about 35 km northwest of IMAX. For this study, stormwater quality samples were taken from an asphalt parking lot from 2010-2014. The median of the 84 event mean concentration (EMC) samples taken were used to estimate the IMAX influent values (Van Seters and Drake, 2015).

Water quality improvements are described as load reduction, which consider the lower volume of the stormwater effluent compared to the volume of influent. Discussions on load reductions are shown in Section 4.6.

Event mean concentrations (EMCs) represent a flow-weighted average concentration of a given parameter during an event. Parameters of concern identified by CVC's Water Quality Strategy (CVC, 2009) were the focus of the water quality monitoring of the site. EMCs were collected for all parameters of concern throughout the monitoring period at all three bioretention sites at IMAX, with median results shown in Table 7. The full results are shown in Appendix D.

Table 7: Median EMCs for parameters of concern for IMAX bioretention swales.

Median EMCs	Estimated influent[a]	IX-2	IX-3	IX-4
Count	84	36	34	39
Total suspended solids (mg/L)	59.2	10.5	6.0	9.0
Total phosphorus (mg/L)	0.17	0.09	0.17	0.13
Orthophosphate (mg/L)	0.04[b]	0.04	**0.13**	**0.10**
Nitrate + nitrite (mg/L)	0.51	**0.55**	**0.87**	**0.67**
Total Kjeldahl nitrogen (mg/L)	1.28	0.58	0.58	0.59
Total ammonia nitrogen (mg/L)	0.27	0.04	0.04	0.07
Aluminum (µg/L)	370	176	70	100
Copper (µg/L)	14.1	10.9	8.6	9.4
Iron (µg/L)	595	267	94	121
Lead (µg/L)	5.50	**7.40**	5.49	4.46
Nitrogen (µg/L)	2.7	1.8	1.4	1.3
Zinc (µg/L)	53.3	12.1	9.6	11.0

Note: **Bold** values are above the estimated influent concentration.
[a]From Van Seters and Drake, 2015.

Total suspended solids are an important stormwater parameter as it represents the total amount of suspended particles carried by stormwater. The lowest effluent total suspended solids concentrations were at the IX-3 bioretention swale, which includes a Jellyfish Filter that is designed to lower total suspended solids values (Figure 16). There was a significant difference (p=0.02) between the concentrations at IX-3 and at the next lowest site (IX-4). These results indicate that this technology is effective at lowering suspended solids concentrations and can be used if high total suspended solids concentrations are a concern.

The median results indicated a 90% reduction in total suspended solids EMCs, which matches the expected removal efficiency for the Jellyfish Filter of 89% based on performance testing by the manufacturer. This is not a direct comparison, however, as the data from IMAX includes the influence of the bioretention swale and does not consider any load reduction due to infiltration.

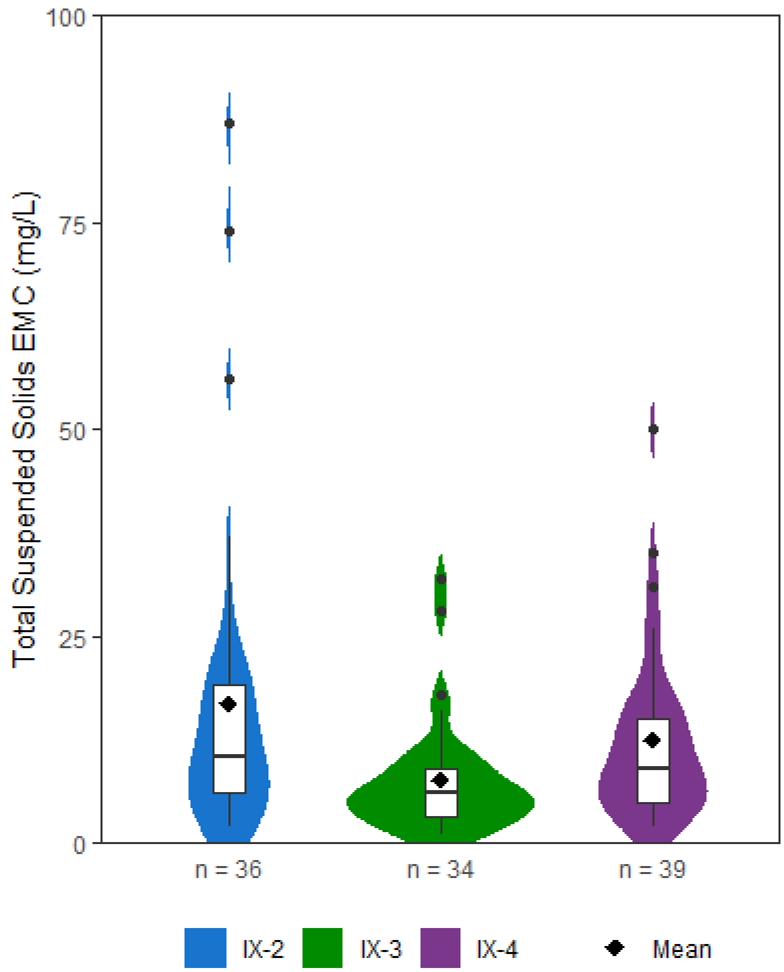

Figure 16: Violin plot of total suspended solids EMCs at IMAX bioretention swales.

The bioretention site with the Sorbtive Media Vault (IX-2), which is designed to lower phosphorus concentrations, had significantly ($p<0.01$) lower total phosphorus and orthophosphate concentrations than the next lowest site (Figure 17). The maximum concentration was also much lower than the highest concentrations at the other two bioretention sites. The other two sites had orthophosphate concentrations higher than the estimated influent. These sites may be preferentially retaining particulate bound phosphorus. While the median EMC at IX-2 (0.09 mg/L) is considerably higher than the benchmark for the Sorbtive Media Vault of 0.03 mg/L, this value could be impacted by the bioretention acting as a source for phosphorus.

Total phosphorus EMCs were all lower than the estimated influent, suggesting that all bioretention features at IMAX lower phosphorus concentrations along with providing runoff volume reduction, and would provide some benefit even if infiltration cannot be achieved. However, the concentrations are still higher than the Provincial Water Quality Objective for avoiding nuisance concentrations of algae in lakes (0.02 mg/L). The results show that the addition of a Sorbtive Media Vault post-treatment is helpful for lowering phosphorus concentrations in stormwater.

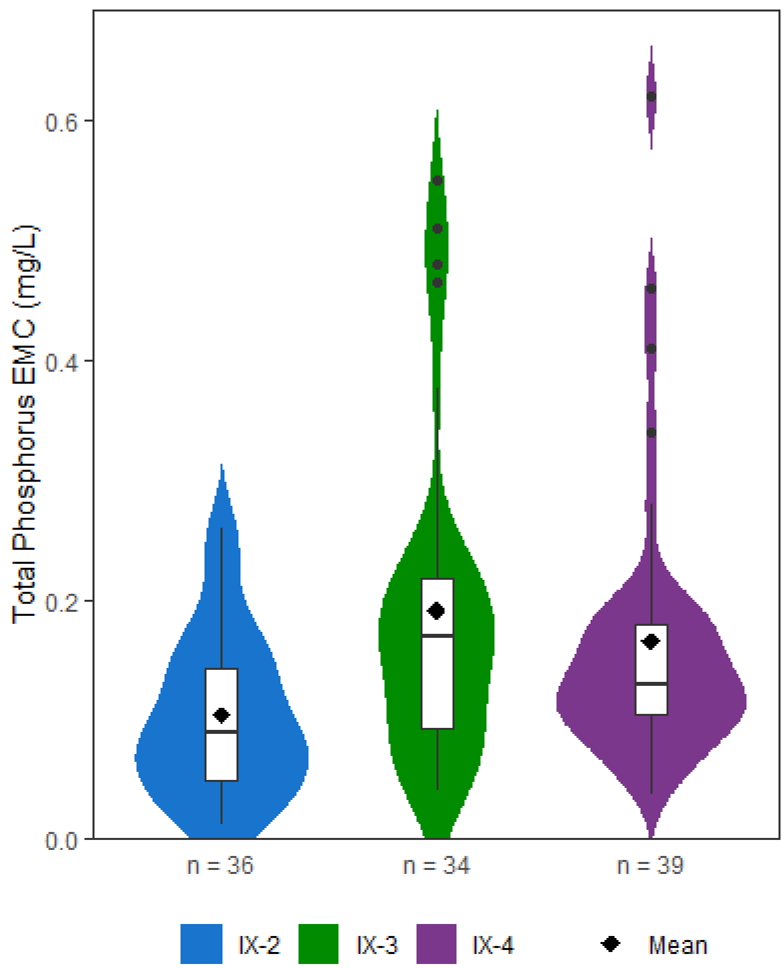

Figure 17: Violin plot of total phosphorus EMCs at IMAX bioretention swales.

All sites had a higher nitrite + nitrate concentration than the estimated influent concentrations. The bioretention features at IMAX may not be as effective at filtering out nitrate + nitrite as other parameters, the estimated influent concentration may be too low, or there may be a local source within the bioretention swales themselves. The plants in the swales may be acting as a source for organic nitrogen. If reducing organic nitrogen concentrations is a concern, these results indicate other stormwater features (e.g., permeable pavement) may be more effective.

The median metals EMCs are lower than the estimated influent values for all but one parameter (lead at IX-2), suggesting the LID features at IMAX lower the concentration of these metals in addition to providing runoff volume reduction. These features may also provide a water quality benefit if they are installed in areas with limited to no infiltration. The bioretention site with the Jellyfish Filter, IX-3, had the lowest median EMC for the majority of the monitored metals. The Jellyfish Filter may preferentially filter out these metals and provide further benefits along with lowering suspended solids.

4.3 Do different permeable pavement designs reduce runoff volume and meet water quality targets?

Permeable pavement can be used to infiltrate stormwater where it falls, resulting in less total runoff volume for local stormwater systems. As some of the stormwater containing common runoff pollutants is infiltrated, this may also lead to a load reduction for these contaminants. The permeable pavement at IMAX has two different types of bedding materials, granular ‘O’ and clearstone (See Section 2.3). Granular ‘O’ is cheaper and less is needed for structural requirements, while clearstone does not contain fines and is notably better for infiltration. Monitoring equipment was installed at both lots to measure runoff and water quality.

The water quantity performance of the two unlined permeable pavement sites were compared by looking at both runoff volume reductions and peak flow reductions. Runoff volume reductions describe how much total water is infiltrated and saved from entering the local stormwater system. Peak flow reductions are important during large events where the capacity of local stormwater systems may be exceeded, causing localized flooding. The water quality impact of these sites was compared by looking at pollutant load reductions. The portion of the lined permeable pavement site is discussed in Section 4.4.2.

4.3.1 Permeable Pavement Volume Reductions

Total inflow, outflow, and runoff volume reduction for the two sites over the permeable pavement monitoring period is shown in Table 8. Note that IX-5 had a longer monitoring period and a larger drainage area, leading to larger inflow volumes. IX-6, the clearstone site, had an overall runoff volume reduction of 93%, compared to 47% for IX-5, the granular ‘O’ site. The difference in void ratios (40% for IX-6 and 20% for IX-5) and presence of fines in the granular ‘O’ bedding material may contribute to the lower volume reduction at IX-5, as it may reduce storage capacity and slow down infiltration into the ground below. The difference in the underdrain system between the two sites, with IX-5 having additional pipes perpendicular to the main underdrain, may also lead to less infiltration.

Another factor may be due to the location of IX-5 at the northwest corner of the property. There are several hills surrounding this corner of the property, and it is possible that during some storm events and wetter times of the year (such as the spring freshet) that shallow groundwater from outside the property enters the underdrain at IX-5. During these times, outflow often lasts much longer than the other IMAX monitoring sites, up to several days or weeks.

Both sites allowed for infiltration, however the clearstone site appears to be especially effective at promoting infiltration and runoff volume reduction. As with the bioretention swales, design considerations, (in this case bedding material, underdrain geometry, and groundwater flow from nearby hills), can influence performance of these stormwater features.

Table 8: Total inflow, outflow, and runoff volume reduction for IMAX permeable pavement sites.

	IX-5	IX-6
Number of monitored events	170	171
Total estimated inflow (m^3)	4947	2604
Total measured outflow (m^3)	2636	169
Runoff volume reduction (%)	47	93

Full event by event data is provided in Appendix C**.** For both sites, runoff volume reduction decreased as precipitation event size and/or intensity increased. This result is expected, as the features become saturated over time during larger events and cannot infiltrate as much water, directing more water towards the underdrain.

Both sites had the highest volume reductions during autumn and lowest during spring. The higher groundwater table due to spring freshet had a greater impact on performance of these sites than the intense summer thunderstorms. This is supported by higher levels seen in the groundwater wells in spring.

Based on the data so far, no decrease in performance was seen with increasing feature age, or with different antecedent conditions.

4.3.2 Peak Flow Reductions

An important benefit of LID features over conventional stormwater infrastructure is the lowering of peak flows and delayed hydrograph response time. Infrastructure damage and flooding can occur when the amount of stormwater at one time is higher than the stormwater system's maximum capacity. While paved surfaces produce runoff almost instantaneously with precipitation, LID features provide some lag time between rainfall and runoff. LID features capture the first few millimeters of rainfall for storage, infiltration, or evaporation, and slow down stormflow as it slowly moves through the feature. Even in features without any volume reduction, delaying and spreading out the stormwater flow can help "flatten the curve" and keep the peak flow within the stormwater system capacity, lowering the chance of flooding and damage without lowering the total stormwater volume.

Peak flow reduction and lag time were calculated for the events at IMAX by comparing the 10-minute period with the highest estimated inflow with the 10-minute period with the highest outflow that occurred at the same time or after the peak inflow (Table 9). For each of these events, both sites reduced and delayed the peak flow. For the largest and most intense storms, the permeable pavement sites at IMAX help relieve pressure on the local stormwater system when it is most stressed by delaying the time of peak flow and reducing its volume.

Table 9: Peak flow reduction and peak lag time for the permeable pavement sites at IMAX for the three largest events in the study period.

Starting date and time	Total event precipitation (mm)	Peak event precipitation (mm/h)	IX-5		IX-6	
			Peak flow reduction (%)	Lag time (h)	Peak flow reduction (%)	Lag time (h)
2014-07-27 19:00	66.0	44.4	72%	1.17	79%	0.33
2015-06-27 10:40	64.2	22.8	85%	9.83	94%	10.50
2015-10-28 02:10	59.6	13.2	47%	0.83	59%	1.00

4.3.3 Permeable Pavement Water Quality

The runoff volume reduction due to infiltration at the permeable pavement sites can also help improve water quality of downstream surface water bodies as less stormwater, and therefore lower contaminant loads, flow into downstream surface water receivers. Both sites surpassed the MECP guideline for enhanced water quality treatment of 80% total suspended solids reduction (Table 10). Due to its much higher runoff volume reductions, IX-6 also had higher pollutant load reductions for all parameters of interest. IX-5 also provided pollutant load reductions for all parameters except for nickel. The negative percent reduction for nickel at this site is likely caused by the estimated influent value being slightly lower than the actual influent value, and little to no nickel reduction by the feature. Particulates from vehicles is a likely source of nickel at this site (Burton and Pitt, 2002). Full event-by-event water quality results are shown in Appendix D. These results indicate that permeable pavement can be effective in reducing total pollutant loads to nearby surface water receivers.

Table 10: Pollutant load reductions for parameters of interest at IX-5 and IX-6.

Parameter	IX-5	IX-6
Count	170	171
Total suspended solids	87%	99%
Total phosphorus	85%	98%
Orthophosphate	63%	88%
Nitrate + nitrite	21%	92%
Total ammonia nitrogen	88%	99%
Total Kjeldahl nitrogen	80%	99%
Aluminum	21%	96%
Copper	70%	97%
Iron	41%	97%
Lead	66%	91%
Nickel	-4%	93%
Zinc	66%	97%

4.4 Does infiltration from the LID features impact the quality of local soil and groundwater?

The LID features at IMAX all promote infiltration and capture stormwater runoff on site, which helps lower the amount of runoff and associated contaminants that can enter the local stormwater system. Some of these contaminants are trapped by the bioretention vegetation, the Jellyfish Filter, and Sorbtive Media Vault. However, any infiltrated stormwater can still affect the soil in the bioretention swales or the local groundwater system. Three different aspects of this were studied at IMAX:

- Soil sampling at the bioretention swales at different times, depths, and locations was used to see if concentrations of stormwater contaminants were increasing in the bioretention soils;
- A portion of the permeable pavement was surrounded by an impermeable liner to determine its effectiveness at limiting infiltration; and,
- Groundwater levels, temperature, and chemistry were monitored to determine any impact the LID features at IMAX were having on the local groundwater system.

4.4.1 Bioretention Soil Chemistry

As the bioretention swales are designed to filter and trap stormwater pollutants, it is possible these pollutants will accumulate within the soil of the feature. This accumulation may lead the soil concentration of these parameters to rise above guideline values and may indicate the need for increased maintenance of the feature. Changes over time, depth, and length (upstream vs downstream end of the swale) of soil chemistry for parameters of interest were analyzed for the IMAX bioretention swales. Changes over time will show if the bioretention swale is accumulating any of these observed stormwater parameters. Changes in depth will show if concentrations are higher in the shallow part of the swale where the stormwater enters or where they settle in the deeper part of the swale. An increase in the upstream end versus the downstream end will show if the pollutants are concentrated near the inlet into the bioretention swale or if they settle as they move throughout the feature.

Soil sampling results for selected parameters are shown in Figure 18, with additional results in Appendix E. Many of the sites showed an increase over time for concentrations of acid-extractable phosphorus. For IX-2 and IX-3, the upstream portion had a higher phosphorus concentration than the downstream portion for the majority of sampling periods and locations. No trend could be established over depth. Thus, phosphorus does appear to be accumulating in the bioretention swales and is more concentrated near the inlets at the upstream end. For orthophosphate, there was no obvious trend over time and depth. At IX-3, the downstream locations always had a higher concentration of orthophosphate than the upstream locations.

Nitrate + nitrite concentrations (see Appendix E) were mostly non-detect, however there were an increasing number of values over the detection limit over time. Most of the more recent results were over the detection limit. There was no trend over length and depth. Total Kjeldahl nitrogen increased over time at some, but not all locations. For most of the sites, the downstream location had a higher concentration than the upstream location. Total ammonia was also analyzed, however all the results were under the detection limit of 20 µg/g. Nitrate + nitrite and total Kjeldahl nitrogen may be accumulating in the bioretention swales, however this is not conclusive based on the data collected.

There were no consistent trends from the results of metals across any of the sites in terms of changes over time, depth, and length. Parameters at sites where an increase over time was observed included copper and iron at IX-2 and iron and zinc at IX-3. All cadmium results were under the detection limit. Overall, it does not appear that metals are accumulating in the bioretention swales.

Figure 18: Selected soil sampling results. Note that the shallow inlet, shallow outlet, and deep outlet results are overlapping for the 2019 phosphorus sample at IX-4.

4.4.2 Performance of Impermeable Liner for Permeable Pavement Systems

In areas where there is concern about polluting shallow groundwater, such as Source Water Protection Areas, an impermeable liner can be placed around the permeable pavement system. While this will not provide runoff volume reduction, it will still provide benefit to local stormwater systems by slowing down stormwater runoff and reducing peak flows. To investigate the performance of using impermeable liners, one was installed under a small section of the permeable pavement lot with the clearstone bedding material and designated as site IX-7. As the site is not an area of groundwater sensitivity, it is a good location to test the lined permeable pavement design. If effective, lined systems could be used in groundwater sensitive areas such as CVC's upper watershed to maintain baseflow in streams while protecting groundwater quality from numerous contaminants such as constituents of road salt. A collection system was installed below the impermeable liner to monitor for leakage.

Over the monitoring period, approximately ~12% of the estimated runoff was measured as discharge (103 m^3 of 842 m^3). Runoff reduction of at least 50% was seen for all but one storm event. Full event by event hydrology data is shown in Appendix C. Visual confirmation and manual measurements ruled out the possibility of equipment malfunction of the level logger. These results suggest that there is considerable leakage somewhere in the system. Possible locations include:

- Around the weir
- Through the concrete in the sump
- Through the liner

Weir leaks were observed from time to time; however this data was not used for the analysis and these leaks were patched as soon as possible. While a leak in the sump is possible, water between events would usually stabilize near the weir notch, and little water was visually observed flowing into the sump between events.

The three stilling wells installed under the liner at IX-7 can be used to provide additional information (locations of monitoring sites in Figure 10; note that the stilling wells extend laterally under IX-7). During almost all events, water levels rose in the wells, indicating the presence of water under the impermeable liner.

These increases could be due to a number of factors, a leak in the impermeable liner, water moving laterally from the edges of the impermeable liner during events, or a combination of both. Since the stilling well located in the middle, IX-7S4, has the lowest increases and slowest response compared to the other two located closer to the edges, it is likely that either there was leakage around the edges and/or corner of the liner, water was moving in from outside IX-7's drainage area, or some combination of both. However, water from outside IX-7's drainage area would not account for the volume reductions at IX-7. If lined systems are to be used when infiltration isn't desirable, special care should be taken to ensure the liner is completely impermeable. The appropriate product selection, implementation staging notes, and installation oversight are critical to achieve this outcome effectively.

The median total suspended solids concentration of sampled water at IX-7 was 42 mg/L, which is much higher than the IX-6 median of 13.5 mg/L, despite having the same base material. The only difference between the two sites is the impermeable liner at IX-7. The high total suspended solids concentrations may be due to the possible leak or bypass of the liner filtering out suspended solids, leaving the water entering the underdrain and the outlet to have a much higher concentration.

4.4.3 LID Influence on Local Groundwater

The LID features at IMAX help reduce stormwater volume and pollutant loading by increasing the infiltration of stormwater into the ground. This infiltrated water may eventually reach the groundwater table, increase groundwater recharge, and increase groundwater contaminant levels. To address these concerns, groundwater has been monitored at the IMAX LID site. Four wells were installed with the locations shown in Figure 10. The groundwater flow direction at IMAX is from NWW to SEE, making MW-07 and MW-08 the upgradient wells, and MW-05 and MW-06 the downgradient wells. However, MW-07 is installed within the permeable parking lot, and thus may also be influenced by infiltration at this site.

Table 11: Groundwater monitoring wells at IMAX.

Well name	Depth (m)[a]	Screen length (m)[a]	Surficial geology[a]	Screened layer geology[a]	Level monitoring period	Quality monitoring period
MW-05	3.96	3.96 to 0.96	Halton till	Halton till	April 2013 to May 2019	June 2012 to November 2018
MW-06	4.27	3.96 to 0.96	Halton till	Halton till	November 2013 to May 2019[b]	November 2013 to November 2018[b]
MW-07	5.49	5.00 to 3.00	Halton till	Georgian Bay shale and Halton till	April 2013 to May 2019	June 2012 to November 2018
MW-08	4.57	4.75 to 1.70	Halton till	Queenston shale	April 2013 to May 2019	June 2012 to November 2018

[a]Information from Groundwater Monitoring Strategy (CVC, 2018b)

[b]MW-06 has a shorter monitoring period due to damage to the original well during construction, requiring a new well to be created.

Precipitation generally increased over the study period at IMAX, with every year from 2015 to 2018 having more precipitation than the previous year. MW-06, MW-07, and MW-08 all show a similar patterns of a higher annual mean water level in 2014, a lower water level in 2015 (the driest year in the monitoring period), and higher annual mean water levels from 2016 to 2018 (Figure 19). MW-05 has a different pattern, with the annual mean water level increasing from 2014 to 2016, and then staying stable. If increased infiltration due to the LID features at IMAX were having a large impact on groundwater levels, it would be expected that the downgradient wells would show an increase not seen in the upgradient wells. This is not the case, as MW-06 has a similar pattern to MW-07 and MW-08, and MW-05 has not been increasing since 2016. Based on the available data, it is unlikely the LID features at IMAX have contributed to an increase in groundwater downgradient of the site.

MW-06, MW-07, and MW-08 all showed a similar seasonal pattern, with higher groundwater levels through the spring months, and the lowest in the late autumn and early winter. This matches the general hydrological pattern in the watershed. While MW-05 did generally have higher levels in the spring than the autumn, the difference was much less pronounced than at the other sites.

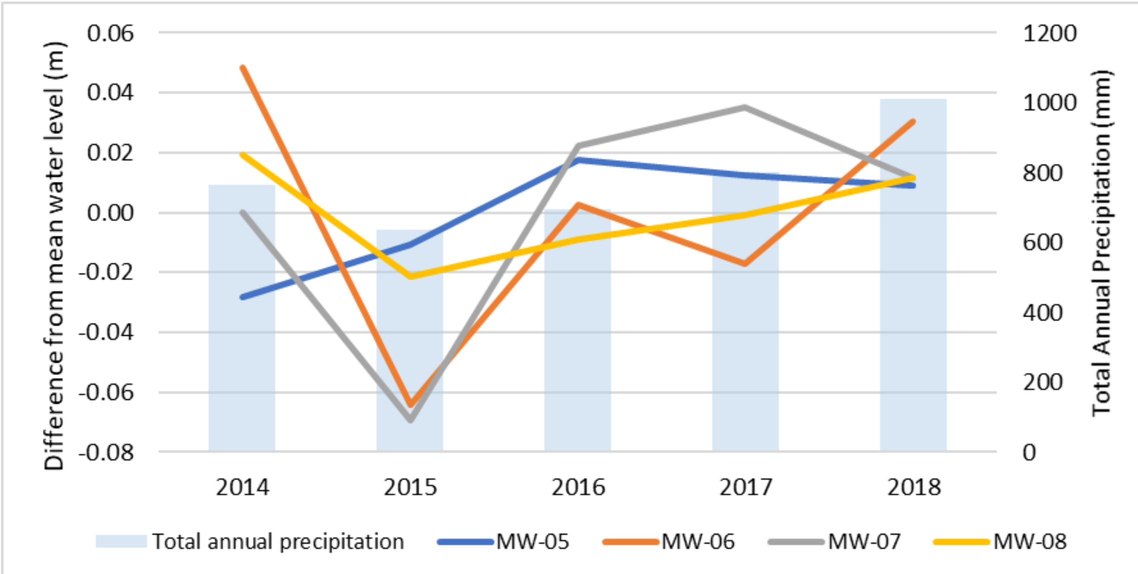

Figure 19: Total annual precipitation and groundwater levels at IMAX. Groundwater levels are shown as the difference between the annual mean and the mean for the entire timeframe.

Increased infiltration of stormwater due to LID features may affect the local groundwater temperature. At IMAX, the mean annual water temperature of the groundwater in all wells followed a similar pattern to the mean annual air temperature (Figure 20), with the lowest values in the coldest full year of the study period (2014) and the highest in the warmest year (2016). The two warmest wells (MW-05 and MW-07) are the two installed within the permeable pavement, as opposed to just outside the well. These results may be influenced by thermal exchange with the pavement surface. There is no obvious pattern between the upgradient and downgradient wells, as the two downgradient wells are between the temperatures of the two upgradient wells. Based on these results, it is not apparent if the LID features at IMAX are causing a change over time in groundwater temperatures.

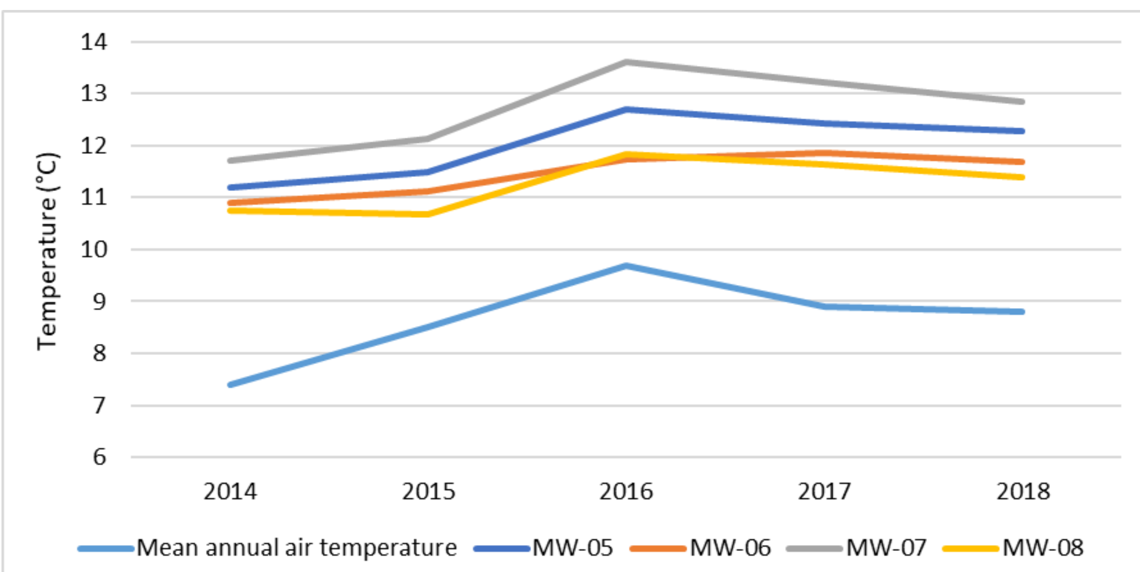

Figure 20: Mean annual temperature for IMAX groundwater wells.

The stormwater infiltrated through LID features will likely reach the local groundwater. This can contaminate nearby drinking water wells. There are no drinking water features near the IMAX project site, making it a good location to assess the water quality impacts of LID features on nearby groundwater.

Chloride is very conservative in the environment and is unlikely to be filtered out by LID features. Any reduction in chloride loads to stormwater systems or surface water bodies would be due to infiltration, which is just shifting the chloride load to the shallow groundwater system. Runoff of roads and parking lots, often high in chloride due to winter road salting, may then contribute a considerable amount of chloride to local groundwater.

The two downgradient wells, MW-05 and MW-06, along with MW-07 (upgradient, but located within the permeable parking lot) had much higher chloride concentrations in both spring and autumn than MW-08 (Figure 21). The greatest difference between spring and autumn chloride concentrations was at MW-05, with an over 1000 mg/L difference between the mean value of the two seasons. MW-07 also had higher values in the spring compared to the autumn. There were no seasonal patterns for MW-06 and MW-08.

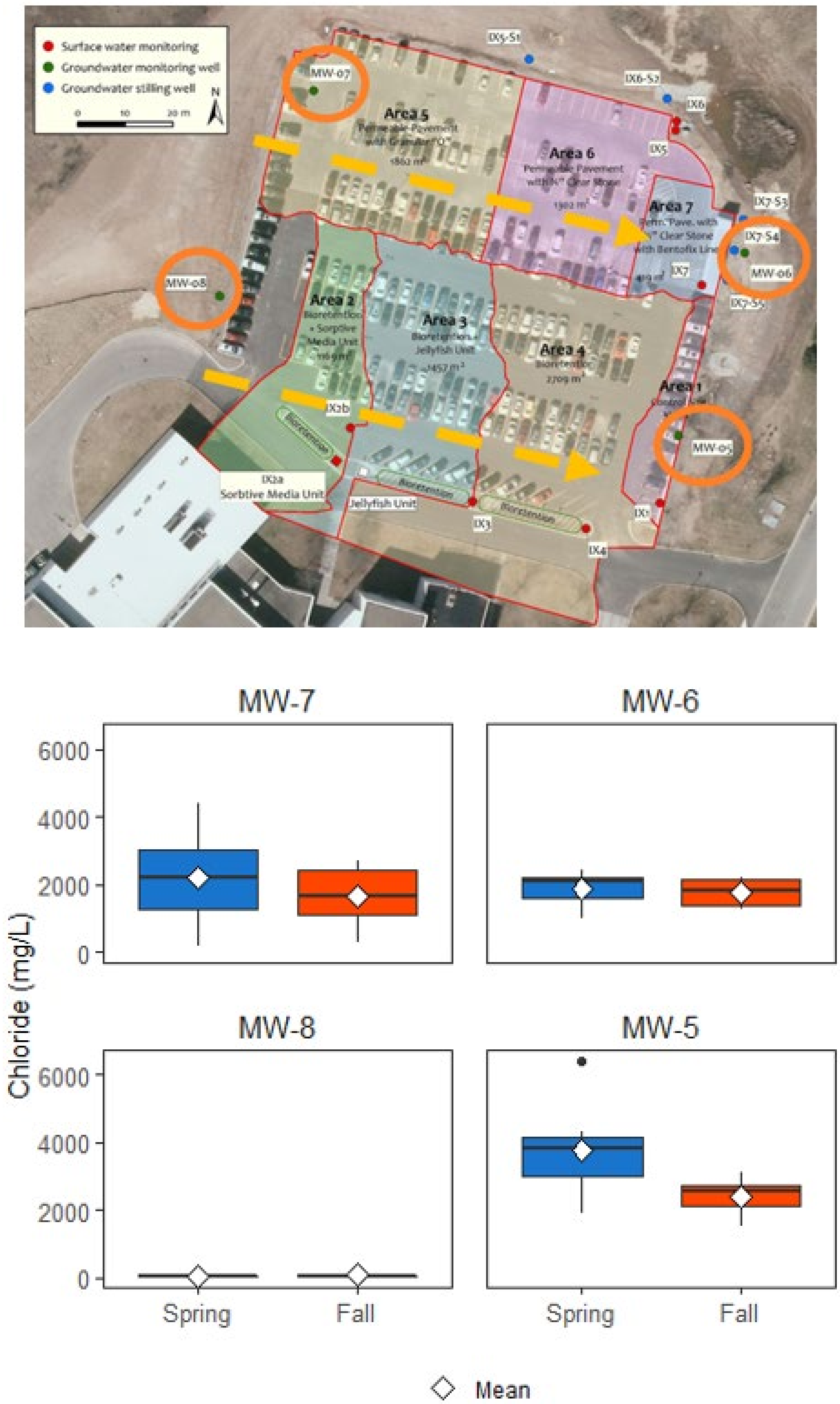

Figure 21: Seasonal chloride concentrations at the four groundwater wells at IMAX, with the map provided for context. Arrows indicate hydraulic gradient.

Peak concentrations for MW-05 and MW-07, the sites with a clear seasonal difference, are in 2015 and 2014, respectively (Figure 22). These were springs after colder winters that possessed longer periods of snow cover. Chloride concentrations at MW-06 were steadily increasing in both seasons and are consistently low at MW-08.

These results indicate that it is likely chloride from road runoff is entering the groundwater at the IMAX project site. There is likely a stronger connection at MW-05 and MW-07, at which concentrations are higher in spring and in years with colder winters. While MW-07 is considered upgradient based on the regional groundwater flow, these results indicate it is very likely influenced by the permeable pavement parking lot it is located in. Another possibility is that MW-08 is located in a geologic unit that is hydrogeologically separate from the other wells and thus not representative of upgradient groundwater conditions, however the groundwater level results show that this is unlikely. If groundwater contamination is a concern, properly installed liners should be used to inhibit infiltration.

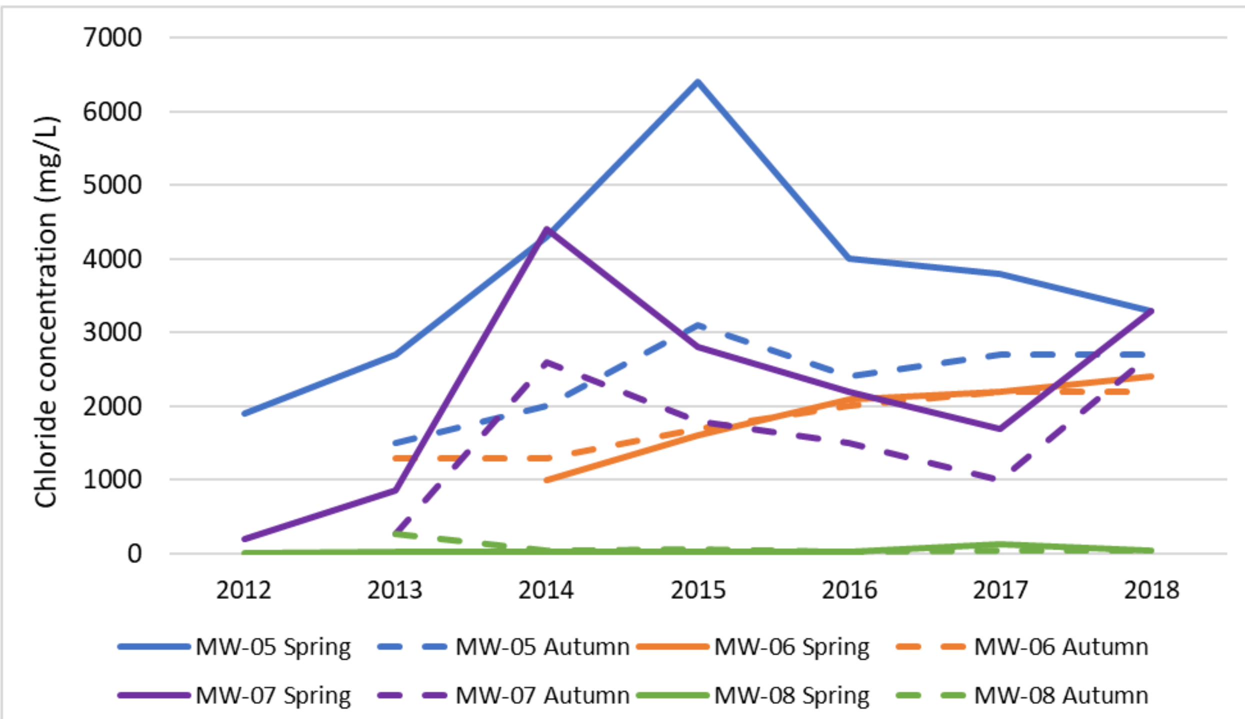

Figure 22: Groundwater chloride concentrations over time at IMAX wells.

The median concentration of parameters of concern in the IMAX groundwater wells are displayed in Table 12 with full results shown in Appendix F. MW-08 had the highest median concentration for all nutrients. These results may be due to the large field just upgradient of this well. Many of the dissolved iron, copper, and lead results were non-detects, however the largest concentrations were seen at MW-06. This site is directly downstream of the permeable pavement sites, which had detectable concentrations of these metals in stormwater effluent. MW-05 had the highest total dissolved solids, chloride, and sulfate values, while the lowest of these were observed at MW-08. Alkalinity was highest at MW-05 and MW-06 and lowest at MW-07 and MW-08. Major cations were generally highest at MW-05 and lowest at MW-08; however, MW-06 had the highest concentration of magnesium. Based on the difference in chemistry between MW-05, MW-06, and MW-08, it is clear that the stormwater features at IMAX are infiltrating into the groundwater. It is also likely that MW-07 is influenced by these features and is not a true upgradient well.

Most of the sites do not have an increasing trend over time for many of the parameters. The one exception being MW-06, which has increasing values over time for chloride, copper, calcium, magnesium, and sodium. There is no clear seasonal trend with these. It is possible road salt is a major contributing factor but travels slow enough in this area to cause a long-term increase versus a seasonal pattern, and/or there may be other sources of chloride and these metals. As the permeable pavement sites all have detectable concentrations of these parameters, they are likely a source through infiltration. The other parameter with a clear increasing trend is alkalinity at MW-05. The fact that there is no temporal trend for most of the groundwater contaminants other than a few at MW-06 indicates that if the groundwater quality at the site is being influenced by infiltration from stormwater features, it does not appear to be getting negatively impacted over time.

Table 12: Median groundwater chemistry results at IMAX wells. Site with the highest median concentration in bold, and the lowest in italics.

Site		MW-05	MW-06	MW-07	MW-08
Number of samples		14*	12**	14*	14*
		All concentrations in mg/L			
Total Dissolved Solids		**6530**	4315	3840	*556*
Nutrients	**Total Phosphorus**	*0.205*	1.045	0.765	**1.2**
	Orthophosphate-P	*<0.02*	*<0.02*	*<0.010*	**0.042**
	Nitrate + Nitrite	*<0.10*	0.105	0.51	**0.54**
	Total Ammonia-N	0.22	0.785	*<0.050*	**1.75**
	Total Kjeldahl Nitrogen	0.58	1.3	*0.465*	**2**
Metals	**Dissolved Iron**	*<0.10*	**1.6**	*<0.10*	*<0.10*
	Dissolved Copper	*<0.0050*	**0.16**	*<0.0050*	*0.0012*
	Dissolved Lead	<0.0005	<0.0005	<0.0005	<0.0005
Anions and Alkalinity	**Dissolved Chloride**	**2900**	2050	1750	*34.5*
	Dissolved Sulphate	**225**	190	215	*52*
	Alkalinity (Total as CaCO3)	620	**640**	*300*	330
Cations	**Dissolved Sodium**	**1600**	440	770	*110*
	Dissolved Magnesium	190	**350**	160	*21*
	Dissolved Calcium	**460**	**460**	270	*43*
	Dissolved Potassium	*15*	**32**	22	20

*13 samples for metals,**11 samples for metals.

4.5 What are the operation and maintenance requirements of bioretention swales and permeable pavement in a commercial office parking lot over the long-term?

Understanding the maintenance needs of the LID facilities is a priority for the monitoring program at IMAX as researchers and practitioners need to assess if these technologies are feasible for implementation across municipal regions with a similar climate. Knowledge of the maintenance needs and life-cycle costs of LID features is also an important component of CVC's IPRA program. Concerns regarding this topic are one of the largest barriers to wide-scale LID implementation.

To inform facility performance, required maintenance activity frequency, and life-cycle costs, CVC conducts site inspections to track the conditions of facility components. For the winter season a different inspection form is used as attributes that inform maintenance are different. The full list of attributes inspected at each facility type located at IMAX is provided in Table 13, and the inspection forms are provided in Appendix G.

Table 13: Inspection attributes by feature and season.

	Spring-Autumn	Winter
Bioretention Swales	• Evidence of erosion • Sediment accumulation • Trash and debris accumulation • Evidence of ponding • Evidence of bare soil • Inlet/outlet blocked/available to accept flow • Vegetation condition	• Snow storage • Salt staining • Evidence of ponding • Inlet/outlet blocked/available to accept flow • Structure damage
Permeable Pavement	• Evidence of erosion • Sediment accumulation • Trash and debris accumulation • Evidence of ponding or clogging • Inlet/outlet blocked/available to accept flow	• Snow storage • Salt staining and granules • Evidence of ponding or clogging • Inlet/outlet blocked/available to accept flow • Structure damage

During the 2013-2018 monitoring period, 61 site inspections were completed at IMAX across all seasons to understand changes in the LID facilities' conditions and identify any seasonal trends. Presented below are the key observations from the monitoring period for the bioretention swales, permeable pavement, winter inspections, along with maintenance and life-cycle costs.

4.5.1 Bioretention Swales

Over the course of the monitoring period, inspections showed a gradual increase in the volume of sediment and erosion within each facility. Most sediment accumulation is concentrated near inlets and in the center of the bioretention swales (Figure 23, left image). The curb cut inlets with a river rock spillway help to focus maintenance activities in the facility and reduce the risk of sediment clogging the entire facility; Figure 23 (right image) shows sediment deposits at two inlets.

Figure 23: Accumulation of sediment in the centre (left) and inlets (right) of a bioretention swale.

Small deposits of sediment were noted at the inlet spillway into the Jellyfish Filter unit. Few occurrences of sediment in the bioretention swale were documented, indicating the Jellyfish Filters are effective at reducing sediment loading as a pre-treatment device (Figure 24).

Figure 24: Jellyfish Filter unit pre-treating runoff reducing sediment entering the bioretention swale.

Site inspections documented an increase in erosion and exposure of bare soil. Mulch was used to enhance visual aesthetics and reduce weed growth in each facility, but it was easily dispersed throughout the bioretention swales during events and carried away into the facility overflows (Figure 25).

Figure 25: Movement of mulch exposing bare soil.

The bioretention swale without additional treatment (IX-4) was susceptible to erosion and exposure of bare soil, likely due to receiving flows greater than its design capacity. During several inspections mulch was observed on the overflow basket cap in this swale indicating the flow rate entering the facility was greater than the rate of infiltration. If the mulch is quickly washed away with high flows in the facility, it is not providing its intended benefit and may increase maintenance costs as mulch needs to be replaced at a greater frequency. Since the anticipated benefits of the mulch were not being achieved in the bioretention swales it was removed after the first year of monitoring.

After the mulch layer was removed, occurrences of erosion and exposure of bare soil continued in specific areas due to the rate of runoff entering the facilities. Once the vegetation in the bioretention swales became larger and more established, evidence of erosion and bare soil was reduced as the larger plant roots helped to stabilize the soil. The presence of invasive weeds increased slightly after the first two years of monitoring but were then eliminated almost entirely by the end of the monitoring period as the native plants became more established (Figure 26).

Figure 26: Weeds in the inlet section of a bioretention swale.

4.5.1.1 Bioretention Swale Winter Inspections

Inspections during winter months observed that the bioretention swales were frequently snow covered and inlets and outlets were blocked with snow (Figure 27). Plowed snow from the parking lot has a specific storage location along the south and north edges of the parking lot and is not typically stored near the bioretention swales. Small amounts of plowed snow are frequently left along the curbed edges of the bioretention swales as the snowplow maneuvers around these facilities. Near the end of the monitoring period, staff observed snow being stored in the bioretention swales. This limits the facility's ability to collect and filter water and may cause ponding on the parking lot from overflow. However, ponding was seldom observed during inspections, suggesting runoff from melt and rain events can still move freely through the facility during winter conditions when natural snow accumulation occurs.

Figure 27: Bioretention swale used for snow storage.

4.5.2 Permeable Pavement

For most of the monitoring period, inspections did not indicate an accumulation of sediment, trash and debris, or erosion in the permeable pavement areas. A minor accumulation of each was observed in the final year, mainly in the lined area (IX-7). This observation is attributed to the small size of this catchment in comparison to the others allowing the inspector to identify small changes in attributes. Additionally, most of the lined facility is within the parking lot thruway and borders the asphalt section of the parking lot. The finished grade of the asphalt parking lot is a slightly higher elevation than the permeable pavement section, allowing sheet flow from the asphalt onto the pavers where sediment accumulates in the paver joints (Figure 28, left). The asphalt section along the edge of the pavers is observed to have a greater number of surface cracks from yearly freeze-thaw cycles than the rest of the asphalt parking lot (Figure 28, right).

These cracks may be due to the movement of sheet flow from the asphalt to the pavers where water infiltrates along the edges of the asphalt and is stored in the subbase. These cracks will need to be repaired or filled with paving tar to prevent more severe cracking from occurring. Much of the sediment in the unlined permeable pavement lots was observed around the light posts where the pavers sank due to the compaction of the paver subbase to secure the light post base. Accumulation of sediment in the paver joints is anticipated over time as parked cars carry sediment into the parking lot from the roadway in tire treads. Maintenance by a vacuum sweeper can be used to remove this sediment.


Figure 28: Sediment accumulation in paver joints at the lined facility (left), surface cracks where asphalt meets permeable pavement (right).

4.5.2.1 Permeable Pavement Winter Inspections

During each winter inspection, salt stains were documented across the permeable pavement parking lot. Although salt staining does not impact the flow of stormwater into the pavers, it could be perceived as an aesthetic flaw. However, over the course of winter inspections no occurrences of ice or snow were observed in the permeable pavement catchments. Occasionally residual salt granules were observed in the paver joints, along with persistent salt staining (Figure 29). This may indicate an opportunity to reduce the amount of salt applied on the parking lot if enough salt has been applied to eliminate ice and sleet that may cause a slip and fall hazard.

Several agencies, including the Region of Peel and the Government of Canada, have provided guidance on the appropriate application of salt for de-icing which should be reviewed to determine the best application load both for ice and sleet management and to limit the impact of salt loading into urban streams. There are many other de-icers that can be applied to the parking lot instead of salt and are often more environmentally friendly. The Sustainable Technologies Evaluation Program (STEP) provides a detailed analysis on alternatives to salt for de-icing as well as cost comparisons, titled Alternatives to Salt: What else melts snow and ice? (STEP, 2020).


Figure 29: Residual salt within paver joints, and salt staining on the permeable pavement.

4.5.3 Structural Damage

During snow removal, curbs along the perimeter of the parking lot and each bioretention swale are vulnerable to being damaged by snowplow maintenance of the site. Curbs are often damaged in locations where the curb extends inward into the lot, even when the curb edge is marked to notify the snowplow operator of the edge. To reduce minor repair costs to the parking lot, curb extensions into the parking lot could be removed from future parking lot designs in favor of outward curb extensions which would also provide additional parking for smaller vehicles.

Minor chips and paver heaving were observed in small areas across the parking lot in the final year of the monitoring period (Figure 30). Chips and cracks in pavers are common and caused either by age or the freeze-thaw process lifting individual pavers while others may settle. This process is common in winter and early spring and will cause some pavers to be struck by the snowplow blade while snow is being cleared.

Figure 30: Minor chips in permeable pavers.

4.5.4 Maintenance and Life-cycle Costs

During the monitoring period CVC completed two interviews with the IMAX facility manager to collect information on the time and cost required to maintain the LID facilities. Information from the interviews is summarized in Table 14.

Snow removal, salting, and general landscaping are common maintenance activities even if LID practices are not part of a property's maintenance plan. The STEP LID life-cycle costing tool (found at https://sustainabletechnologies.ca/lid-lcct/) can be used to estimate maintenance costs (TRCA, 2019).

Snow removal and salting of the permeable pavement is completed the same way as an asphalt parking lot and would not necessitate any additional costs other than what would already be required for winter parking lot maintenance. Better salt management practices including a reduction in application rates are still recommended for the permeable pavement surface, potentially resulting in salt application reductions and cost savings over time. However, the permeable pavement parking lot will need to be swept or vacuumed to remove sediment build up in the paver joints to avoid clogging. CVC and STEP recommend this maintenance task to be done annually (TRCA, 2016). The permeable pavers did not receive any vacuuming or inspections during the monitoring period. As a note, monitoring staff did not observe any significant clogging of the pavers that would warrant immediate action.

The greatest maintenance expense to IMAX is the cost of maintaining the Jellyfish Filters and the Sorbtive Media Vault. The Jellyfish Filters are typically replaced yearly, and the Sorbtive Media fabric was replaced in 2017. These features require specialized equipment and expertise to maintain and replace components. Understanding the long-term benefits of the Jellyfish Filter pre-treatment and whether the treatment extends the lifespan of the media in the bioretention swale compared to the two swales without pre-treatment would help to prepare a cost-benefit analysis on necessary pre-treatment maintenance verses bioretention rehabilitation.

Table 14: Summary of IMAX facility manager LID facility maintenance interviews.

	Bioretention Swales	Permeable Pavement	Jellyfish Unit and Sorbtive Media Chamber
Maintenance Activities	• Weeding • Pruning • Trash removal • Cutting back perennials • Removing dead plant debris • Clearing inlets	• Salting • Snow removal • Paver replacement	• Jellyfish filter cleaning • Replacing Sorbtive fabric • Annual inspection
Maintenance Performed by	Fern Ridge Eco Landscaping Inc.	Property management contractor	Minotaur Stormwater Services Limited
Time Spent on Maintenance	40 minutes	Unknown	Unknown
Maintenance Frequency	Every 2 weeks	Unknown	Jellyfish inlet sump: When sediment depth of 12 inches or greater or every 3 years (whichever occurs first)[a] Jellyfish Filter: Yearly or as necessary as based on inspection[a]
Costs	Not provided. Included in cost of maintaining the entire IMAX property (lawns and gardens)	Unknown	Annual inspection: $395 Jellyfish Filter cleaning and Sorbtive Chamber fabric replacement in 2017: $9,210

[a]Estimates from the Jellyfish Filter Owner Manual (Imbrium, 2020)

4.6 What are the overall water quantity and quality benefits to the receiver downstream of LID features?

LID features were installed at IMAX to improve the parking lot drainage and provide water quantity and quality benefits to Sheridan Creek and Rattray Marsh, a provincially significant wetland. To see how effective these features were, they were evaluated by looking at total runoff volume reduction and pollutant load reductions. Runoff volume reductions represent the proportion of stormwater that is captured at the source and does not enter the local stormwater system, providing erosion control benefits to downstream receivers. Pollutant load reductions signify the proportion of stormwater contaminants captured by these features. A 100% pollutant load reduction would mean all contaminants are effectively captured, while a negative reduction means the feature acts as a source of that parameter.

Seasonal and long-term patterns for all sites were also examined. Weather patterns during the changing seasons in southern Ontario may lead to differing LID performance. Due to concerns about accurate water balances during the winter season due to snow removal and snow storage, only concentration results (as opposed to volume and load reductions), were analyzed for winter data. Annual volume reductions were compared at all sites to see if there was a decrease in performance over time due to clogging of the features.

4.6.1 Total Runoff Volume and Pollutant Load Reductions

The LID features at IMAX provided both a water quantity and water quality benefit to the downstream receivers. Overall, the six LID catchments had a combined runoff volume reduction of 64%, lowering the amount of water directed to the local stormwater system by more than half. The features were also effective water quality treatment devices, with an overall total suspended solids reduction of 92%, total phosphorus reduction of 76%, and orthophosphate reduction of 22%.

Overall runoff volume and load reductions for all sites are shown in Table 15. Full event by event hydrology data is shown in Appendix C, and water quality data in Appendix D. Runoff volume reductions ranged from 47% to 93%. All sites met the MECP guideline for enhanced water quality treatment of 80% total suspended solids reduction with the lowest reduction being 87%. All sites provided load reductions for almost every parameter, with three exceptions (orthophosphate at two locations, and nickel at one).

Table 15: Total runoff volume and pollutant load reductions for IMAX LID sites. Negative load reductions in italics.

	IX-2	IX-3	IX-4	IX-5	IX-6	IX-7
Site Details	**Bioretention Swales**			**Permeable Pavement**		
	With Sorbtive Media Vault	**With Jellyfish Filter**	**No additional treatment**	**With Granular ‘O’ bedding**	**With 20mm Clearstone bedding**	**With 20mm Clearstone bedding and liner**
Water quantity (runoff volume reductions)						
Runoff volume reduction	75%	63%	56%	47%	93%	88%
Water quality (pollutant load reductions)						
Total suspended solids	94%	95%	92%	87%	99%	89%
Total phosphorus	85%	57%	62%	85%	98%	97%
Orthophosphate	71%	*-52%*	*-35%*	63%	88%	90%
Nitrate + nitrite	73%	38%	45%	21%	92%	86%

	IX-2	IX-3	IX-4	IX-5	IX-6	IX-7
Site Details	**Bioretention Swales**			**Permeable Pavement**		
	With Sorbtive Media Vault	**With Jellyfish Filter**	**No additional treatment**	**With Granular 'O' bedding**	**With 20mm Clearstone bedding**	**With 20mm Clearstone bedding and liner**
Water quantity (runoff volume reductions)						
Total ammonia nitrogen	96%	94%	89%	88%	99%	86%
Total Kjeldahl nitrogen	87%	82%	79%	80%	99%	94%
Aluminum	85%	90%	83%	21%	96%	87%
Copper	80%	77%	71%	70%	97%	90%
Iron	87%	92%	89%	41%	97%	91%
Lead	60%	55%	61%	66%	91%	78%
Nickel	83%	80%	78%	*-4%*	93%	71%
Zinc	94%	93%	90%	66%	97%	93%

4.6.2 Seasonal and Long-term Patterns

Volume reduction by season is displayed in Table 16. For the purpose of this study, meteorological seasons were used, and winter data was not included in this table. At all sites, the highest volume reductions were found in autumn. For the three bioretention sites, the lowest volume reductions were in the summer. This was due to the higher number of intense precipitation events in the summer relative to the other seasons. All three permeable pavement sites, however, had the lowest volume reductions in the spring. This indicates that compared to the bioretention sites the higher groundwater tables due to spring freshet had a greater impact on performance of these sites than the intense summer thunderstorms. This is supported by higher water levels seen in the groundwater wells in spring.

Table 16: Volume reduction by season for the LID features at IMAX. The highest seasonal load reductions are bold, and the lowest are shaded.

Monitoring station	Spring	Summer	Autumn
IX-2	74.4%	70.3%	**80.1%**
IX-3	59.8%	59.1%	**72.4%**
IX-4	56.6%	51.6%	**60.3%**
IX-5	37.4%	45.1%	**56.0%**
IX-6	92.1%	94.0%	**94.4%**
IX-7	84.1%	88.3%	**92.0%**

Due to the difficulties calculating winter water balances, winter data could not be used to determine volume reductions and load reductions. However, water quality samples were collected year-round at the bioretention sites. While these winter samples may not be able to provide good load reduction information, they can still provide information on the quality of water exiting the site. Depending on snow removal practices, snow that falls on one catchment may be moved to another, bringing pollutants with it. This may affect some of the results and be the cause of some of the differences seen.

Results show that at all sites the highest total suspended solids and total phosphorus concentrations were found in spring and the lowest in autumn (Figure 31 and Figure 32). The autumn results especially show that it is important to not rely on data from only one season when evaluating performance. In the winter and spring, the vegetation in the bioretention swales is not as well established, which may limit filtration of these contaminants. In addition, spring results may include runoff from melting snow, which would collect pollutants throughout the cold weather season. The additional pollutants due to the melting snow may collect on both the parking lot and surface of the swales, slowly being released through the system.

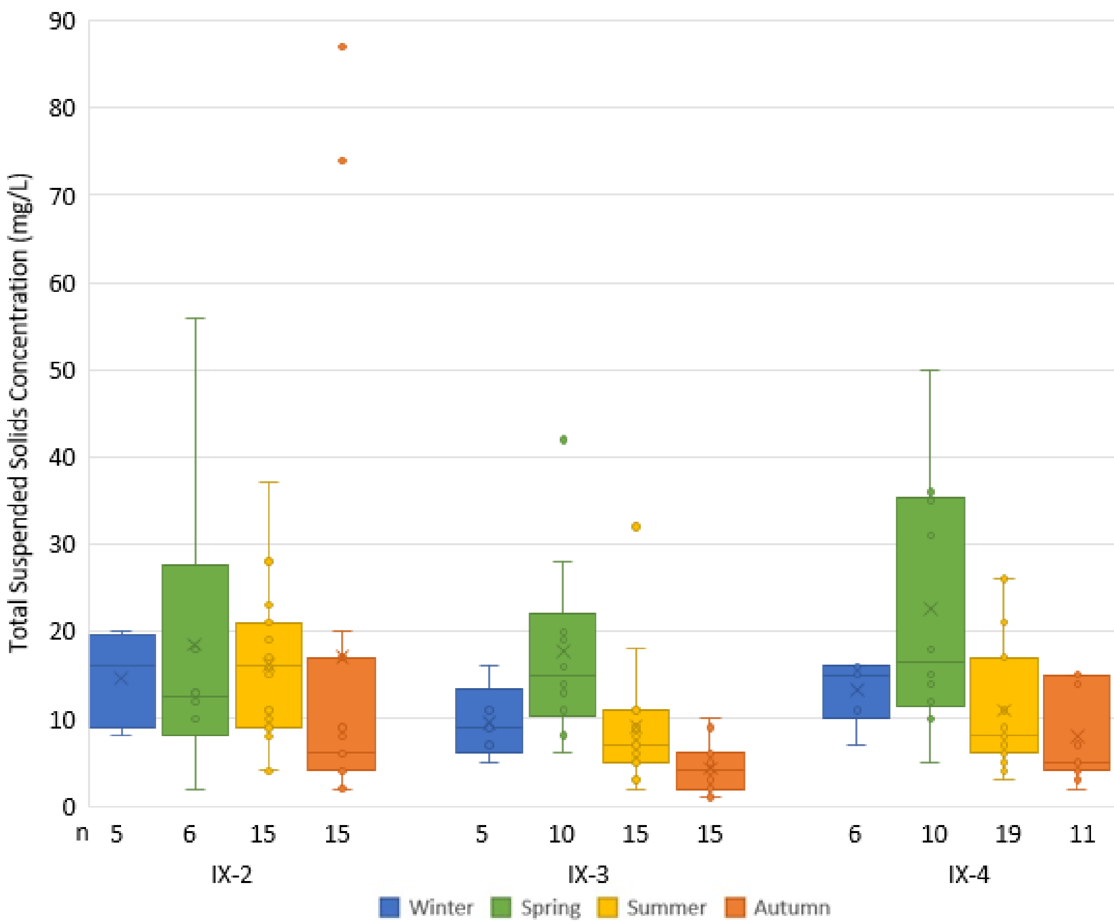

Figure 31: Seasonal box plot of total suspended solids concentrations at IMAX bioretention sites.

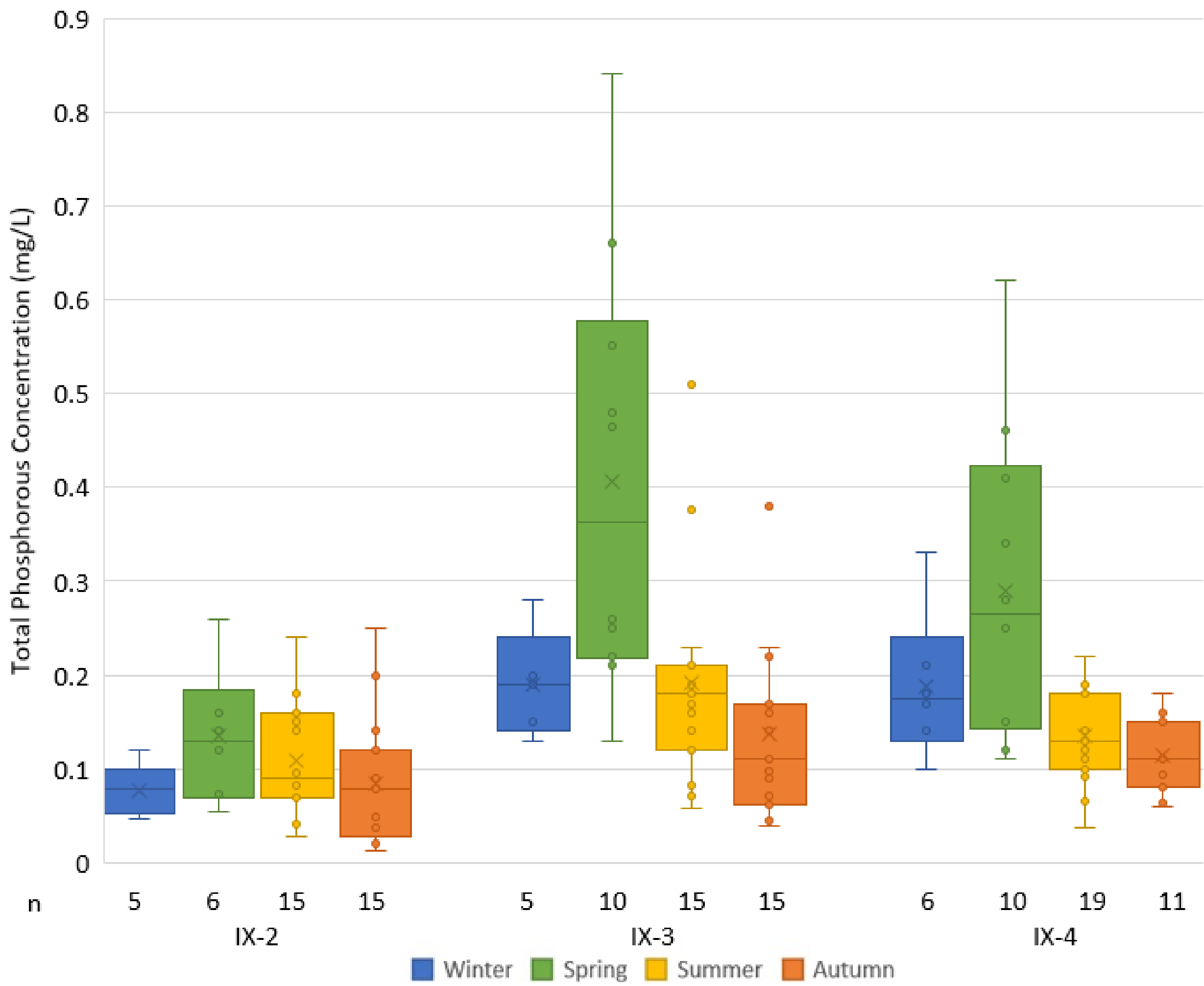

Figure 32: Seasonal box plot of total phosphorus concentrations at IMAX bioretention sites.

As LID features age, fine sediments may clog the pore spaces and decrease infiltration rates and volume reductions, although this may be mitigated by proper maintenance. The total volume reductions by year are plotted on Figure 33. With the current dataset, the year-to-year variability is masking any long-term change in performance over time. A longer-term dataset is likely needed to show the impact of age on LID features.

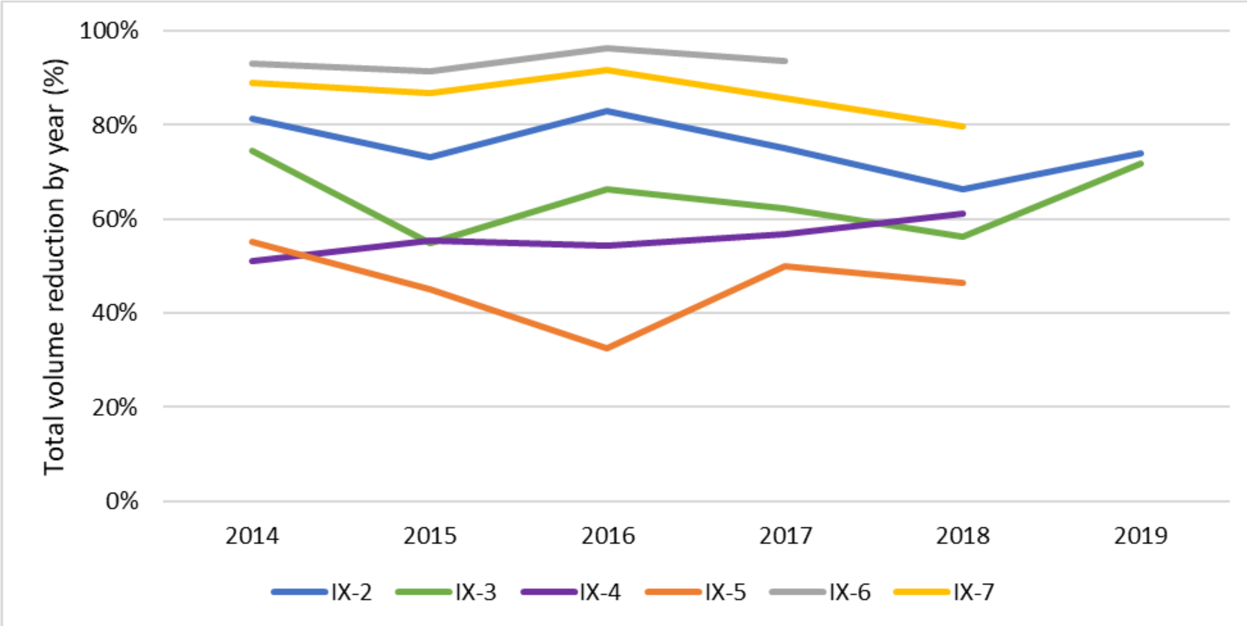

Figure 33: Volume reduction by year for the LID sites at IMAX.

5 CONCLUSIONS AND NEXT STEPS

Both urbanization and climate change are altering the hydrology in southern Ontario's urban areas, leading to increased levels of flooding and erosion while decreasing water quality during storm events. To mitigate impacts, low impact development (LID) features are being implemented and monitored. LID practices are stormwater management features that are designed to mimic natural hydrology and lower runoff volumes and improve water quality compared to traditional curb and gutter stormwater management.

Credit Valley Conservation's stormwater monitoring program conducted a long-term monitoring project to determine how well LID features perform in southern Ontario's climate and local geography. One of the monitoring sites is the parking lot at IMAX's head office, in Mississauga, Ontario. The parking lot was retrofitted with several LID features and includes different catchments that were monitored over a seven-year period.

The monitoring report and results are grouped by topics below:

1) What factors lead to stormwater overflow of bioretention swales, and what is the impact on water quality?

Each of the bioretention features at IMAX included an overflow to allow excess water to bypass treatment and go directly to the storm system during large events to avoid ponding on the parking lot. As there is no water quality treatment for this water, there may be implications for downstream water sources if overflow events happen frequently. All of the IMAX bioretention features were sized to provide water quality treatment for precipitation event depths of up to 25 mm. The results show the following:

- The biggest determining factor of frequency of overflow was site design, as one of the sites had a much higher incidence of overflow than the others (36% of events vs 5% and 7%). The actual drainage area was much larger than the designed drainage area (+68%), leading this site to be under designed and producing overflow for many events under 25 mm depth.
- Peak precipitation intensity, and to a lesser extent total precipitation depth, also increased the chance of overflow occurring. Overflow occurred during the four most intense events at all sites, and all sites had overflow for some more intense events that were under the design precipitation depth of 25 mm.
- Two of the bioretention swales managed to produce no overflow for many events with a precipitation depth much higher than designed.
- Overflow events led to higher concentrations of total suspended solids and most other stormwater parameters.

2) Are treatment trains more effective at providing water quality benefits compared to stand-alone LID features?

The IMAX LID retrofit contains three bioretention swales. Two of the swales contain additional stormwater treatment, one with a Jellyfish Filter pre-treatment designed to lower total suspended solids concentrations at IX-3 and the second with a Sorbtive Media Vault post-treatment designed to lower phosphorus concentrations at IX-2. While these additional stormwater treatment features are designed to work with or without other treatment (e.g., bioretention), a side-by-side comparison of results can determine the added benefit, if any, compared to a stand-alone bioretention. The results show that:

- The bioretention site with the Jellyfish Filter pre-treatment had significantly lower total suspended solids concentrations compared to the other two bioretention sites.
- The bioretention site with the Sorbtive Media Vault post-treatment had significantly lower total phosphorus and orthophosphate concentrations compared to the other two bioretention sites.
- Treatment trains containing bioretention features combined with additional stormwater technologies are more effective at reducing total suspended solids concentrations (using Jellyfish Filters) and phosphorus concentrations (using Sorbtive Media) and can be used if stringent total suspended solids or phosphorus controls are required at a given site location.
- The Jellyfish Filter is also effective at lowering the concentration of some metals.

3) Do different permeable pavement designs reduce runoff volume and meet water quality targets?

Permeable pavement can be used as a stormwater management feature to capture stormwater runoff at its source, reduce runoff volume reductions, reduce peak flows, and improve water quality. Two different types of bedding material were used for the permeable pavement at IMAX, granular ‘O’ and clearstone. Granular ‘O’ is cheaper and less is needed for structural requirements, however unlike clearstone it contains fine particles that may hinder infiltration. The results indicate:

- The granular ‘O’ site had a total runoff volume reduction of 47% compared to 93% for the clearstone site. As with the bioretention swales, design considerations, (in this case, underdrain geometry, subbase material affecting actual void space and resulting storage capacity, and

groundwater flow from outside the catchment), can influence performance of these stormwater features.
- The high volume reduction of the clearstone site indicates it is very effective at infiltrating stormwater. If granular 'O' is used due to cost or design constraints, it still provides some runoff volume reduction, and therefore a downstream benefit, compared to traditional stormwater features.
- Both sites were also effective at reducing the peak flow of the largest events observed during the study period and delaying the time of peak flow. This relieves pressure on the local stormwater system at a time when it is most vulnerable.
- Water chemistry results show that both sites provide enhanced water quality treatment of at least 80% total suspended solids reduction and provided pollutant load reductions for all parameters of interest with the exception of nickel at the granular 'O' site. The clearstone site had higher pollutant load reductions as a result of higher runoff volume reductions.

4) Does infiltration from the LID features impact the quality of local soil and groundwater?

As the LID features at IMAX all promote infiltration, it is possible that pollutants from stormwater runoff may contaminate the soil of the bioretention swales and the local groundwater. The soils and groundwater at IMAX were monitored to see how much they were impacted. In addition, an impermeable liner under one of the permeable lots was tested. Results indicate the following:

- Based on soil sampling, phosphorus levels are increasing over time in the bioretention media. Metals are not yet measurably increasing in the bioretention media.
- The impermeable liner installed in part of the clearstone section of the permeable pavement does not appear to be stopping infiltration into the native soils. Limited evidence suggests that this may be due to water leaking around the edge of the liner.
- If lined systems are to be used when infiltration isn't desirable, care should be taken to ensure the liner is completely impermeable. This may include appropriate product selection, implementation staging notes, and installation oversight.
- Groundwater monitoring has not shown an increase in local groundwater level due to the infiltration from stormwater features at IMAX. These features may be causing an increase in temperature at some, but not all, of the groundwater well locations.
- Groundwater sampling results indicate that likely chloride from road runoff is entering the groundwater at the IMAX project site, and that the infiltrated stormwater is changing the groundwater chemistry and increasing the concentration of some metals.

5) What are the operation and maintenance requirements of bioretention swales and permeable pavement in a commercial office parking lot over the long-term?

Inspections of the LID features over the monitoring period has revealed:
- Over the course of the monitoring period, there was a gradual increase in sediment and erosion in the swales and was greatest in the bioretention swale that has the largest drainage area.
- Many of the trees in the bioretention swale did not survive and were not replaced, likely due to the small size of the swale.

- Winter inspections of the swales seldom showed ponding, indicating infiltration throughout winter, however the bioretention swales were used as snow storage in some years.
- Accumulation of trash and sediment, along with erosion was generally not seen on the permeable pavement, with only a small amount of increasing sediment seen at one portion of the lot.
- Broken and cracked pavers were observed but were repaired.
- Granules of salt and salt staining were common in the winter, indicating over-salting. Reduced salt application is recommended for the permeable pavement.
- The monitoring program at IMAX (as of 2019) has not yet seen any decrease over time of performance of the LID features to capture runoff and provide water quality treatment.

Recommendations include:

- Regular maintenance will ensure that these features continue to function properly.
- Weeding, pruning, the removal of dead vegetation, and inlet cleaning should continue for the bioretention swales.
- The Jellyfish Filters and Sorbtive Media Vault should be inspected annually and cleaned per the manufacturer's recommendation.
- The permeable pavement areas should be vacuumed and cleaned yearly or if excessive sediment or ponding is observed.
- The bioretention features should not be used for snow storage.
- Winter salt application should be reviewed to see if it can be lowered as there are indications of over-salting. Reduced salt application is recommended for permeable pavement surfaces.

6) What are the overall water quantity and quality benefits to the receiver downstream of LID features?

To determine the overall water quality benefit of the LID features at IMAX, runoff volume reductions and pollutant load reductions were evaluated for all sites. Seasonal and long-term patterns were also reviewed. Key observations include:

- The LID features at IMAX had a combined runoff volume reduction of 64%, total suspended solids reduction of 92%, total phosphorus reduction of 76%, and orthophosphate reduction of 22%, providing a water quantity and quality benefit to downstream receivers.
- Runoff volume reductions at individual locations ranged from 47% to 93%.
- All sites met the Ontario guideline for enhanced water quality of 80% total suspended solids reduction.
- All sites provided load reductions for almost every parameter.
- The season with the highest runoff volume reduction at all sites was autumn, and the season with the lowest runoff volume reduction was summer at the bioretention sites and spring at the permeable pavement sites.
- Total suspended solids concentrations were highest in spring and lowest in autumn across all bioretention sites.
- There is no obvious decrease in performance over time so far at the IMAX LID sites (as of 2019).

Stormwater monitoring at IMAX ceased in 2019, however between 2019 and 2024 a series of technical memos will be released on several topics including the use of continuous conductivity probes to study chloride concentrations and using soil moisture probe data to provide more information about winter bioretention performance. Monitoring at IMAX is planned to start up again after a five-year hiatus to further study the long-term performance of these features.

6 GLOSSARY

Adapted from Credit Valley Conservation (2021).

Term	Definition
Automatic sampler	An automatic sampler is used to collect samples from flow events to test for water quality and does not need staff nearby to operate. It can be programmed to start collecting samples based on water level rises and can collect multiple samples at pre-programmed intervals.
Bioretention swale	A type of low impact development that uses engineered soil media and vegetation to capture, filter, infiltrate, and evapotranspire stormwater. Bioretention practices vary in complexity based on soil types, design objectives, and available resources, from simple landscaped depressions to complex systems with impermeable liners, gravel storage layers, special soil mixtures, and underdrains.
Catchment area	In hydrology, a catchment is an area of land that drains rainfall to a single point. Water leaves the catchment from this point. If an area of land drains to a single pipe or outlet, it can be defined as a catchment. Subcatchments are themselves catchments within other, larger catchments. Researchers apply these terms iteratively depending on the scale at which they are working. In urban areas, catchments and subcatchments are typically defined by the municipal storm sewer system.
Effluent	Water that is flowing out of a stormwater management feature.
Event mean concentration (EMC)	Flow-weighted composite water quality samples. The EMC of a compound multiplied by the total discharge of a storm event will give the total load (mass) of the compound during the event.
Evapotranspiration	The combined loss of water to the atmosphere from land and water surfaces by evaporation and from plants by transpiration
Influent	Water flowing into a stormwater management feature.
Jellyfish Filter	A stormwater management device designed by Imbrium Systems to filter out total suspended solids (Imbrium, 2020).
Low impact development (LID)	Also known as green stormwater infrastructure (GSI), low impact development (LID) is a stormwater management strategy that seeks to mitigate the impacts of increased runoff and stormwater pollution. LID practices manage runoff as close as possible to the source in order to preserve or restore pre-development hydrologic and ecological functions. To preserve pre-development functions, LID uses design to minimize runoff and to protect natural drainage patterns. To restore pre-development functions, LID uses distributed structural practices that filter, detain, retain, infiltrate, evapotranspire, and harvest stormwater. LID practices can effectively remove sediment, nutrients, pathogens, and metals from runoff, and they reduce the volume and intensity of stormwater flows.

Overflow	Many stormwater features are designed with an overflow, which allows water to bypass the system and drain directly to the local stormwater system when the capacity of the feature is exceeded. Features should be designed to minimize overflow events while still restricting water from backing up onto roads and parking lots. Overflows are often situated at heights that allow some water to pond and slowly infiltrate, but low enough to prevent stormwater backing up from the feature onto the road or parking lot it is intended to drain.
Peak flow	Peak flow is the maximum flow rate recorded during an event
Permeable pavement	A stormwater feature that uses interlocking concrete pavers with an opening between to allow drainage into an aggregate base. Stormwater that enters the base will either infiltrate into the native soils or enter an underdrain system.
Pollutant load reduction	The reduction in total mass of a pollutant leaving a stormwater feature during an event compared to the mass of the pollutant entering the feature.
Runoff	Rainwater that flows over hard surfaces such as roofs and roads as runoff instead of infiltrating into the ground. Urban runoff carries heavy metals, nutrients, bacteria, and other pollutants into local streams, adversely affecting human, animal, and plant life.
Runoff volume reduction	The reduction in the volume of stormwater runoff leaving a stormwater feature during an event compared to the volume entering the feature.
Sorbtive media	An oxide-coated high surface area reactive engineered media that absorbs and retains phosphorus and does not leach pollutants into infiltrated stormwater (Imbrium, 2014).
Treatment train	A combination of multiple stormwater management practices working together.
Watershed	An area of land which drains streams and rainfall to a specific water body (e.g., a river) or outlet point. Subwatersheds are themselves watersheds within other, larger watersheds. Researchers apply these terms iteratively depending on the scale at which they are working.
Water balance	The accounting of inflow and outflow of water in a system according to the components of the hydrologic cycle.

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Appendix A:

Sampling Methodology
February 2022

1.0 MONITORING LOCATIONS

The monitoring program included water quantity and quality monitoring for seven different independent catchment areas, groundwater monitoring, and a meteorological station located just north of the parking lot. The catchment areas include the three bioretention swales, three permeable pavement areas, and a control site. A map of the catchment areas and monitoring stations is shown in Figure 1. Areas 2, 3, and 4 drain to the bioretention swales and are monitored at the outlet locations IX-2, IX-3, and IX-4, respectively. Areas 5, 6, and 7 are the permeable pavement areas and are monitored at the outlet locations IX-5, IX-6, and IX-7, respectively. Area 1 drains to the control site (IX-1). The drainage areas shown are based on as-built surveys and are the ones used for the report. Some of the drainage areas changed substantially from the design phase, with the largest increase (+68%) for Area 4. This is suspected to be due to improper grading of the parking lot. Table 1 is a summary of the monitoring for the bioretention swales and Table 2 is a summary of the monitoring for the permeable pavement.

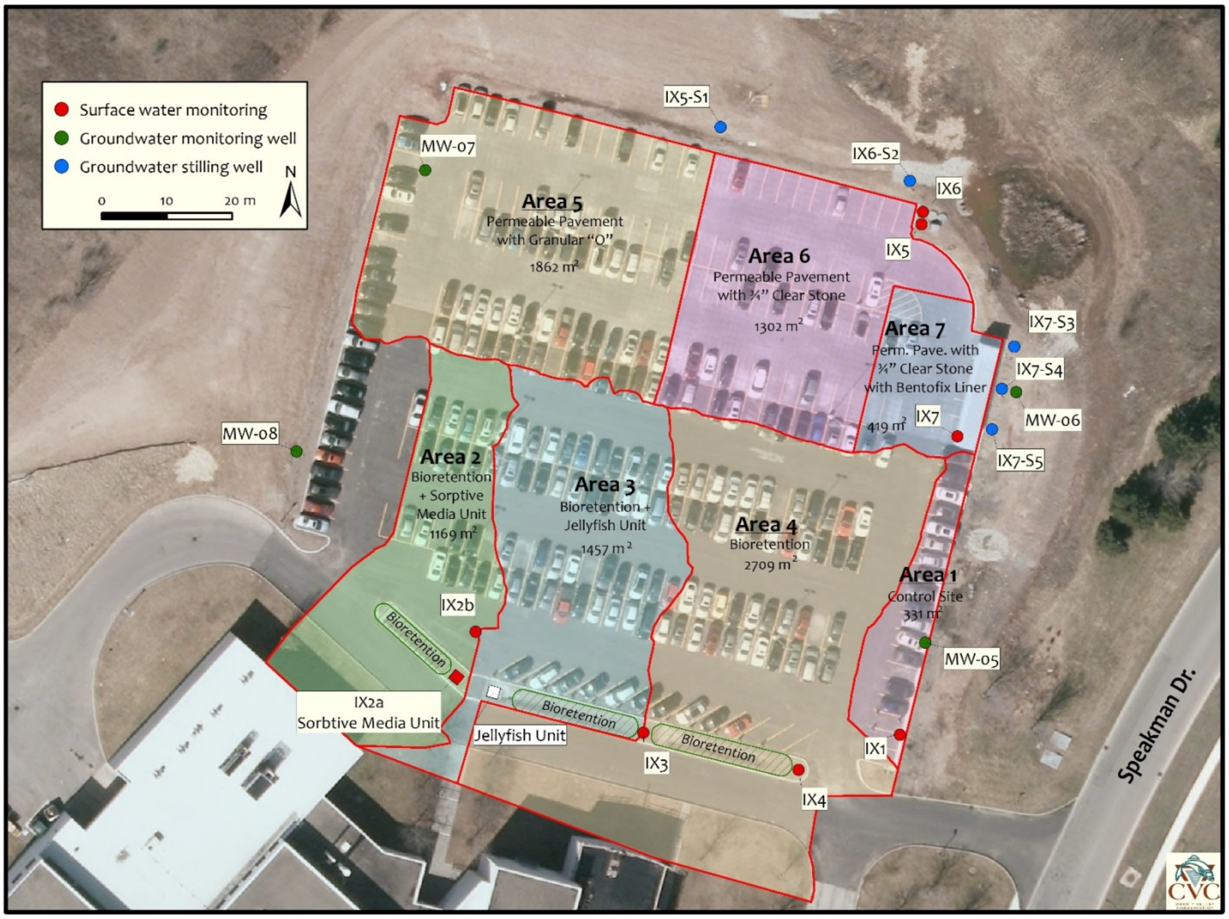

Figure 1: Catchment Areas and monitoring stations. Note: Drainage areas listed for Areas 2, 3 and 4 are the impervious fraction.

Table 1: Monitoring summary for the bioretention swales.

	Area 2 (IX-2)	**Area 3 (IX-3)**	**Area 4 (IX-4)**
LID System Description	Asphalt to bioretention to Sorbtive Vault	Asphalt to Jellyfish Filter to bioretention	Asphalt to stand-alone bioretention cell
Drainage Area (m^2)	1128	1394	2637
Monitoring	• Total volume of water leaving the site • Water quality • Height of ponding water • Water level in swale • Water level in Sorbtive Vault • Soil moisture and temperature	• Total volume of water leaving the site • Water quality • Height of ponding water • Water level in swale • Water level in jellyfish filter	• Total volume of water leaving the site • Water quality • Height of ponding water • Water level in swale • Soil moisture and temperature

Table 2: Monitoring summary at the permeable pavement.

	Area 5 (IX-5)	**Area 6 (IX-6)**	**Area 7 (IX-7)**
LID System Description	Permeable Pavement with Granular “O” aggregate.	Permeable Pavement with ¾” Clearstone aggregate.	Permeable Pavement with ¾” Clearstone aggregate lined with a geosynthetic clay liner.
Drainage Area (m^2)	1862	1302	419
Monitoring	• Total volume of water leaving the site • Water quality • Continuous conductivity	• Total volume of water leaving the site • Water quality	• Total volume of water leaving the site • Water quality • Continuous conductivity

Area 1 in Figure 1 was designated as the control site, with total outflow and water chemistry being monitored from a portion of the parking lot not being treated by LID. However, there were a number of challenges with the monitoring infrastructure at the monitoring location IX-1. There were consistent leaks in both the concrete structure and weir, leading to issues with the flow data. In addition, changes from the designed drainage area and the as-built drainage area meant that the area was smaller than expected, and consisted of mainly lightly used parking stalls, as they were either portioned off for monitoring access or designated visitor stalls. As a result, this meant that this monitoring location was not overly representative as a control site.

Due to these issues, data from this site will not be used in this report. To estimate the chemistry of untreated water at the site, results were used from a similar study using similar methods at a site located about 35 km away in Vaughan, Ontario.

2.0 MONITORING EQUIPMENT

Table 3 outlines the monitoring equipment installed at the locations outlined in Figure 1. For the monitoring locations IX-2b, IX-3, IX-4, and IX-7 the data logger and automatic sampler were stored within manholes. For IX-5 and IX-6, they were stored in an above-ground storage box. For the level loggers used to determine ponding depth, PVC pipes were used which were only slotted above the ground surface. Slotted wells were used to determine the depth of water in the swales and groundwater depths (Figure 2).

Table 3: Monitoring equipment at the IMAX project site.

Type of measurement	Equipment used	Locations
Volume of water leaving the catchment area	ISCO 2150 or ISCO 4150 area velocity flow and level meter, and weir	IX-2b, IX-3, IX-4, IX-5, IX-6, and IX-7
Stormwater quality sampling	ISCO 6712 automatic sampler	IX-2b, IX-3, IX-4, IX-5, IX-6, and IX-7
Bioswale ponding depths	HOBO Model U20 level loggers	Located in each of the swales
Height of water in swales, Sorbtive Vault, and Jellyfish Filter	HOBO Model U20 level loggers	Located within each of the three swales, in the Sorbtive Vault, and in the Jellyfish Filter
Groundwater levels	HOBO Model U20 level loggers	MW-5, MW-6, MW-7, and MW-8
Water level downstream of permeable pavement	HOBO Model U20 level loggers	IX5-S1, IX6-S2, IX7-S3, IX7-S4, IX7-S5
Water temperature	HOBO Model UA-002-64K loggers	IX-2a, IX-3, IX-4, IX-5, IX-6, IX-7
Continuous conductivity	HOBO Model U24-001/002	IX-5, IX-7
Soil moisture and temperature	HOBO Soil Moisture Smart Sensor, HOBO Temperature Smart Sensor, and HOBO USB Micro Station	Upstream and downstream of bioswales in Area 2 and 4
Precipitation and air temperature	Hydrological Services TB3 Rain Gauge (Heated)	Located just north of the IMAX parking lot

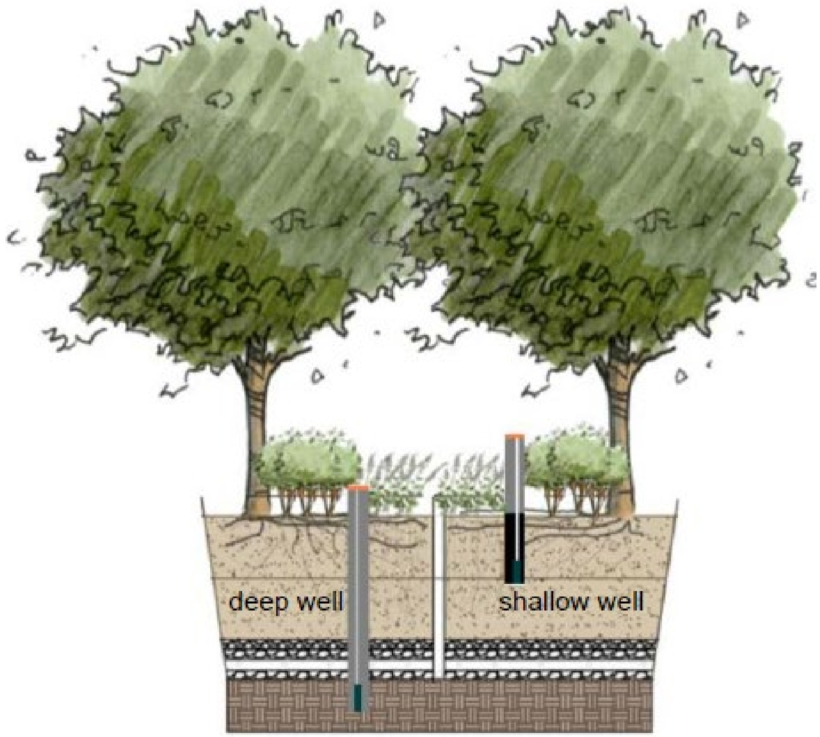

Figure 2: Example figure depicting types of wells used to monitor the bioswales. The deep well in this picture (on the left) measures the water level within the feature, while the shallow well (on the right) measures ponding. Groundwater wells were also used at IMAX.

3.0 SAMPLING METHODOLOGY

Precipitation Event Sampling

Automatic samplers are used to create flow-proportional composite samples for each event. This allows an event mean concentration (EMC) to be determined for each parameter. Prior to each sampling event, the automatic samplers are programs to collect water at regular intervals over a length of time that flow is predicted at the site based on the forecast. The automatic samplers contain 24 different bottles and are filled up by half a bottle or a full bottle at each interval. After the event, staff visit the site and download the flow data. Based on the amount of flow occurring when each of the induvial bottles in the automatic sampler are collected, a proportional volume of water from each bottle is mixed into a stainless steel container. This composite sample is then used to fill lab-approved bottles for analysis, which are preserved as necessary. These are held in a cooler or fridge and brought to a lab for analysis as soon as possible.

With very few exceptions, samples were only collected if the sampling program collected runoff for long enough during the event to cover 80% of the flow.

Samples are analyzed for:

- Chloride
- Turbidity

- Conductivity
- pH
- Total Suspended Solids (TSS)
- Total Dissolved Solids (TDS)
- Nutrients:
    - Total Phosphorus
    - Orthophosphate
    - Total Kjehldahl Nitrogen (TKN)
    - Total Ammonia
    - Nitrate & Nitrite
- Total Metals (Cadmium, Chromium, Copper, Iron, Lead, Nickel and Zinc)
- Polycyclic Aromatic Hydrocarbons (PAH's) –These parameters have been discontinued due to low levels and many non-detects.

All water quality samples are brought to an accredited Canadian laboratory, Maxxam Analytics (now Bureau Veritas), in Mississauga (which has received accreditation from Standards Council of Canada for all water quality parameters of interest), or the Ministry of Environment and Climate Change (now Ministry of Environment, Conservation and Parks) lab, for analysis. Table 4 summarizes water quality parameters, analytical methods and associated method detection limits (MDLs).

Table 4: Quality Parameters of Interest[1], Analytical Methods & Method Detection Limits (MDLs).

Water Quality Parameter	Units	Analytical Method	MDL[2]
Total Cadmium (Cd)	ug/L	EPA 6020	0.01
Total Copper (Cu)	ug/L	EPA 6020	0.1
Total Iron (Fe)	ug/L	EPA 6020	5
Total Lead (Pb)	ug/L	EPA 6020	0.05
Total Nickel (Ni)	ug/L	EPA 6020	0.1
Total Zinc (Zn)	ug/L	EPA 6020	0.5
Dissolved Chloride (Cl)	mg/L	EPA 325.2	1
Nitrate (NO_3)	mg/L	SM 4500 NO3I/NO2B	0.1
Total Kjeldahl Nitrogen (TKN)	mg/L	EPA 351.2 Rev 2	0.1
Orthophosphate (PO_4)	mg/L	APHA 4500 P-G	0.002-0.004[3]
Total Phosphorus (TP)	mg/L	SM 4500 P,B,F	0.02-0.004[3]
Total Suspended Solids (TSS)	mg/L	SM 2540D	1

1 The water quality parameters listed are recommended parameters of interest; CVC has performed a broad screening of over 27 parameters.

2 Method detection limit is sometimes lower than the sample detection limit due to available sample volume and laboratory interferences.

3 Laboratory MD values ranged throughout the monitoring period

Soil Sampling

Soil samples (both shallow ~5 cm deep, and deep ~30 cm deep) were taken near the upstream and downstream end of each of the three swales. To collect these samples, soil was taken at three locations along a transect and then mixed together, in order to create a sample representative of that part of the swale. Shallow samples were collected first, then followed by deep samples at the same location. The soil was put into lab approved bottles and dropped off at a laboratory as soon as possible.

Groundwater Sampling

Groundwater quality samples were generally taken twice a year throughout the study period from 2012-2018 at the four groundwater sites shown in Figure 1. A sample was taken in spring (March to early June) and autumn (November or December). No autumn sample was taken in 2012, and a winter (January) sample was taken in 2017. Sampling did not start at MW-06 until autumn 2013, as the original well was damaged during site construction, and a new well needed to be installed. Samples were taken using a Waterra manual foot valve pump. At least three well volumes of water were purged from the well prior to sample collection, unless this was not possible due to poor recharge rates.

Inertial pumps were used to collect groundwater samples. Each site used a different pump to minimize cross contamination. Prior to collecting each sample, three well volumes were pumped out of each site, with the exception of MW-7, which often dried up before three well volumes could be collected. After three well volumes were pumped out, pumping continued while the parameters of this water (temperature, pH, conductivity) were continuously monitored until they stabilized. At that point, water was pumped into lab approved bottles, and filtered and preserved as necessary. These were then stored in a cooler or fridge and then brought to a lab for analysis as soon as possible.

4.0 DURATION OF MONITORING

Monitoring started as construction finished in 2013. However, due to several monitoring challenges during the first year, the data period presented began in 2014 and continued until the equipment was removed in 2019. Several of the sites were installed later or removed earlier (see Table 5). Due to concerns about freezing, several level loggers were removed every winter. These included those used to measure ponding in the swales, the level logger in the Jellyfish Filter, and the monitoring equipment in IX-6. Equipment in IX-5 was removed during the first couple of winters due to concerns about freezing, but left in once continuous conductivity was installed in mid-2016.

Table 5: Time period for major monitoring at IMAX.

Site	Measurement	Start date	End date
IX-2	Outflow	Winter 2014	Spring 2019
	Water chemistry	Winter 2014	Autumn 2017
	Ponding depth	Spring 2014	Autumn 2018
	Depth of water in swale	Spring 2014	Spring 2019
	Sorbtive Vault height	Winter 2014	Spring 2019
	Soil moisture and temperature	Autumn 2017	Spring 2019
IX-3	Outflow	Winter 2014	Spring 2019
	Water chemistry	Winter 2014	Autumn 2017
	Ponding depth	Spring 2014	Autumn 2018
	Depth of water in swale	Spring 2014	Spring 2019
	Depth of water in Jellyfish filter	Spring 2015	Spring 2019
IX-4	Outflow	Winter 2014	Autumn 2018
	Water chemistry	Winter 2014	Autumn 2017
	Ponding depth	Spring 2014	Autumn 2018
	Depth of water in swale	Spring 2014	Spring 2019
	Soil moisture and temperature	Autumn 2017	Spring 2019
IX-5	Outflow	Spring 2014	Autumn 2018
	Water chemistry	Spring 2014	Autumn 2017
	Continuous conductivity	Spring 2016	Autumn 2018
IX-6	Outflow	Spring 2014	Autumn 2017
	Water chemistry	Spring 2014	Autumn 2017
IX-7	Outflow	Winter 2014	Spring 2018
	Water chemistry	Winter 2014	Autumn 2017
	Continuous conductivity	Winter 2014	Spring 2018

5.0 DATA ANALYSIS

Precipitation Event Definition

Precipitation, flow, discharge, water level, and continuous conductivity data were collected at 10-minute intervals and summarized by precipitation event. Events were defined as precipitation of at least 2 mm and/or flow occurring. The end of the event was defined as a six-hour period without flow and/or precipitation detected. Due to this definition, there were some cases where a single event at one monitoring location would be counted as multiple events at others, due to continuous flow that was not occurring at the latter locations.

Inflow Estimation Using the Simple Method

As inflow to the bioretention sites enters along curb cuts, it is extremely difficult to measure inflow directly. For the permeable pavements, water enters throughout the entire area of the pavement, making direct measurement of inflow impossible. The Simple Method[1] was therefore selected to estimate influent

1 Schueler, T. 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. Metropolitan Washington Council of Governments. Washington, DC

volume. The Simple Method is a spreadsheet-based runoff estimation procedure that is used for determining stormwater runoff and pollutant loading for urban areas. It determines estimated inflow based on drainage area, amount of precipitation, and a runoff coefficient. While the Simple Method is typically used to calculate annual runoff, the formula was modified to determine runoff on an event-by-event basis. A BMP component was also added to account for LID areas. Note that the BMP area is not considered in the runoff coefficient calculation since complete infiltration into the practice is assumed for BMP areas. The drainage areas for IMAX were determined using an as-built survey.

The runoff coefficient is defined as:

$Rv = 0.05 + 0.9 * I_a$
Where:
R_v is the runoff coefficient
0.9 is the fraction of rainfall events that produce runoff
I_a is the impervious fraction (Impervious Area/Drainage Area to the BMP)

The modified Simple Method formula used is:

$V_i = P * ((A_d * R_v) + A_{BMP})$
Where:
V_i = influent volume (in L)
P is the event precipitation (in mm)
A_d is the drainage area to the BMP (in m^2)
R_v is the runoff coefficient
A_{BMP} is the BMP area (in m^2)

Best results are produced when the method is used for smaller catchments at a development site scale. Further modeling would be required for determining runoff for a large watershed. The Simple Method can overestimate inflow volume for smaller events where rainfall depths would be used up by catchment wetting and surface depression storage. This occurs because the Simple Method applies the same runoff coefficient to storms of all magnitudes.

Estimated influent volume was compared to actual effluent volume to evaluate the volume reduction.

Appendix B:

Climate Station Results
February 2022

Precipitation and air temperature were monitored at a CVC climate station located a few metres north of the IMAX parking lot. Monthly and annual total precipitation are shown in Table 1, and average air temperature in Table 2. For comparison, annual values from Environment and Climate Change Canada’s (ECCC) climate station at Toronto Pearson International Airport (Climate ID: 6158731) are also shown. The ECCC climate station is located 18 kilometres northwest of the IMAX parking lot and has been maintained since 1937. There were some differences in precipitation between the two stations due to localized storms, however the overall patterns of which years were wet and dry were similar.

Table 1: Monthly and annual total precipitation recorded at CVC's IMAX climate station. Annual precipitation from Environment and Climate Change Canada's climate station at Toronto Pearson International Airport is added for a comparison.

	Total Precipitation (mm)					
	2014	**2015**	**2016**	**2017**	**2018**	**2019**
January	49.4	26.8	35.0	74.2	63.8	20.6
February	62.0	8.2	57.6	46.4	66.2	48.4
March	14.2	9.4	87.0	68.0	32.6	73.4
April	97.2	74.6	46.4	111.0	146.4	95.0
May	64.0	63.6	54.8	158.0	68.8	
June	53.8	117.6	37.4	74.8	84.4	
July	130.6	25.0	56.0	47.6	93.6	
August	64.2	72.6	86.0	45.4	148.6	
September	96.2	84.2	73.2	21.0	65.2	
October	57.0	92.6	41.0	58.6	72.2	
November	45.6	31.2	57.2	64.4	106.8	
December	30.8	29.6	62.4	30.2	60.8	
Annual total	**765.0**	**635.4**	**694.0**	**799.6**	**1009.4**	**237.4***
Toronto Pearson International Airport annual total	**733.8**	**675.3**	**630.6**	**846**	**885**	**300.8***

*Indicates partial year total (January to April)

Table 2: Monthly and annual average air temperature recorded at CVC's IMAX climate station. Annual average air temperature from Environment and Climate Change Canada's climate station at Toronto Pearson International Airport is added for a comparison.

	Mean Temperature (°C)					
	2014	**2015**	**2016**	**2017**	**2018**	**2019**
January	-8.3	-7.2	-3.3	-1.6	-5.4	-6.4
February	-7.9	-12.2	-2.0	-0.3	-1.5	-3.8
March	-3.7	-1.4	2.5	-0.4	-0.2	-1.1
April	5.4	7.8	4.6	8.8	3.1	5.8
May	13.6	16.2	14.2	11.8	16.1	
June	18.9	17.2	19.4	18.7	18.9	
July	20.8	21.5	23.0	21.1	22.7	
August	20.7	20.3	23.6	19.9	22.5	
September	16.7	19.2	18.7	17.7	18.4	
October	10.4	9.8	11.5	12.9	8.9	
November	1.9	6.4	6.1	3.7	1.5	
December	0.0	4.1	-1.5	-4.8	-0.1	
Annual average	**7.4**	**8.5**	**9.7**	**8.9**	**8.8**	**-1.4***
Toronto Pearson International Airport annual average	**7.4**	**8.5**	**10.0**	**9.3**	**8.9**	**-1.4***

*Indicates partial year average (January to April)

To see how these values compare to the long term average, the annual precipitation and air temperature values at the ECCC Toronto Pearson station are compared to the 30-year climate normals in Figure 1. Four of the five years during the monitoring period were warm years, with 2016 in the 96th percentile for temperature. Three of the five years were dry years, while two were wet years.

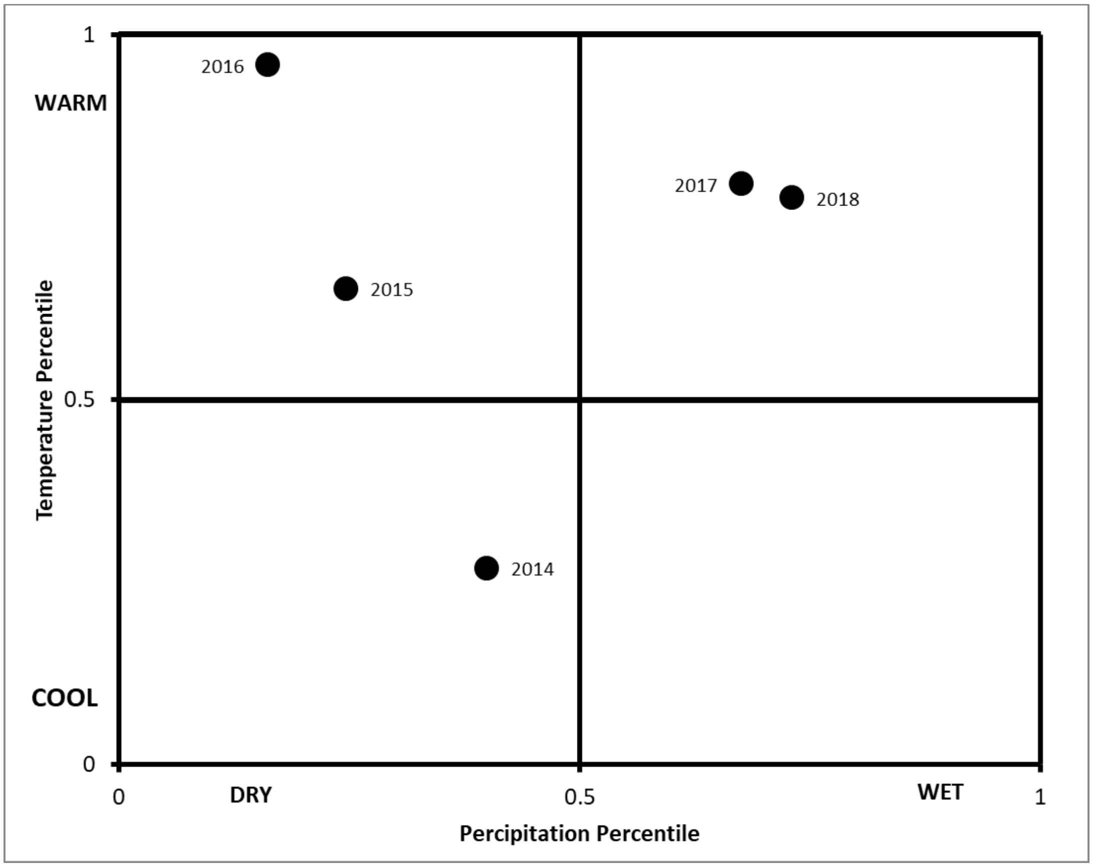

Figure 1: Percentile rank of air temperature and precipitation for the 2014-2018 annual ECCC Toronto Pearson International Airport climate data compared to the 1981-2010 climate normals at the same location.

Appendix C:

Stormwater Hydrologic Event Data
February 2022

Table 1: IX-2 storm event data.

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2014-04-12 23:20	IX-2-001	4.2	8	6.0	7187	3694	49%	0.0	0.0
2014-04-14 12:40	IX-2-002	4.3	7	4.8	6289	742	88%	0.0	0.0
2014-04-14 23:50	IX-2-003	9.8	10.8	8.4	9703	2419	75%	0.0	0.0
2014-04-25 15:30	IX-2-004	3.7	5.6	4.8	5031	23	100%	0.0	0.0
2014-04-29 07:10	IX-2-005	8.0	34	12.0	30546	9748	68%	0.0	0.0
2014-04-30 03:10	IX-2-006	24.8	11.6	8.4	10421	275	97%	0.0	0.0
2014-05-13 03:20	IX-2-007	2.3	12.2	24.0	10960	1772	84%	0.0	0.0
2014-05-13 15:00	IX-2-008	7.2	6.4	25.2	5750	747	87%	0.0	0.0
2014-05-14 17:10	IX-2-009	6.8	10.6	12.0	9523	2357	75%	0.0	0.0
2014-05-15 11:00	IX-2-010	16.7	18.6	4.8	16710	570	97%	0.0	0.0
2014-05-20 08:40	IX-2-011	12.5	5.40	12.0	4851	321	93%	0.0	0.0
2014-05-23 13:40	IX-2-012	4.5	2.4	8.4	2156	83	96%	0.0	0.0
2014-06-02 22:20	IX-2-013	7.3	8.4	6.0	7547	9	100%	0.0	0.0
2014-06-11 05:20	IX-2-014	3.7	2.8	4.8	2516	0	100%	0.0	0.0
2014-06-11 21:10	IX-2-015	4.7	13.6	21.6	12218	3773	69%	1.0	0.0
2014-06-17 18:00	IX-2-016	1.3	14.4	42.0	12937	3519	73%	0.3	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2014-06-23 16:50	IX-2-017	1.5	2.8	6.0	2516	0	100%	0.0	0.0
2014-06-24 17:30	IX-2-018	2.5	4.4	7.2	3953	235	94%	0.2	0.0
2014-06-25 14:20	IX-2-019	9.3	3.6	9.6	3234	119	96%	0.2	0.0
2014-07-07 02:20	IX-2-020	4.5	14	9.6	12578	817	94%	0.0	0.0
2014-07-08 11:30	IX-2-021	3.5	8.6	25.2	7726	924	88%	0.2	0.0
2014-07-13 05:40	IX-2-022	1.3	2.4	7.2	2156	0	100%	0.0	0.0
2014-07-15 01:30	IX-2-023	13.2	9.8	18.0	8804	1628	82%	0.3	0.0
2014-07-16 14:00	IX-2-024	2.2	3.6	16.8	3234	44	99%	0.2	0.0
2014-07-19 14:00	IX-2-025	8.2	13	8.4	11679	1446	88%	0.3	0.0
2014-07-20 14:00	IX-2-026	1.3	3.6	9.6	3234	34	99%	0.0	0.0
2014-07-23 01:00	IX-2-027	1.7	5.6	14.4	5031	338	93%	0.3	0.0
2014-07-27 19:00	IX-2-028	14.8	66	44.4	59294	15247	74%	2.5	0.0
2014-08-04 07:40	IX-2-029	15.8	16	18.0	14374	5623	61%	0.3	0.0
2014-08-05 19:30	IX-2-030	1.2	8.6	38.4	7726	1725	78%	0.3	0.0
2014-08-11 22:20	IX-2-031	7.7	26.6	21.6	23897	6962	71%	1.5	0.0
2014-08-19 23:10	IX-2-032	9.5	3.6	6.0	3234	0	100%	0.0	0.0
2014-08-20 19:10	IX-2-033	2.3	6.8	21.6	6109	875	86%	0.2	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2014-09-02 11:40	IX-2-034	3.7	9.4	31.2	8445	3375	60%	0.2	0.0
2014-09-05 19:10	IX-2-035	11.0	36.8	24.0	33061	7598	77%	1.2	0.0
2014-09-10 15:50	IX-2-036	13.5	21.2	13.2	19046	430	98%	1.3	0.0
2014-09-13 07:10	IX-2-037	7.3	4.2	6.0	3773	46	99%	0.0	0.0
2014-09-15 15:30	IX-2-038	10.0	4.2	3.6	3773	154	96%	0.0	0.0
2014-09-21 05:50	IX-2-039	3.2	17.2	24.0	15452	1317	91%	1.2	0.0
2014-10-03 13:30	IX-2-040	16.7	10.6	7.2	9523	244	97%	0.2	0.0
2015-04-02 18:30	IX-2-041	0.8	2.4	4.8	2156	0	100%	#N/A	#N/A
2015-04-03 18:00	IX-2-042	2.5	3.0	2.4	2695	0	100%	#N/A	#N/A
2015-04-08 08:00	IX-2-043	11.5	15.2	9.6	13656	3434	75%	#N/A	#N/A
2015-04-09 13:10	IX-2-044	21.5	15.8	15.6	14195	5750	59%	1.7	0.0
2015-04-13 16:50	IX-2-045	3.5	4.8	7.2	4312	332	92%	0.2	0.0
2015-04-19 22:30	IX-2-046	17.0	25.2	6.0	22640	5231	77%	4.5	0.0
2015-04-21 12:10	IX-2-047	8.2	4.4	4.8	3953	11	100%	0.2	0.0
2015-05-11 20:00	IX-2-048	1.7	4.8	12.0	4312	83	98%	0.0	0.0
2015-05-30 12:50	IX-2-049	33.8	58.8	34.8	52826	25114	52%	2.0	0.0
2015-06-07 21:20	IX-2-050	13.2	21.6	19.2	19405	3671	81%	1.3	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2015-06-12 03:40	IX-2-051	15.0	10.4	10.8	9343	846	91%	1.0	0.0
2015-06-14 08:00	IX-2-052	8.2	6.4	8.4	5750	110	98%	0.0	0.0
2015-06-16 02:50	IX-2-053	3.5	8.6	27.6	7726	1013	87%	0.5	0.0
2015-06-22 18:10	IX-2-054	9.0	3.4	4.8	3055	0	100%	0.0	0.0
2015-06-27 10:40	IX-2-055	31.7	64.2	22.8	57677	24158	58%	5.8	0.0
2015-07-07 12:40	IX-2-056	8.7	15.4	33.6	13835	2463	82%	0.3	0.0
2015-07-14 08:00	IX-2-057	6.0	2.0	2.4	1797	0	100%	0.0	0.0
2015-07-17 10:40	IX-2-058	4.7	5.2	3.6	4672	0	100%	0.0	0.0
2015-07-19 16:10	IX-2-059	0.3	2.2	9.6	1976	0	100%	0.0	0.0
2015-08-02 17:20	IX-2-060	10.3	27.4	44.4	24616	5178	79%	0.8	0.0
2015-08-04 16:30	IX-2-061	1.3	2.0	7.2	1797	0	100%	0.0	0.0
2015-08-10 12:10	IX-2-062	7.0	22.6	28.8	20304	6020	70%	1.2	0.0
2015-08-14 06:00	IX-2-063	2.2	2.8	3.6	2516	0	100%	0.0	0.0
2015-08-19 22:10	IX-2-064	1.2	4.6	14.4	4133	310	92%	0.0	0.0
2015-08-20 09:10	IX-2-065	3.7	10.00	31.2	8984	1923	79%	0.5	0.0
2015-09-11 18:20	IX-2-066	13.5	19.60	6.0	17609	1837	90%	0.0	0.0
2015-09-19 14:10	IX-2-067	1.3	4.40	10.8	3953	340	91%	0.0	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2015-09-29 12:20	IX-2-068	5.5	41.00	38.4	36834	13613	63%	1.2	0.0
2015-10-08 20:30	IX-2-069	5.7	7.00	6.0	6289	329	95%	0.0	0.0
2015-10-15 16:40	IX-2-070	5.2	5.20	6.0	4672	92	98%	0.0	0.0
2015-10-28 02:10	IX-2-071	27.2	59.6	13.2	53545	22581	58%	3.3	0.0
2015-10-31 23:10	IX-2-072	4.5	4.4	4.8	3953	64	98%	0.0	0.0
2015-11-06 01:00	IX-2-073	9.3	2.0	2.4	1797	0	100%	0.0	0.0
2015-11-10 12:50	IX-2-074	15.3	12.6	3.6	11320	376	97%	0.0	0.0
2015-11-12 06:50	IX-2-075	6.8	3.2	4.8	2875	40	99%	0.0	0.0
2015-11-21 20:50	IX-2-076	3.0	2.8	2.4	2516	0	100%	0.0	0.0
2015-11-27 10:30	IX-2-077	14.8	3.6	2.4	3234	0	100%	0.0	0.0
2015-12-14 14:10	IX-2-078	5.2	3.0	4.8	2695	0	100%	#N/A	#N/A
2015-12-21 07:30	IX-2-079	20.5	3.6	2.4	3234	0	100%	#N/A	#N/A
2015-12-26 22:40	IX-2-080	8.3	5.2	3.6	4672	83	98%	#N/A	#N/A
2016-03-14 01:50	IX-2-081	12.2	10.4	8.4	9343	403	96%	#N/A	#N/A
2016-03-15 01:40	IX-2-082	6.0	6.2	3.6	5570	13	100%	#N/A	#N/A
2016-03-28 03:20	IX-2-083	11.0	10.2	10.8	9164	0	100%	#N/A	#N/A
2016-03-31 02:20	IX-2-084	21.0	26.6	30.0	23897	4073	83%	#N/A	#N/A

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2016-06-06 11:50	IX-2-085	9.5	8.4	9.6	7547	1416	81%	1.7	0.0
2016-06-26 21:10	IX-2-086	4.0	3.2	7.2	2875	0	100%	0.0	0.0
2016-06-28 17:40	IX-2-087	1.2	2.2	6.0	1976	0	100%	0.0	0.0
2016-07-01 08:00	IX-2-088	6.5	8.4	22.8	7547	1304	83%	0.2	0.0
2016-07-13 23:50	IX-2-089	7.5	9.8	22.8	8804	802	91%	0.5	0.0
2016-07-14 18:10	IX-2-090	4.8	17.6	40.8	15812	4896	69%	0.8	0.2
2016-07-25 04:10	IX-2-091	2.0	17.4	51.6	15632	5366	66%	0.5	0.0
2016-08-12 11:30	IX-2-092	1.2	3.8	14.4	3414	72	98%	0.2	0.0
2016-08-13 00:40	IX-2-093	1.5	2.2	8.4	1976	95	95%	0.2	0.0
2016-08-13 11:10	IX-2-094	10.0	12.6	30.0	11320	1885	83%	0.3	0.0
2016-08-16 01:20	IX-2-095	11.7	22.0	36.0	19765	4547	77%	1.0	0.0
2016-08-18 21:40	IX-2-096	1.2	10.0	43.2	8984	2218	75%	0.3	0.0
2016-08-20 01:30	IX-2-097	2.2	6.4	13.2	5750	884	85%	0.5	0.0
2016-08-21 06:30	IX-2-098	0.8	1.4	8.4	1258	8	99%	0.2	0.0
2016-08-25 00:40	IX-2-099	1.5	3.8	9.6	3414	149	96%	0.0	0.0
2016-08-25 11:30	IX-2-100	6.7	22.2	42.0	19944	6524	67%	0.8	0.0
2016-09-07 18:20	IX-2-101	8.3	12.8	58.8	11500	1305	89%	0.3	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2016-09-10 09:00	IX-2-102	2.0	3.0	8.4	2695	53	98%	0.3	0.0
2016-09-17 04:30	IX-2-103	13.5	13.0	21.6	11679	566	95%	0.8	0.0
2016-09-26 10:40	IX-2-104	2.5	15.4	21.6	13835	2554	82%	1.0	0.0
2016-09-29 07:30	IX-2-105	14.8	27.6	14.4	24796	6524	74%	5.7	0.0
2016-10-01 07:30	IX-2-106	2.2	2.4	2.4	2156	0	100%	0.3	0.0
2016-10-01 20:40	IX-2-107	16.2	15.0	22.8	13476	2983	78%	1.8	0.0
2016-10-20 02:30	IX-2-108	37.0	15.2	3.6	13656	16	100%	0.5	0.0
2016-10-27 00:10	IX-2-109	17.0	5.4	3.6	4851	127	97%	0.8	0.0
2016-11-02 11:10	IX-2-110	20.7	30.0	15.6	26952	6726	75%	5.3	0.0
2016-11-19 11:10	IX-2-111	2.8	5.0	4.8	4492	52	99%	1.3	0.0
2016-11-24 00:10	IX-2-112	14.8	4.4	3.6	3953	14	100%	1.7	0.0
2016-11-26 01:30	IX-2-113	4.5	3.2	2.4	2875	3	100%	1.8	0.0
2016-11-28 23:00	IX-2-114	6.0	5.0	4.8	4492	413	91%	2.3	0.0
2016-11-30 19:30	IX-2-115	4.0	6.0	6.0	5390	354	93%	2.8	0.0
2017-03-24 04:40	IX-2-116	3.2	6.6	6.0	5929	640	89%	#N/A	#N/A
2017-03-24 23:10	IX-2-117	13.7	7.0	3.6	6289	24	100%	#N/A	#N/A
2017-03-26 21:40	IX-2-118	9.0	2.4	2.4	2156	0	100%	#N/A	#N/A

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2017-03-30 16:50	IX-2-119	31.5	22.2	8.4	19944	3695	81%	#N/A	#N/A
2017-04-03 21:20	IX-2-120	18.8	21.4	19.2	19226	5434	72%	#N/A	#N/A
2017-04-06 01:00	IX-2-121	26.7	31.2	6.0	28030	9990	64%	#N/A	#N/A
2017-04-15 10:40	IX-2-122	3.2	4.2	4.8	3773	323	91%	#N/A	#N/A
2017-04-20 09:10	IX-2-123	14.2	28.4	8.4	25515	8650	66%	9.2	0.5
2017-04-25 07:30	IX-2-124	8.0	2.6	3.6	2336	0	100%	0.3	0.0
2017-04-27 17:30	IX-2-125	2.3	6.6	10.8	5929	933	84%	1.2	0.0
2017-04-30 05:10	IX-2-126	1.8	1.0	2.4	898	84	91%	0.7	0.0
2017-04-30 17:00	IX-2-127	25.8	41.0	24.0	36834	16359	56%	7.5	1.3
2017-05-04 13:10	IX-2-128	31.0	51.0	4.8	45818	19341	58%	10.0	0.0
2017-05-21 06:20	IX-2-129	19.7	15.4	13.2	13835	1630	88%	1.0	0.0
2017-05-24 21:00	IX-2-130	32.3	52.2	14.4	46896	22172	53%	6.0	1.3
2017-05-30 16:40	IX-2-131	8.3	7.0	13.2	6289	595	91%	0.3	0.0
2017-05-31 13:30	IX-2-132	2.3	2.6	9.6	2336	174	93%	0.2	0.0
2017-06-04 05:30	IX-2-133	4.2	5.4	4.8	4851	268	94%	0.0	0.0
2017-06-05 02:50	IX-2-134	5.8	4.6	15.6	4133	604	85%	0.5	0.0
2017-06-06 06:50	IX-2-135	11.5	3.8	4.8	3414	0	100%	0.0	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2017-06-20 19:30	IX-2-136	3.0	5.2	8.4	4672	56	99%	0.2	0.0
2017-06-22 10:30	IX-2-137	6.3	2.6	3.6	2336	30	99%	0.0	0.0
2017-06-23 00:40	IX-2-138	11.8	18.6	13.2	16710	2708	84%	1.8	0.0
2017-06-27 04:00	IX-2-139	16.0	3.6	6.0	3234	3	100%	0.3	0.0
2017-06-29 00:20	IX-2-140	13.8	5.0	3.6	4492	107	98%	0.2	0.0
2017-06-30 04:10	IX-2-141	4.7	19.8	45.6	17788	7073	60%	0.8	0.3
2017-07-01 00:20	IX-2-142	0.3	0.6	2.4	539	0	100%	0.0	0.0
2017-07-01 14:10	IX-2-143	3.3	10.4	21.6	9343	2714	71%	0.8	0.0
2017-07-13 06:40	IX-2-144	4.0	8.6	6.0	7726	287	96%	1.7	0.0
2017-07-16 16:00	IX-2-145	2.2	3.8	6.0	3414	175	95%	0.8	0.0
2017-07-20 10:00	IX-2-146	2.2	11.8	49.2	10601	2658	75%	0.7	0.0
2017-07-26 19:10	IX-2-147	20.2	9.4	10.8	8445	1018	88%	2.0	0.0
2017-08-01 14:00	IX-2-148	1.3	2.2	7.2	1976	47	98%	0.3	0.0
2017-08-04 06:50	IX-2-149	11.5	14.2	18.0	12757	2512	80%	2.0	0.0
2017-08-12 10:10	IX-2-150	6.2	7.0	21.6	6289	1083	83%	0.5	0.0
2017-08-15 03:10	IX-2-151	1.5	2.0	3.6	1797	8	100%	0.5	0.0
2017-10-04 12:10	IX-2-152	8.2	3.8	16.8	3414	210	94%	0.2	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2017-10-09 01:00	IX-2-153	20.7	20.4	9.6	18327	7255	60%	5.3	0.0
2017-10-11 16:50	IX-2-154	3.3	3.6	4.8	3234	294	91%	0.7	0.0
2017-10-14 17:10	IX-2-155	17.2	8.4	3.6	7547	253	97%	3.3	0.0
2017-10-15 10:30	IX-2-156	8.8	3.0	13.2	2695	303	89%	0.5	0.0
2017-10-23 15:10	IX-2-157	10.5	10.0	10.8	8984	537	94%	2.3	0.0
2017-10-28 05:30	IX-2-158	9.3	5.2	2.4	4672	0	100%	1.7	0.0
2017-11-01 20:40	IX-2-159	13.7	10.8	4.8	9703	1199	88%	3.8	0.0
2017-11-02 23:50	IX-2-160	8.2	7.4	6.0	6648	766	88%	3.5	0.0
2017-11-04 22:30	IX-2-161	24.8	14.6	7.2	13117	605	95%	8.2	0.0
2017-11-15 19:00	IX-2-162	7.3	4.0	2.4	3594	0	100%	0.3	0.0
2017-11-18 05:00	IX-2-163	22.5	24.6	8.4	22101	4004	82%	11.7	0.0
2017-12-04 22:50	IX-2-164	10.7	6.8	3.6	6109	195	97%	#N/A	#N/A
2018-03-27 08:50	IX-2-165	16.3	4.6	2.4	4131	0	100%	#N/A	#N/A
2018-03-29 10:10	IX-2-166	13.8	19.0	3.6	17062	699	96%	#N/A	#N/A
2018-04-24 18:20	IX-2-167	27.0	21.2	7.2	19038	1184	94%	#N/A	#N/A
2018-04-27 22:40	IX-2-168	15.3	8.8	9.6	7902	216	97%	1.0	0.0
2018-05-03 14:40	IX-2-169	5.7	4.8	10.8	4310	485	89%	0.7	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2018-05-04 02:30	IX-2-170	11.2	11.0	14.4	9878	2429	75%	1.5	0.0
2018-05-10 01:50	IX-2-171	3.8	2.6	6.0	2335	3	100%	0.0	0.0
2018-05-15 02:30	IX-2-172	9.3	25.8	74.4	23168	6634	71%	1.3	0.2
2018-05-19 05:00	IX-2-173	21.5	9.8	6.0	8800	560	94%	0.2	0.0
2018-05-22 02:10	IX-2-174	5.3	8.8	6.0	7902	875	89%	0.2	0.0
2018-05-31 18:50	IX-2-175	2.7	3.4	20.4	3053	93	97%	0.0	0.0
2018-06-03 15:50	IX-2-176	3.2	12.2	34.8	10956	4658	57%	0.5	0.0
2018-06-22 22:00	IX-2-177	17.7	16.0	10.8	14368	3400	76%	1.3	0.0
2018-06-24 06:20	IX-2-178	9.0	39.0	24.0	35022	24132	31%	4.2	0.2
2018-06-27 03:10	IX-2-179	5.8	12.4	25.2	11135	4811	57%	1.5	0.0
2018-06-27 20:20	IX-2-180	9.2	2.4	3.6	2155	99	95%	0.5	0.0
2018-07-05 16:40	IX-2-181	15.7	37.6	70.8	33765	19092	43%	1.7	0.5
2018-07-16 18:10	IX-2-182	11.8	9.8	40.8	8800	1204	86%	0.5	0.0
2018-07-22 00:40	IX-2-183	15.0	24.4	10.8	21911	7683	65%	5.3	0.0
2018-07-24 16:40	IX-2-184	82.7	20.8	52.8	18678	12286	34%	2.3	0.2
2018-08-06 13:20	IX-2-185	40.0	44.6	68.4	40051	25339	37%	4.3	0.5
2018-08-08 05:30	IX-2-186	156.0	29.4	46.8	26401	18472	30%	5.2	0.5

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2018-08-16 15:20	IX-2-187	1.3	4.6	27.6	4131	584	86%	0.2	0.0
2018-08-17 00:00	IX-2-188	3.8	1.2	2.4	1078	135	87%	0.7	0.0
2018-08-17 16:50	IX-2-189	11.7	24.8	80.4	22270	9361	58%	3.2	0.2
2018-08-21 06:10	IX-2-190	11.5	29.0	44.4	26042	10698	59%	3.3	0.7
2018-08-22 04:40	IX-2-191	2.3	1.2	3.6	1078	115	89%	1.0	0.0
2018-08-25 13:20	IX-2-192	2.0	4.6	7.2	4131	0	100%	1.0	0.0
2018-08-25 22:40	IX-2-193	1.8	5.2	12.0	4670	0	100%	1.2	0.0
2018-08-27 08:00	IX-2-194	0.3	4.0	22.8	3592	0	100%	0.3	0.0
2018-09-03 12:20	IX-2-195	5.7	2.0	9.6	1796	0	100%	0.2	0.0
2018-09-10 01:30	IX-2-196	21.8	23.2	9.6	20834	9266	56%	8.3	0.0
2018-09-21 16:20	IX-2-197	0.2	2.8	16.8	2514	0	100%	0.2	0.0
2018-09-24 22:40	IX-2-198	12.0	11.8	7.2	10596	350	97%	2.2	0.0
2018-09-25 17:00	IX-2-199	14.5	8.0	18.0	7184	2211	69%	2.2	0.0
2018-09-28 20:00	IX-2-200	4.8	3.4	3.6	3053	0	100%	0.5	0.0
2018-09-30 20:10	IX-2-201	22.2	23.6	10.8	21193	3912	82%	9.3	0.0
2018-10-02 02:40	IX-2-202	11.5	22.2	37.2	19936	9394	53%	6.5	0.5
2018-10-04 04:30	IX-2-203	3.8	3.2	12.0	2874	275	90%	0.7	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2018-10-06 06:10	IX-2-204	21.0	7.0	4.8	6286	0	100%	2.0	0.0
2018-10-12 21:20	IX-2-205	7.2	2.6	2.4	2335	0	100%	0.3	0.0
2018-10-27 04:10	IX-2-206	32.0	7.8	1.2	7004	0	100%	1.3	0.0
2018-10-30 22:10	IX-2-207	13.2	13.0	8.4	11674	559	95%	6.8	0.0
2018-11-01 09:30	IX-2-208	29.3	40.8	10.8	36638	12623	66%	20.3	0.0
2018-11-06 03:10	IX-2-209	9.5	7.2	3.6	6466	394	94%	5.8	0.0
2018-11-24 10:50	IX-2-210	12.5	4.8	3.6	4310	0	100%	#N/A	#N/A
2018-11-26 06:20	IX-2-211	18.3	23.4	4.8	21013	6651	68%	#N/A	#N/A
2018-12-20 20:40	IX-2-212	18.8	18.6	7.2	16703	3722	78%	#N/A	#N/A
2018-12-27 22:10	IX-2-213	9.7	7.0	4.8	6286	337	95%	#N/A	#N/A
2019-04-07 21:10	IX-2-214	10.0	6.4	4.8	5747	860	85%	#N/A	#N/A
2019-04-20 08:00	IX-2-215	11.5	10.6	6.0	9519	3026	68%	#N/A	#N/A
2019-04-23 09:50	IX-2-216	6.5	3.2	8.4	2874	370	87%	#N/A	#N/A
2019-04-26 01:40	IX-2-217	14.8	21.8	15.6	19576	8697	56%	#N/A	#N/A
2019-04-30 22:30	IX-2-218	10.7	9.2	6.0	8262	1666	80%	#N/A	#N/A
2019-05-01 15:40	IX-2-219	5.7	9.4	10.8	8441	3480	59%	#N/A	#N/A
2019-05-03 00:00	IX-2-220	11.2	15.8	6.0	14188	4920	65%	#N/A	#N/A

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2019-05-06 21:00	IX-2-221	13.2	9.4	7.2	8441	1139	87%	#N/A	#N/A
2019-05-09 16:00	IX-2-222	21.0	11.0	20.4	9878	1544	84%	#N/A	#N/A
2019-05-12 13:40	IX-2-223	43.0	21.8	3.6	19576	2357	88%	#N/A	#N/A
2019-05-15 14:50	IX-2-224	1.5	2.8	12.0	2514	185	93%	#N/A	#N/A

Table 2: IX-3 storm event data.

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2014-04-12 23:20	IX-3-001	7.2	8.0	6.0	10854	2704	75%	#N/A	#N/A
2014-04-14 12:40	IX-3-002	29.5	17.8	8.4	24149	7168	70%	#N/A	#N/A
2014-04-22 05:20	IX-3-003	4.5	1.6	3.6	2171	7	100%	#N/A	#N/A
2014-04-25 15:30	IX-3-004	7.5	5.6	4.8	7598	1371	82%	#N/A	#N/A
2014-04-29 07:10	IX-3-005	46.7	45.6	12.0	61866	16424	73%	#N/A	#N/A
2014-05-13 03:20	IX-3-006	3.8	12.2	24.0	16552	5024	70%	#N/A	#N/A
2014-05-13 15:00	IX-3-007	8.5	6.4	25.2	8683	1462	83%	#N/A	#N/A

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2014-05-14 17:10	IX-3-008	6.8	10.6	12.0	14381	3458	76%	#N/A	#N/A
2014-05-15 11:00	IX-3-009	18.2	18.6	4.8	25235	3494	86%	#N/A	#N/A
2014-05-18 14:20	IX-3-010	3.2	1.6	4.8	2171	36	98%	#N/A	#N/A
2014-05-19 17:40	IX-3-011	2.5	1.0	6.0	1357	16	99%	#N/A	#N/A
2014-05-20 08:40	IX-3-012	18.0	5.4	12.0	7326	1438	80%	#N/A	#N/A
2014-05-23 13:40	IX-3-013	3.3	2.4	8.4	3256	254	92%	#N/A	#N/A
2014-06-02 22:20	IX-3-014	9.3	8.4	6.0	11396	1446	87%	2.2	0.0
2014-06-03 15:10	IX-3-015	1.3	1.0	4.8	1357	2	100%	0.0	0.0
2014-06-08 16:00	IX-3-016	3.5	1.8	2.4	2442	8	100%	0.0	0.0
2014-06-11 05:20	IX-3-017	9.5	2.8	4.8	3799	890	77%	0.5	0.0
2014-06-11 21:10	IX-3-018	15.8	13.6	21.6	18451	9735	47%	2.0	0.0
2014-06-17 18:00	IX-3-019	7.3	14.4	42.0	19536	9046	54%	0.8	0.0
2014-06-23 16:50	IX-3-020	2.8	2.8	6.0	3799	48	99%	0.3	0.0
2014-06-24 17:30	IX-3-021	5.2	4.4	7.2	5969	821	86%	0.8	0.0
2014-06-25 14:20	IX-3-022	11.0	3.6	9.6	4884	561	89%	0.5	0.0
2014-07-07 02:20	IX-3-023	6.0	14.0	9.6	18994	4425	77%	2.2	0.0
2014-07-07 14:40	IX-3-024	1.0	1.4	8.4	1899	2	100%	0.2	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2014-07-08 11:30	IX-3-025	4.5	8.6	25.2	11668	2283	80%	1.7	0.0
2014-07-13 05:40	IX-3-026	2.2	2.4	7.2	3256	21	99%	0.3	0.0
2014-07-15 01:30	IX-3-027	13.2	9.8	18.0	13296	3021	77%	1.5	0.0
2014-07-16 14:00	IX-3-028	2.3	3.6	16.8	4884	323	93%	0.5	0.0
2014-07-19 14:00	IX-3-029	9.7	13.0	8.4	17637	3180	82%	3.3	0.0
2014-07-20 14:00	IX-3-030	2.5	3.6	9.6	4884	231	95%	1.0	0.0
2014-07-23 01:00	IX-3-031	2.3	5.6	14.4	7598	761	90%	1.3	0.0
2014-07-27 19:00	IX-3-032	18.2	66.0	44.4	89542	48459	46%	8.5	0.2
2014-08-04 07:40	IX-3-033	15.8	16.0	18.0	21707	5438	75%	2.7	0.0
2014-08-05 19:30	IX-3-034	7.5	8.8	38.4	11939	3150	74%	0.8	0.0
2014-08-11 22:20	IX-3-035	8.3	26.6	21.6	36088	11139	69%	3.2	0.0
2014-08-19 23:10	IX-3-036	10.7	3.6	6.0	4884	12	100%	1.0	0.0
2014-08-20 19:10	IX-3-037	2.8	6.8	21.6	9226	1785	81%	1.5	0.0
2014-09-02 11:40	IX-3-038	4.7	9.4	31.2	12753	2254	82%	2.0	0.0
2014-09-05 19:10	IX-3-039	12.2	36.8	24.0	49927	13845	72%	7.3	0.0
2014-09-10 15:50	IX-3-040	13.5	21.2	13.2	28762	5946	79%	6.0	0.0
2014-09-13 07:10	IX-3-041	7.3	4.2	6.0	5698	176	97%	1.5	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2014-09-15 15:30	IX-3-042	10.0	4.2	3.6	5698	169	97%	1.7	0.0
2014-09-21 05:50	IX-3-043	4.5	17.2	24.0	23335	6215	73%	3.3	0.0
2014-10-03 13:30	IX-3-044	16.7	10.6	7.2	14381	1679	88%	5.2	0.0
2014-10-06 22:10	IX-3-045	11.2	4.4	6.0	5969	15	100%	2.0	0.0
2014-10-07 16:20	IX-3-046	6.8	15.8	12.0	21436	3094	86%	6.3	0.0
2014-10-15 00:00	IX-3-047	7.3	2.6	3.6	3527	126	96%	0.7	0.0
2014-10-20 06:50	IX-3-048	2.7	1.6	3.6	2171	10	100%	0.5	0.0
2014-10-20 16:20	IX-3-049	4.5	2.0	3.6	2713	32	99%	1.8	0.0
2014-10-21 06:30	IX-3-050	15.3	3.8	6.0	5155	70	99%	2.0	0.0
2014-10-31 05:30	IX-3-051	28.8	14.2	4.8	19265	2173	89%	2.7	0.0
2014-11-04 16:10	IX-3-052	8.5	4.0	2.4	5427	77	99%	0.0	0.0
2014-11-06 19:00	IX-3-053	6.5	4.4	2.4	5969	220	96%	0.5	0.0
2014-11-16 17:10	IX-3-054	25.5	5.4	2.4	7326	631	91%	0.0	0.0
2015-04-02 18:30	IX-3-055	13.5	2.6	4.8	3527	495	86%	#N/A	#N/A
2015-04-03 18:00	IX-3-056	11.5	3.0	2.4	4070	935	77%	#N/A	#N/A
2015-04-04 20:00	IX-3-057	10.2	1.8	2.4	2442	433	82%	#N/A	#N/A
2015-04-08 07:50	IX-3-058	108.5	31.0	15.6	42058	33255	21%	#N/A	#N/A

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2015-04-13 16:50	IX-3-059	31.0	4.8	7.2	6512	3493	46%	0.8	0.0
2015-04-16 22:50	IX-3-060	29.8	1.2	1.2	1628	318	80%	0.0	0.0
2015-04-19 22:30	IX-3-061	84.2	30.0	6.0	40701	32078	21%	7.2	0.0
2015-05-11 20:00	IX-3-062	8.3	4.8	12.0	6512	2776	57%	0.5	0.0
2015-05-30 12:50	IX-3-063	44.3	58.8	34.8	79774	49985	37%	5.3	0.0
2015-06-07 21:20	IX-3-064	30.7	21.8	19.2	29576	15805	47%	2.5	0.0
2015-06-12 03:40	IX-3-065	26.7	10.4	10.8	14110	5484	61%	1.3	0.0
2015-06-14 08:00	IX-3-066	9.0	6.4	8.4	8683	1812	79%	0.5	0.0
2015-06-16 02:50	IX-3-067	6.8	8.6	27.6	11668	4581	61%	0.7	0.0
2015-06-22 18:10	IX-3-068	11.8	3.4	4.8	4613	257	94%	0.0	0.0
2015-06-27 10:40	IX-3-069	40.8	64.2	22.8	87100	54481	37%	10.8	0.0
2015-07-07 12:40	IX-3-070	12.0	15.4	33.6	20893	6692	68%	1.2	0.0
2015-07-14 08:00	IX-3-071	6.0	2.0	2.4	2713	0	100%	0.0	0.0
2015-07-17 10:40	IX-3-072	7.2	5.2	3.6	7055	953	86%	0.0	0.0
2015-07-19 16:10	IX-3-073	2.3	2.2	9.6	2985	63	98%	0.0	0.0
2015-08-02 17:20	IX-3-074	13.0	27.4	44.4	37174	16445	56%	2.0	0.0
2015-08-04 16:30	IX-3-075	3.5	2.0	7.2	2713	35	99%	0.2	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2015-08-10 12:10	IX-3-076	12.0	22.6	28.8	30661	12994	58%	2.0	0.0
2015-08-14 06:00	IX-3-077	4.3	2.8	3.6	3799	164	96%	0.2	0.0
2015-08-15 06:20	IX-3-078	2.5	1.6	6.0	2171	21	99%	0.0	0.0
2015-08-19 22:10	IX-3-079	4.2	4.6	14.4	6241	1303	79%	0.3	0.0
2015-08-20 09:10	IX-3-080	7.0	10.0	31.2	13567	5765	58%	1.0	0.0
2015-09-08 06:10	IX-3-081	4.3	1.8	2.4	2442	11	100%	0.0	0.0
2015-09-09 07:50	IX-3-082	3.2	1.4	3.6	1899	28	99%	0.0	0.0
2015-09-11 18:20	IX-3-083	49.8	35.6	6.0	48299	10444	78%	9.3	0.0
2015-09-19 14:10	IX-3-084	4.2	4.4	10.8	5969	1129	81%	0.5	0.0
2015-09-29 12:20	IX-3-085	14.3	41.0	38.4	55625	28578	49%	2.5	0.0
2015-10-03 14:50	IX-3-086	17.2	1.8	2.4	2442	86	96%	0.0	0.0
2015-10-08 20:30	IX-3-087	14.2	7.0	6.0	9497	2923	69%	2.2	0.0
2015-10-15 16:40	IX-3-088	21.3	5.4	6.0	7326	1545	79%	1.0	0.0
2015-10-20 06:10	IX-3-089	6.8	1.4	2.4	1899	34	98%	0.0	0.0
2015-10-21 22:30	IX-3-090	3.7	1.6	9.6	2171	339	84%	0.3	0.0
2015-10-24 10:40	IX-3-091	18.3	13.0	13.2	17637	5467	69%	2.5	0.0
2015-10-28 02:10	IX-3-092	35.5	59.6	13.2	80859	37210	54%	14.3	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2015-10-31 23:10	IX-3-093	14.5	4.4	4.8	5969	1465	75%	1.5	0.0
2015-11-06 01:00	IX-3-094	20.0	2.0	2.4	2713	191	93%	0.3	0.0
2015-11-10 12:50	IX-3-095	24.2	12.8	3.6	17366	4172	76%	6.8	0.0
2015-11-12 06:50	IX-3-096	10.2	3.2	4.8	4341	551	87%	1.3	0.0
2015-11-18 20:40	IX-3-097	15.8	1.4	2.4	1899	151	92%	0.0	0.0
2015-11-21 10:40	IX-3-098	16.0	3.8	2.4	5155	737	86%	2.8	0.0
2015-11-27 10:30	IX-3-099	17.0	3.6	2.4	4884	311	94%	2.3	0.0
2015-12-01 17:30	IX-3-100	7.8	0.8	2.4	1085	12	99%	0.0	0.0
2015-12-14 14:10	IX-3-101	8.8	3.0	4.8	4070	398	90%	#N/A	#N/A
2015-12-17 00:40	IX-3-102	8.0	0.8	2.4	1085	6	99%	#N/A	#N/A
2015-12-21 07:30	IX-3-103	30.8	4.0	2.4	5427	322	94%	#N/A	#N/A
2015-12-26 22:40	IX-3-104	10.8	5.2	3.6	7055	1264	82%	#N/A	#N/A
2016-04-21 21:50	IX-3-105	8.7	2.2	3.6	2985	70	98%	0.0	0.0
2016-04-25 19:30	IX-3-106	18.2	19.6	27.6	26591	9040	66%	5.2	0.0
2016-05-01 02:40	IX-3-107	22.8	6.6	3.6	8954	1853	79%	2.0	0.0
2016-05-13 00:30	IX-3-108	45.3	17.2	8.4	23335	10369	56%	2.7	0.0
2016-05-16 19:10	IX-3-109	5.5	1.4	2.4	1899	10	99%	0.0	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2016-06-04 22:40	IX-3-110	25.0	23.0	40.8	31204	11159	64%	2.5	0.0
2016-06-06 11:50	IX-3-111	20.7	8.4	9.6	11396	4458	61%	1.7	0.0
2016-06-26 21:10	IX-3-112	5.7	3.2	7.2	4341	428	90%	0.2	0.0
2016-06-28 17:40	IX-3-113	5.2	2.2	6.0	2985	299	90%	0.0	0.0
2016-07-01 08:00	IX-3-114	13.7	8.4	22.8	11396	3799	67%	0.5	0.0
2016-07-09 17:20	IX-3-115	10.7	1.8	6.0	2442	62	97%	0.0	0.0
2016-07-13 23:50	IX-3-116	38.5	27.4	40.8	37174	14848	60%	1.8	0.0
2016-07-25 04:10	IX-3-117	10.0	17.4	51.6	23607	10263	57%	0.7	0.0
2016-08-12 11:30	IX-3-118	3.5	3.8	14.4	5155	622	88%	0.2	0.0
2016-08-13 00:40	IX-3-119	27.5	14.8	30.0	20079	5408	73%	1.8	0.0
2016-08-16 01:20	IX-3-120	17.2	22.0	36.0	29847	11466	62%	3.3	0.0
2016-08-18 21:40	IX-3-121	12.3	10.0	43.2	13567	5018	63%	0.7	0.0
2016-08-20 01:30	IX-3-122	11.0	6.6	13.2	8954	2915	67%	1.0	0.0
2016-08-21 06:30	IX-3-123	5.0	1.4	8.4	1899	186	90%	0.2	0.0
2016-08-25 00:40	IX-3-124	39.8	26.0	42.0	35274	19197	46%	2.2	0.2
2016-09-07 18:20	IX-3-125	23.5	12.8	58.8	17366	5904	66%	0.5	0.0
2016-09-10 09:00	IX-3-126	11.2	3.8	8.4	5155	787	85%	0.8	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2016-09-17 04:30	IX-3-127	23.2	13.2	21.6	17908	4317	76%	2.8	0.0
2016-09-26 10:40	IX-3-128	29.5	15.6	21.6	21165	8241	61%	1.8	0.0
2016-09-29 07:30	IX-3-129	38.8	27.6	14.4	37445	15934	57%	8.3	0.0
2016-10-01 07:30	IX-3-130	59.0	17.4	22.8	23607	9334	60%	2.8	0.0
2016-10-08 06:50	IX-3-131	7.5	1.6	3.6	2171	54	98%	0.0	0.0
2016-10-20 02:30	IX-3-132	39.7	15.2	3.6	20622	1974	90%	6.0	0.0
2016-10-27 00:10	IX-3-133	17.0	5.4	3.6	7326	923	87%	2.2	0.0
2016-11-02 11:10	IX-3-134	26.8	30.0	15.6	40701	11906	71%	6.8	0.0
2016-11-08 17:10	IX-3-135	10.0	1.4	1.2	1899	57	97%	0.2	0.0
2016-11-24 00:10	IX-3-136	16.2	4.4	3.6	5969	687	88%	3.8	0.0
2016-11-26 01:30	IX-3-137	5.3	3.2	2.4	4341	191	96%	2.0	0.0
2016-11-28 23:00	IX-3-138	36.2	5.0	4.8	6784	1749	74%	2.5	0.0
2016-11-30 11:20	IX-3-139	29.5	7.0	6.0	9497	2584	73%	3.7	0.0
2017-03-30 16:10	IX-3-140	58.3	22.2	8.4	30119	12507	58%	#N/A	#N/A
2017-04-03 12:30	IX-3-141	60.3	21.4	19.2	29033	16465	43%	#N/A	#N/A
2017-04-06 01:00	IX-3-142	225.5	32.0	6.0	43414	22903	47%	#N/A	#N/A
2017-04-15 10:40	IX-3-143	25.2	4.2	4.8	5698	3405	40%	#N/A	#N/A

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2017-04-20 09:10	IX-3-144	19.7	28.4	8.4	38530	10101	74%	12.0	0.0
2017-04-25 07:30	IX-3-145	8.0	2.6	3.6	3527	55	98%	1.8	0.0
2017-04-27 17:30	IX-3-146	6.2	6.6	10.8	8954	4196	53%	2.8	0.0
2017-04-30 05:10	IX-3-147	58.0	42.4	24.0	57524	23823	59%	21.8	0.0
2017-05-31 13:30	IX-3-148	6.8	2.6	9.6	3527	429	88%	1.5	0.0
2017-06-04 05:30	IX-3-149	82.8	14.8	15.6	20079	7868	61%	15.0	0.0
2017-06-20 19:30	IX-3-150	15.2	5.4	8.4	7326	1767	76%	1.8	0.0
2017-06-22 10:30	IX-3-151	43.5	21.2	13.2	28762	11826	59%	10.0	0.0
2017-06-25 12:30	IX-3-152	5.2	1.8	6.0	2442	65	97%	0.8	0.0
2017-06-27 04:00	IX-3-153	16.0	3.6	6.0	4884	210	96%	1.0	0.0
2017-06-29 00:20	IX-3-154	19.0	5.0	3.6	6784	1473	78%	2.3	0.0
2017-06-30 04:10	IX-3-155	8.0	19.8	45.6	26863	14582	46%	2.3	0.2
2017-07-01 14:10	IX-3-156	43.5	10.4	21.6	14110	8816	38%	1.3	0.0
2017-07-13 06:40	IX-3-157	42.8	10.2	6.0	13838	6973	50%	3.0	0.0
2017-07-16 04:00	IX-3-158	18.7	3.8	6.0	5155	1129	78%	1.2	0.0
2017-07-20 10:10	IX-3-159	12.3	11.8	49.2	16009	5696	64%	1.0	0.0
2017-07-26 19:10	IX-3-160	44.2	9.4	10.8	12753	3330	74%	1.5	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2017-08-01 14:00	IX-3-161	3.8	2.2	7.2	2985	149	95%	0.5	0.0
2017-08-04 06:50	IX-3-162	13.3	14.2	18.0	19265	5177	73%	2.0	0.0
2017-08-12 10:10	IX-3-163	10.3	7.0	21.6	9497	1790	81%	0.7	0.0
2017-08-17 14:00	IX-3-164	20.8	14.8	16.8	20079	8299	59%	3.0	0.0
2017-08-31 00:50	IX-3-165	6.7	4.2	4.8	5698	702	88%	1.2	0.0
2017-09-03 02:20	IX-3-166	19.2	12.4	9.6	16823	6175	63%	3.3	0.0
2017-09-04 18:20	IX-3-167	21.3	6.6	12.0	8954	3560	60%	1.7	0.0
2017-09-29 10:00	IX-3-168	11.0	2.0	3.6	2713	13	100%	0.0	0.0
2017-10-04 12:10	IX-3-169	13.2	3.8	16.8	5155	499	90%	0.5	0.0
2017-10-07 03:50	IX-3-170	8.0	1.2	2.4	1628	23	99%	0.0	0.0
2017-10-08 00:30	IX-3-171	5.0	1.4	4.8	1899	193	90%	0.7	0.0
2017-10-09 01:00	IX-3-172	21.0	20.4	9.6	27677	11821	57%	7.3	0.0
2017-10-11 16:50	IX-3-173	8.8	3.6	4.8	4884	914	81%	1.3	0.0
2017-10-14 17:10	IX-3-174	29.2	11.4	13.2	15466	3026	80%	9.3	0.0
2017-10-23 15:10	IX-3-175	30.5	11.2	10.8	15195	3886	74%	4.3	0.0
2017-10-28 05:30	IX-3-176	12.3	5.2	2.4	7055	484	93%	3.0	0.0
2017-11-01 20:40	IX-3-177	73.7	18.2	6.0	24692	9872	60%	11.7	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2017-11-04 22:30	IX-3-178	118.2	14.6	7.2	19808	10231	48%	15.7	0.0
2017-11-12 22:50	IX-3-179	40.0	1.0	1.2	1357	327	76%	0.0	0.0
2017-11-15 19:00	IX-3-180	30.5	4.0	2.4	5427	976	82%	4.0	0.0
2017-11-18 05:00	IX-3-181	92.0	24.6	8.4	33375	11793	65%	14.0	0.0
2017-11-30 13:50	IX-3-182	9.5	1.6	2.4	2171	117	95%	#N/A	#N/A
2017-12-04 22:50	IX-3-183	40.3	6.8	3.6	9226	3382	63%	#N/A	#N/A
2018-04-24 18:20	IX-3-184	76.2	21.2	7.2	28768	15082	48%	#N/A	#N/A
2018-04-27 22:40	IX-3-185	118.2	8.8	9.6	11942	4608	61%	2.7	0.0
2018-05-02 21:00	IX-3-186	17.5	1.4	8.4	1900	148	92%	0.0	0.0
2018-05-03 14:40	IX-3-187	155.0	16.4	14.4	22255	13579	39%	2.2	0.0
2018-05-10 01:50	IX-3-188	60.8	2.8	6.0	3800	1297	66%	0.3	0.0
2018-05-15 02:30	IX-3-189	18.3	25.8	74.4	35011	23685	32%	3.0	0.2
2018-05-19 05:00	IX-3-190	21.5	9.8	6.0	13299	2249	83%	2.2	0.0
2018-05-22 02:10	IX-3-191	7.3	8.8	6.0	11942	2797	77%	2.2	0.0
2018-05-31 18:50	IX-3-192	3.0	3.4	20.4	4614	477	90%	0.3	0.0
2018-06-03 15:50	IX-3-193	10.8	12.2	34.8	16555	8801	47%	0.8	0.0
2018-06-13 07:00	IX-3-194	8.5	1.6	3.6	2171	8	100%	0.0	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2018-06-22 22:00	IX-3-195	18.3	16.0	10.8	21712	7391	66%	2.7	0.0
2018-06-24 06:20	IX-3-196	9.7	39.0	24.0	52923	25148	52%	4.8	0.0
2018-06-27 03:10	IX-3-197	7.5	12.4	25.2	16827	6822	59%	1.5	0.0
2018-06-27 20:20	IX-3-198	5.0	2.4	3.6	3257	121	96%	0.7	0.0
2018-07-05 16:40	IX-3-199	12.5	37.6	70.8	51023	47687	7%	1.7	0.5
2018-07-16 18:10	IX-3-200	9.7	9.8	40.8	13299	2971	78%	1.0	0.0
2018-07-22 00:40	IX-3-201	15.7	24.4	10.8	33111	9389	72%	5.8	0.0
2018-07-24 16:40	IX-3-202	13.2	19.8	52.8	26869	24709	8%	1.7	0.2
2018-08-06 13:20	IX-3-203	14.8	44.6	68.4	60522	22029	64%	3.0	0.2
2018-08-08 05:30	IX-3-204	16.0	29.0	46.8	39353	13956	65%	3.5	0.2
2018-08-16 15:20	IX-3-205	13.2	5.8	27.6	7871	624	92%	0.3	0.0
2018-08-17 16:50	IX-3-206	32.3	24.8	80.4	33654	20522	39%	2.0	0.2
2018-08-21 06:10	IX-3-207	103.0	30.2	44.4	40981	21028	49%	3.5	0.0
2018-08-25 13:20	IX-3-208	14.5	9.8	12.0	13299	1249	91%	2.5	0.0
2018-08-27 08:00	IX-3-209	27.3	4.0	22.8	5428	825	85%	0.5	0.0
2018-09-06 00:20	IX-3-210	41.8	0.8	1.2	1086	405	63%	0.0	0.0
2018-09-21 16:20	IX-3-211	4.5	2.8	16.8	3800	64	98%	0.0	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2018-09-24 22:40	IX-3-212	35.8	19.8	18.0	26869	10559	61%	5.8	0.0
2018-09-28 20:00	IX-3-213	7.0	3.4	3.6	4614	156	97%	0.5	0.0
2018-09-30 20:10	IX-3-214	22.8	23.6	10.8	32025	5027	84%	8.5	0.0
2018-10-02 02:40	IX-3-215	12.0	22.2	37.2	30125	5589	81%	5.0	0.0
2018-10-04 04:30	IX-3-216	5.3	3.2	12.0	4342	593	86%	0.8	0.0
2018-10-06 06:10	IX-3-217	22.5	7.0	4.8	9499	968	90%	1.8	0.0
2018-10-12 21:20	IX-3-218	9.5	2.6	2.4	3528	167	95%	0.0	0.0
2019-04-07 21:10	IX-3-219	14.3	6.4	4.8	8685	2693	69%	#N/A	#N/A
2019-04-12 12:20	IX-3-220	4.8	1.4	2.4	1900	46	98%	#N/A	#N/A
2019-04-14 08:00	IX-3-221	28.0	26.4	14.4	35825	12260	66%	#N/A	#N/A
2019-04-16 14:20	IX-3-222	5.7	1.4	1.2	1900	41	98%	#N/A	#N/A
2019-04-18 20:30	IX-3-223	60.5	31.4	6.0	42610	15206	64%	#N/A	#N/A
2019-04-23 09:50	IX-3-224	20.0	3.2	8.4	4342	1161	73%	#N/A	#N/A
2019-04-26 01:40	IX-3-225	44.3	21.8	15.6	29583	18062	39%	#N/A	#N/A
2019-04-29 18:40	IX-3-226	8.5	0.8	1.2	1086	31	97%	#N/A	#N/A
2019-04-30 22:30	IX-3-227	10.0	9.2	6.0	12484	1737	86%	#N/A	#N/A
2019-05-01 15:40	IX-3-228	5.7	9.4	10.8	12756	2788	78%	#N/A	#N/A

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2019-05-03 00:00	IX-3-229	10.0	15.8	6.0	21441	3603	83%	#N/A	#N/A
2019-05-06 21:00	IX-3-230	14.3	9.4	7.2	12756	1961	85%	#N/A	#N/A
2019-05-09 16:00	IX-3-231	21.0	11.0	20.4	14927	3022	80%	#N/A	#N/A
2019-05-12 13:40	IX-3-232	43.0	21.8	3.6	29583	3066	90%	#N/A	#N/A
2019-05-15 14:50	IX-3-233	3.7	2.8	12.0	3800	203	95%	#N/A	#N/A

Table 3: IX-4 storm event data.

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2014-05-13 03:20	IX-4-001	20.8	18.6	25.2	40285	26522	34%	#N/A	#N/A
2014-05-14 17:10	IX-4-002	6.8	10.6	12.0	22958	11945	48%	#N/A	#N/A
2014-05-15 11:00	IX-4-003	19.5	18.6	4.8	40285	15210	62%	#N/A	#N/A
2014-05-18 14:20	IX-4-004	2.3	1.6	4.8	3465	25	99%	#N/A	#N/A
2014-05-19 17:40	IX-4-005	2.0	1.0	6.0	2166	20	99%	#N/A	#N/A
2014-05-20 08:40	IX-4-006	23.7	5.4	12.0	11696	5815	50%	#N/A	#N/A
2014-05-23 13:40	IX-4-007	3.5	2.4	8.4	5198	974	81%	#N/A	#N/A
2014-06-02 22:20	IX-4-008	9.8	8.4	6.0	18193	4673	74%	0.0	0.0
2014-06-03 15:10	IX-4-009	2.0	1.0	4.8	2166	32	99%	0.0	0.0
2014-06-08 16:00	IX-4-010	4.2	1.8	2.4	3899	44	99%	0.0	0.0
2014-06-11 05:20	IX-4-011	3.8	2.8	4.8	6064	250	96%	0.0	0.0
2014-06-11 21:10	IX-4-012	7.0	13.6	21.6	29456	16736	43%	2.0	0.3
2014-06-17 18:00	IX-4-013	9.7	14.4	42.0	31188	22457	28%	0.8	0.3
2014-06-23 16:50	IX-4-014	3.3	2.8	6.0	6064	500	92%	0.2	0.0
2014-06-24 17:30	IX-4-015	7.8	4.4	7.2	9530	5739	40%	0.7	0.0
2014-06-25 14:20	IX-4-016	9.3	3.6	9.6	7797	1473	81%	0.5	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2014-07-07 02:20	IX-4-017	16.7	15.4	9.6	33354	16979	49%	1.7	0.0
2014-07-08 11:30	IX-4-018	6.0	8.6	25.2	18626	10236	45%	0.7	0.2
2014-07-13 05:40	IX-4-019	2.8	2.4	7.2	5198	1793	66%	0.2	0.0
2014-07-15 01:30	IX-4-020	13.2	9.8	18.0	21225	10375	51%	0.8	0.0
2014-07-16 14:00	IX-4-021	3.0	3.6	16.8	7797	2881	63%	0.5	0.0
2014-07-19 14:00	IX-4-022	10.3	13.0	8.4	28156	11373	60%	2.2	0.0
2014-07-20 14:00	IX-4-023	3.3	3.6	9.6	7797	2492	68%	0.7	0.0
2014-07-23 01:00	IX-4-024	9.2	5.8	14.4	12562	7354	41%	1.0	0.0
2014-07-27 19:00	IX-4-025	16.3	66.0	44.4	142946	97320	32%	5.7	1.5
2014-08-04 07:40	IX-4-026	15.8	16.0	18.0	34654	19971	42%	2.3	0.2
2014-08-05 19:30	IX-4-027	7.5	8.8	38.4	19059	13450	29%	0.8	0.3
2014-08-11 22:20	IX-4-028	9.3	26.6	21.6	57612	32133	44%	2.5	0.5
2014-08-19 23:10	IX-4-029	11.7	3.6	6.0	7797	1097	86%	0.3	0.0
2014-08-20 19:10	IX-4-030	6.2	6.8	21.6	14728	8857	40%	1.0	0.2
2014-08-30 09:10	IX-4-031	1.7	1.0	4.8	2166	10	100%	0.0	0.0
2014-09-01 21:20	IX-4-032	2.7	1.4	2.4	3032	265	91%	0.0	0.0
2014-09-02 11:40	IX-4-033	6.0	9.4	31.2	20359	12911	37%	0.7	0.3

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2014-09-05 19:10	IX-4-034	13.0	36.8	24.0	79703	48341	39%	5.5	0.5
2014-09-10 15:50	IX-4-035	13.5	21.2	13.2	45916	18345	60%	3.5	0.0
2014-09-13 07:10	IX-4-036	7.3	4.2	6.0	9097	2157	76%	0.8	0.0
2014-09-15 15:30	IX-4-037	10.0	4.2	3.6	9097	2488	73%	1.0	0.0
2014-09-21 05:50	IX-4-038	5.5	17.2	24.0	37253	21972	41%	3.0	0.2
2014-09-21 18:20	IX-4-039	3.3	1.2	1.2	2599	77	97%	0.0	0.0
2014-10-03 13:30	IX-4-040	16.7	10.6	7.2	22958	9544	58%	2.7	0.0
2014-10-06 22:10	IX-4-041	11.8	4.4	6.0	9530	526	94%	0.8	0.0
2014-10-07 16:20	IX-4-042	8.0	15.8	12.0	34220	13567	60%	4.5	0.2
2014-10-15 00:00	IX-4-043	6.2	2.6	3.6	5631	285	95%	0.0	0.0
2014-10-20 06:50	IX-4-044	2.5	1.6	3.6	3465	136	96%	0.3	0.0
2014-10-20 16:20	IX-4-045	4.7	2.0	3.6	4332	255	94%	0.5	0.0
2014-10-21 06:30	IX-4-046	15.3	3.8	6.0	8230	867	89%	0.8	0.0
2014-10-31 05:30	IX-4-047	28.8	14.2	4.8	30755	8041	74%	4.7	0.0
2014-11-04 16:10	IX-4-048	8.5	4.0	2.4	8663	1154	87%	0.5	0.0
2014-11-06 19:00	IX-4-049	7.5	4.4	2.4	9530	1746	82%	2.0	0.0
2014-11-16 17:10	IX-4-050	25.5	5.4	2.4	11696	1806	85%	3.5	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2015-03-26 10:10	IX-4-051	5.2	1.2	2.4	2599	280	89%	#N/A	#N/A
2015-04-02 18:30	IX-4-052	4.2	2.4	4.8	5198	759	85%	#N/A	#N/A
2015-04-03 18:00	IX-4-053	6.5	3.0	2.4	6498	1244	81%	#N/A	#N/A
2015-04-04 20:00	IX-4-054	7.0	1.8	2.4	3899	432	89%	#N/A	#N/A
2015-04-08 08:00	IX-4-055	11.7	15.2	9.6	32921	19733	40%	#N/A	#N/A
2015-04-09 13:10	IX-4-056	21.5	15.8	15.6	34220	27854	19%	3.0	1.0
2015-04-13 16:50	IX-4-057	4.3	4.8	7.2	10396	3648	65%	1.0	0.0
2015-04-19 22:30	IX-4-058	19.3	25.2	6.0	54579	19550	64%	7.7	0.0
2015-04-21 12:10	IX-4-059	10.2	4.4	4.8	9530	893	91%	0.7	0.0
2015-05-11 20:00	IX-4-060	4.8	4.8	12.0	10396	3519	66%	0.7	0.0
2015-05-30 12:50	IX-4-061	34.3	58.8	34.8	127352	70009	45%	5.2	1.2
2015-06-07 21:20	IX-4-062	16.7	21.6	19.2	46782	27895	40%	4.0	0.3
2015-06-12 03:40	IX-4-063	15.0	10.4	10.8	22525	7377	67%	2.8	0.0
2015-06-14 08:00	IX-4-064	8.2	6.4	8.4	13861	3422	75%	1.7	0.0
2015-06-16 02:50	IX-4-065	5.7	8.6	27.6	18626	9871	47%	1.5	0.2
2015-06-22 18:10	IX-4-066	18.2	3.6	4.8	7797	1390	82%	0.2	0.0
2015-06-27 10:40	IX-4-067	32.5	64.2	22.8	139048	57550	59%	10.7	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2015-07-07 12:40	IX-4-068	10.2	15.4	33.6	33354	15569	53%	1.7	0.2
2015-07-14 08:00	IX-4-069	6.0	2.0	2.4	4332	16	100%	0.0	0.0
2015-07-17 10:40	IX-4-070	6.2	5.2	3.6	11262	1884	83%	0.2	0.0
2015-07-19 16:10	IX-4-071	1.8	2.2	9.6	4765	624	87%	0.2	0.0
2015-08-02 17:20	IX-4-072	11.7	27.4	44.4	59344	29262	51%	1.7	0.8
2015-08-04 16:30	IX-4-073	2.8	2.0	7.2	4332	404	91%	0.2	0.0
2015-08-10 12:10	IX-4-074	8.8	22.6	28.8	48948	24692	50%	2.5	0.7
2015-08-14 06:00	IX-4-075	4.0	2.8	3.6	6064	1217	80%	0.0	0.0
2015-08-15 06:20	IX-4-076	2.2	1.6	6.0	3465	170	95%	0.2	0.0
2015-08-19 22:10	IX-4-077	2.7	4.6	14.4	9963	4003	60%	0.5	0.0
2015-08-20 09:10	IX-4-078	4.8	10.0	31.2	21659	11568	47%	0.8	0.3
2015-09-08 06:10	IX-4-079	3.8	1.8	2.4	3899	17	100%	0.0	0.0
2015-09-09 07:50	IX-4-080	2.5	1.4	3.6	3032	52	98%	0.0	0.0
2015-09-11 18:20	IX-4-081	48.5	35.6	6.0	77104	23884	69%	4.5	0.0
2015-09-19 14:10	IX-4-082	2.5	4.4	10.8	9530	3464	64%	0.7	0.0
2015-09-29 12:20	IX-4-083	7.7	41.0	38.4	88800	56484	36%	2.5	1.5
2015-10-08 20:30	IX-4-084	7.2	7.0	6.0	15161	3987	74%	1.0	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2015-10-15 16:40	IX-4-085	6.8	5.2	6.0	11262	2976	74%	1.3	0.0
2015-10-20 06:10	IX-4-086	4.0	1.4	2.4	3032	33	99%	0.0	0.0
2015-10-21 22:30	IX-4-087	2.2	1.6	9.6	3465	434	87%	0.5	0.0
2015-10-24 10:40	IX-4-088	14.7	13.0	13.2	28156	13797	51%	2.2	0.5
2015-10-28 02:10	IX-4-089	27.2	59.6	13.2	129085	76262	41%	13.3	1.8
2015-10-31 23:10	IX-4-090	6.2	4.4	4.8	9530	1744	82%	1.3	0.0
2015-11-06 01:00	IX-4-091	11.0	2.0	2.4	4332	147	97%	0.0	0.0
2015-11-10 12:50	IX-4-092	15.8	12.6	3.6	27290	8554	69%	2.5	0.0
2015-11-12 06:50	IX-4-093	7.3	3.2	4.8	6931	1003	86%	1.0	0.0
2015-11-18 20:40	IX-4-094	11.2	1.4	2.4	3032	14	100%	0.0	0.0
2015-11-21 10:40	IX-4-095	3.5	1.0	1.2	2166	99	95%	0.0	0.0
2015-11-21 20:50	IX-4-096	4.8	2.8	2.4	6064	1080	82%	1.3	0.0
2015-11-27 10:30	IX-4-097	14.8	3.6	2.4	7797	478	94%	0.0	0.0
2015-12-14 14:10	IX-4-098	6.5	3.0	4.8	6498	647	90%	#N/A	#N/A
2015-12-21 07:30	IX-4-099	20.5	3.6	2.4	7797	564	93%	#N/A	#N/A
2015-12-26 22:40	IX-4-100	9.7	5.2	3.6	11262	3033	73%	#N/A	#N/A
2016-03-14 01:50	IX-4-101	12.2	10.4	8.4	22525	10426	54%	#N/A	#N/A

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2016-03-15 01:40	IX-4-102	20.8	6.4	3.6	13861	5414	61%	#N/A	#N/A
2016-03-16 11:30	IX-4-103	15.5	1.6	2.4	3465	816	76%	#N/A	#N/A
2016-03-28 03:20	IX-4-104	12.5	10.2	10.8	22092	5520	75%	#N/A	#N/A
2016-03-31 02:20	IX-4-105	25.0	26.6	30.0	57612	30694	47%	#N/A	#N/A
2016-04-21 21:50	IX-4-106	10.7	2.2	3.6	4765	88	98%	0.0	0.0
2016-04-25 19:30	IX-4-107	17.3	19.6	27.6	42451	20045	53%	5.8	0.7
2016-06-04 22:40	IX-4-108	20.2	23.0	40.8	49815	22630	55%	3.0	0.3
2016-06-06 11:50	IX-4-109	11.0	8.4	9.6	18193	8417	54%	1.8	0.0
2016-06-26 21:10	IX-4-110	8.3	3.2	7.2	6931	2162	69%	0.3	0.0
2016-06-28 17:40	IX-4-111	11.7	2.2	6.0	4765	1291	73%	0.0	0.0
2016-07-01 08:00	IX-4-112	21.2	8.4	22.8	18193	11261	38%	0.7	0.3
2016-07-09 17:20	IX-4-113	4.2	1.6	6.0	3465	623	82%	0.2	0.0
2016-07-13 23:50	IX-4-114	9.0	9.8	22.8	21225	9162	57%	1.0	0.2
2016-07-14 18:10	IX-4-115	6.5	17.6	40.8	38119	23223	39%	1.3	0.5
2016-07-25 04:10	IX-4-116	4.2	17.4	51.6	37686	22110	41%	0.8	0.5
2016-08-12 11:30	IX-4-117	3.2	3.8	14.4	8230	2370	71%	0.3	0.0
2016-08-13 00:40	IX-4-118	3.5	2.2	8.4	4765	1796	62%	0.5	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2016-08-13 11:10	IX-4-119	12.0	12.6	30.0	27290	13390	51%	1.3	0.3
2016-08-16 01:20	IX-4-120	11.7	22.0	36.0	47649	24079	49%	3.3	0.5
2016-08-18 21:40	IX-4-121	3.3	10.0	43.2	21659	12210	44%	0.7	0.3
2016-08-20 01:30	IX-4-122	4.0	6.4	13.2	13861	6571	53%	1.2	0.0
2016-08-21 06:30	IX-4-123	2.2	1.4	8.4	3032	560	82%	0.3	0.0
2016-08-25 00:40	IX-4-124	3.7	3.8	9.6	8230	3739	55%	0.7	0.0
2016-08-25 11:30	IX-4-125	14.0	22.2	42.0	48082	35029	27%	1.3	0.7
2016-09-07 18:20	IX-4-126	8.3	12.8	58.8	27723	12531	55%	0.7	0.2
2016-09-10 09:00	IX-4-127	3.2	3.0	8.4	6498	1448	78%	0.7	0.0
2016-09-17 04:30	IX-4-128	15.2	13.0	21.6	28156	9575	66%	1.7	0.2
2016-09-26 10:40	IX-4-129	4.5	15.4	21.6	33354	15231	54%	1.8	0.3
2016-09-29 07:30	IX-4-130	17.3	27.6	14.4	59777	25755	57%	5.8	1.0
2016-10-01 07:30	IX-4-131	4.5	2.4	2.4	5198	685	87%	0.0	0.0
2016-10-01 20:40	IX-4-132	18.5	15.0	22.8	32488	14222	56%	2.2	0.5
2016-10-08 06:50	IX-4-133	3.0	1.6	3.6	3465	614	82%	0.0	0.0
2016-10-20 02:30	IX-4-134	39.2	15.2	3.6	32921	4575	86%	1.0	0.0
2016-10-27 00:10	IX-4-135	17.0	5.4	3.6	11696	1443	88%	0.8	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2016-10-30 09:40	IX-4-136	3.2	1.0	2.4	2166	18	99%	0.0	0.0
2016-11-02 11:10	IX-4-137	52.5	30.0	15.6	64976	43255	33%	6.2	1.5
2016-11-08 17:10	IX-4-138	10.0	1.4	1.2	3032	750	75%	0.0	0.0
2016-11-19 11:10	IX-4-139	5.3	5.0	4.8	10829	3112	71%	1.5	0.0
2016-11-24 00:10	IX-4-140	16.8	4.4	3.6	9530	1437	85%	1.5	0.0
2016-11-26 01:30	IX-4-141	5.7	3.2	2.4	6931	1048	85%	1.8	0.0
2016-11-28 23:00	IX-4-142	8.5	5.0	4.8	10829	2575	76%	2.5	0.0
2016-11-30 11:20	IX-4-143	16.3	7.0	6.0	15161	4553	70%	2.3	0.0
2017-03-18 19:50	IX-4-144	21.8	1.2	2.4	2599	354	86%	#N/A	#N/A
2017-03-24 04:40	IX-4-145	6.3	6.6	6.0	14295	3007	79%	#N/A	#N/A
2017-03-24 23:10	IX-4-146	16.8	7.0	3.6	15161	1337	91%	#N/A	#N/A
2017-03-26 21:40	IX-4-147	11.2	2.4	2.4	5198	115	98%	#N/A	#N/A
2017-03-30 16:50	IX-4-148	37.3	22.2	8.4	48082	11253	77%	#N/A	#N/A
2017-04-03 21:20	IX-4-149	26.8	21.4	19.2	46349	20438	56%	#N/A	#N/A
2017-04-06 01:00	IX-4-150	35.2	31.2	6.0	67575	38999	42%	#N/A	#N/A
2017-04-10 22:40	IX-4-151	2.5	0.4	2.4	866	19	98%	#N/A	#N/A
2017-04-15 10:40	IX-4-152	7.2	4.2	4.8	9097	2227	76%	#N/A	#N/A

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2017-04-20 09:10	IX-4-153	20.2	28.4	8.4	61510	25176	59%	7.8	1.3
2017-04-25 07:30	IX-4-154	8.2	2.6	3.6	5631	407	93%	0.2	0.0
2017-04-27 17:30	IX-4-155	9.8	6.6	10.8	14295	7805	45%	1.5	0.2
2017-04-30 05:10	IX-4-156	43.2	42.0	24.0	90966	41319	55%	10.5	4.2
2017-05-04 13:10	IX-4-157	36.7	51.0	4.8	110458	44687	60%	26.2	0.0
2017-05-21 06:20	IX-4-158	26.5	15.4	13.2	33354	11569	65%	3.0	0.0
2017-05-24 21:00	IX-4-159	44.5	52.4	14.4	113491	67055	41%	12.0	4.3
2017-05-30 16:40	IX-4-160	27.2	9.6	13.2	20792	7729	63%	3.3	0.2
2017-06-04 05:30	IX-4-161	15.2	6.2	4.8	13428	3738	72%	0.5	0.0
2017-06-05 02:50	IX-4-162	10.2	4.6	15.6	9963	3383	66%	2.0	0.0
2017-06-06 06:50	IX-4-163	16.5	3.8	4.8	8230	1596	81%	0.0	0.0
2017-06-20 19:30	IX-4-164	7.7	5.2	8.4	11262	5092	55%	0.5	0.0
2017-06-22 10:30	IX-4-165	6.3	2.6	3.6	5631	1659	71%	0.7	0.0
2017-06-23 00:40	IX-4-166	18.3	18.6	13.2	40285	24333	40%	6.2	0.7
2017-06-25 12:30	IX-4-167	5.2	1.8	6.0	3899	765	80%	0.0	0.0
2017-06-26 13:40	IX-4-168	3.0	0.8	2.4	1733	37	98%	0.0	0.0
2017-06-27 04:00	IX-4-169	16.0	3.6	6.0	7797	730	91%	0.3	0.0

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2017-06-29 00:20	IX-4-170	13.8	5.0	3.6	10829	2538	77%	0.8	0.0
2017-06-30 04:10	IX-4-171	10.0	19.8	45.6	42884	28422	34%	1.3	0.8
2017-07-01 00:20	IX-4-172	3.0	0.6	2.4	1300	5	100%	0.0	0.0
2017-07-01 14:10	IX-4-173	20.8	10.4	21.6	22525	16317	28%	1.2	0.5
2017-07-13 06:40	IX-4-174	6.7	8.6	6.0	18626	7033	62%	0.2	0.0
2017-07-13 21:50	IX-4-175	5.7	1.6	3.6	3465	525	85%	0.0	0.0
2017-07-16 16:00	IX-4-176	5.2	3.8	6.0	8230	2147	74%	0.8	0.0
2017-07-20 10:10	IX-4-177	7.7	11.8	49.2	25557	12814	50%	1.3	0.2
2017-07-22 08:50	IX-4-178	5.8	1.2	2.4	2599	113	96%	0.0	0.0
2017-07-26 19:10	IX-4-179	38.8	9.4	10.8	20359	5024	75%	1.2	0.0
2017-11-12 22:50	IX-4-180	19.8	1.0	1.2	2166	438	80%	0.0	0.0
2017-11-15 19:00	IX-4-181	11.2	4.0	2.4	8663	798	91%	0.0	0.0
2017-11-18 05:00	IX-4-182	80.8	24.6	8.4	53280	28305	47%	10.7	0.2
2017-11-30 13:50	IX-4-183	4.0	1.6	2.4	3465	174	95%	#N/A	#N/A
2017-12-04 22:50	IX-4-184	11.5	6.8	3.6	14728	1800	88%	#N/A	#N/A
2018-03-27 8:50	IX-4-185	49.2	4.6	2.4	9964	1150	88%	#N/A	#N/A
2018-03-29 10:10	IX-4-186	43.7	19.0	3.6	41154	10629	74%	#N/A	#N/A

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2018-04-24 18:20	IX-4-187	76.2	21.2	7.2	45919	9853	79%	#N/A	#N/A
2018-04-27 22:40	IX-4-188	55.3	8.8	9.6	19061	4562	76%	1.2	0.0
2018-05-02 21:00	IX-4-189	223.5	20.4	14.4	44186	18427	58%	2.8	0.2
2018-05-15 2:30	IX-4-190	98.3	25.8	74.4	55883	31010	45%	2.3	0.5
2018-05-19 5:00	IX-4-191	69.0	10.0	6.0	21660	6127	72%	1.2	0.0
2018-05-22 2:10	IX-4-192	111.8	9.0	6.0	19494	8824	55%	1.3	0.0
2018-05-31 18:50	IX-4-193	21.0	3.4	20.4	7364	1902	74%	0.3	0.0
2018-06-03 15:50	IX-4-194	62.0	13.0	34.8	28158	13797	51%	0.8	0.3
2018-06-22 22:00	IX-4-195	57.2	55.0	24.0	119130	57769	52%	7.2	1.8
2018-06-27 3:10	IX-4-196	31.5	14.8	25.2	32057	13504	58%	2.3	0.5
2018-07-05 16:40	IX-4-197	142.0	37.6	70.8	81442	46876	42%	1.8	1.2
2018-07-16 18:10	IX-4-198	32.3	9.8	40.8	21227	8380	61%	0.5	0.2
2018-07-20 23:50	IX-4-199	12.7	0.4	2.4	866	84	90%	0.0	0.0
2018-07-22 0:40	IX-4-200	63.8	24.4	10.8	52850	24120	54%	5.0	0.3
2018-07-24 16:40	IX-4-201	235.8	21.4	52.8	46352	27586	40%	1.5	0.5

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)	Ponding length (h)	Overflow length (h)
2018-08-06 13:20	IX-4-202	14.8	44.6	68.4	96604	35244	64%	3.3	1.7
2018-08-08 5:30	IX-4-203	16.5	29.0	46.8	62814	21992	65%	3.7	0.8
2018-08-16 15:20	IX-4-204	15.0	5.8	27.6	12563	2881	77%	0.5	0.2
2018-08-17 16:50	IX-4-205	38.5	24.8	80.4	53717	26222	51%	3.3	1.0
2018-11-03 5:40	IX-4-206	8.3	1.4	1.2	3032	47	98%	0.0	0.0
2018-11-05 6:20	IX-4-207	8.5	1.6	1.2	3466	129	96%	0.0	0.0
2018-11-06 3:10	IX-4-208	11.8	7.2	3.6	15595	2524	84%	3.7	0.0
2018-11-24 10:50	IX-4-209	31.0	4.8	3.6	10397	621	94%	#N/A	#N/A
2018-11-26 6:20	IX-4-210	19.3	23.4	4.8	50684	6209	88%	#N/A	#N/A
2018-12-20 20:40	IX-4-211	18.8	18.6	7.2	40288	10226	75%	#N/A	#N/A
2018-12-27 22:10	IX-4-212	38.3	7.0	4.8	15162	2546	83%	#N/A	#N/A

Table 4: IX-5 storm event data.

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2014-04-04 11:50	IX-5-001	53.3	5.8	4.8	10734	9098	15%
2014-04-07 18:00	IX-5-002	47.5	16.0	6.0	29610	30937	-4%
2014-04-12 23:20	IX-5-003	90.3	26.2	8.4	48486	20538	58%
2014-04-25 15:30	IX-5-004	3.7	5.6	4.8	10363	0	100%
2014-04-29 07:10	IX-5-005	73.0	45.6	12.0	84388	42054	50%
2014-05-13 03:20	IX-5-006	108.2	47.8	25.2	88459	63840	28%
2014-05-20 08:40	IX-5-007	48.3	5.4	12.0	9993	7153	28%
2014-05-23 13:40	IX-5-008	0.5	2.4	8.4	4441	0	100%
2014-06-02 22:20	IX-5-009	19.0	9.4	6.0	17396	28	100%
2014-06-11 05:20	IX-5-010	3.7	2.8	4.8	5182	0	100%
2014-06-11 21:10	IX-5-011	31.8	13.6	21.6	25168	21996	13%
2014-06-17 18:00	IX-5-012	26.0	14.8	42.0	27389	22283	19%
2014-06-23 16:50	IX-5-013	1.5	2.8	6.0	5182	0	100%
2014-06-24 17:30	IX-5-014	2.5	4.4	7.2	8143	0	100%
2014-06-25 14:20	IX-5-015	9.3	3.6	9.6	6662	0	100%
2014-07-07 02:20	IX-5-016	59.5	24.0	25.2	44415	14376	68%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2014-07-13 05:40	IX-5-017	1.3	2.4	7.2	4441	0	100%
2014-07-15 01:30	IX-5-018	58.7	13.4	18.0	24798	5575	78%
2014-07-19 14:00	IX-5-019	63.8	16.6	9.6	30720	12131	61%
2014-07-23 01:00	IX-5-020	32.8	5.8	14.4	10734	2526	76%
2014-07-27 19:00	IX-5-021	40.2	66.0	44.4	122140	65772	46%
2014-08-04 07:40	IX-5-022	73.8	25.6	38.4	47376	10822	77%
2014-08-11 22:20	IX-5-023	41.2	26.6	21.6	49226	25187	49%
2014-08-19 23:10	IX-5-024	9.5	3.6	6.0	6662	0	100%
2014-08-20 19:10	IX-5-025	2.3	6.8	21.6	12584	0	100%
2014-09-02 11:40	IX-5-026	3.7	9.4	31.2	17396	0	100%
2014-09-05 19:10	IX-5-027	55.0	36.8	24.0	68102	41632	39%
2014-09-10 15:50	IX-5-028	46.8	21.2	13.2	39233	19919	49%
2014-09-13 07:10	IX-5-029	46.7	4.2	6.0	7773	658	92%
2014-09-15 15:30	IX-5-030	41.5	4.2	3.6	7773	693	91%
2014-09-21 05:50	IX-5-031	37.8	18.4	24.0	34051	15204	55%
2014-10-03 13:30	IX-5-032	18.3	10.6	7.2	19616	20	100%
2014-10-06 22:10	IX-5-033	10.2	4.4	6.0	8143	0	100%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2014-10-07 16:20	IX-5-034	39.8	16.0	12.0	29610	13717	54%
2014-10-15 00:00	IX-5-035	4.7	2.6	3.6	4812	0	100%
2014-10-20 16:20	IX-5-036	3.2	2.0	3.6	3701	0	100%
2014-10-21 06:30	IX-5-037	25.2	3.8	6.0	7032	52	99%
2014-10-31 05:30	IX-5-038	52.0	14.2	4.8	26279	7743	71%
2014-11-04 16:10	IX-5-039	8.5	4.0	2.4	7402	0	100%
2014-11-06 19:00	IX-5-040	36.7	4.6	2.4	8513	414	95%
2014-11-24 00:00	IX-5-041	52.7	24.2	14.4	44785	26061	42%
2015-04-02 18:30	IX-5-042	0.8	2.4	4.8	4441	0	100%
2015-04-03 06:30	IX-5-043	97.7	5.2	2.4	9623	1655	83%
2015-04-08 08:00	IX-5-044	196.5	35.8	15.6	66252	50367	24%
2015-04-19 22:30	IX-5-045	113.2	30.0	6.0	55518	37108	33%
2015-05-11 20:00	IX-5-046	104.7	4.8	12.0	8883	1167	87%
2015-05-30 12:50	IX-5-047	146.8	59.6	34.8	110296	80710	27%
2015-06-07 21:20	IX-5-048	280.5	49.0	27.6	90680	36028	60%
2015-06-22 18:10	IX-5-049	9.0	3.4	4.8	6292	0	100%
2015-06-27 10:40	IX-5-050	115.8	64.2	22.8	118809	94108	21%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2015-07-07 12:40	IX-5-051	66.8	15.4	33.6	28499	11804	59%
2015-07-14 08:00	IX-5-052	6.0	2.0	2.4	3701	0	100%
2015-07-17 10:40	IX-5-053	100.3	7.4	9.6	13695	1801	87%
2015-08-02 17:20	IX-5-054	67.3	29.4	44.4	54408	27161	50%
2015-08-10 12:10	IX-5-055	52.2	22.6	28.8	41824	18802	55%
2015-08-14 06:00	IX-5-056	2.2	2.8	3.6	5182	0	100%
2015-08-15 06:20	IX-5-057	45.5	1.6	6.0	2961	448	85%
2015-08-19 22:10	IX-5-058	62.8	15.2	31.2	28129	8751	69%
2015-09-11 18:20	IX-5-059	107.8	35.6	6.0	65882	28094	57%
2015-09-19 14:10	IX-5-060	52.7	4.4	10.8	8143	1168	86%
2015-09-29 12:20	IX-5-061	67.5	41.0	38.4	75875	50742	33%
2015-10-08 20:30	IX-5-062	111.8	7.4	6.0	13695	3877	72%
2015-10-15 16:40	IX-5-063	66.5	6.0	6.0	11104	913	92%
2015-10-21 22:30	IX-5-064	60.0	1.6	9.6	2961	603	80%
2015-10-24 10:40	IX-5-065	87.3	13.0	13.2	24058	12630	48%
2015-10-28 02:10	IX-5-066	180.7	64.0	13.2	118439	76340	36%
2015-11-06 01:00	IX-5-067	9.3	2.0	2.4	3701	0	100%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2015-11-10 12:50	IX-5-068	122.0	16.0	4.8	29610	12178	59%
2015-11-21 20:50	IX-5-069	68.8	3.0	2.4	5552	993	82%
2015-11-27 10:30	IX-5-070	74.8	3.8	2.4	7032	421	94%
2016-04-21 21:50	IX-5-071	4.8	2.2	3.6	4071	0	100%
2016-04-25 19:30	IX-5-072	113.7	19.6	27.6	36272	35484	2%
2016-05-01 00:30	IX-5-073	180.3	7.6	3.6	14065	11582	18%
2016-05-13 00:30	IX-5-074	173.3	18.8	8.4	34791	28632	18%
2016-05-26 12:30	IX-5-075	90.5	28.4	70.8	52557	56095	-7%
2016-06-04 22:40	IX-5-076	101.3	31.4	40.8	58109	73547	-27%
2016-06-26 21:10	IX-5-077	4.0	3.2	7.2	5922	0	100%
2016-06-28 17:40	IX-5-078	1.2	2.2	6.0	4071	0	100%
2016-07-01 08:00	IX-5-079	50.0	8.4	22.8	15545	14004	10%
2016-07-13 23:50	IX-5-080	58.2	27.4	40.8	50707	47398	7%
2016-07-25 04:10	IX-5-081	32.7	17.4	51.6	32201	20567	36%
2016-08-12 11:30	IX-5-082	0.3	3.8	14.4	7032	0	100%
2016-08-13 00:40	IX-5-083	0.5	2.2	8.4	4071	0	100%
2016-08-13 11:10	IX-5-084	38.2	12.8	30.0	23688	10852	54%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2016-08-16 01:20	IX-5-085	35.7	22.0	36.0	40713	21529	47%
2016-08-18 21:40	IX-5-086	75.8	18.0	43.2	33311	11472	66%
2016-08-25 00:40	IX-5-087	51.0	26.0	42.0	48116	34969	27%
2016-09-07 18:20	IX-5-088	36.7	12.8	58.8	23688	5642	76%
2016-09-10 09:00	IX-5-089	1.0	3.0	8.4	5552	0	100%
2016-09-17 04:30	IX-5-090	44.7	13.2	21.6	24428	5883	76%
2016-09-26 10:40	IX-5-091	37.0	15.6	21.6	28870	11122	61%
2016-09-29 07:30	IX-5-092	110.7	45.0	22.8	83277	67449	19%
2016-11-02 11:10	IX-5-093	61.2	30.0	15.6	55518	36353	35%
2016-11-19 11:10	IX-5-094	2.7	5.0	4.8	9253	0	100%
2016-11-24 00:10	IX-5-095	84.5	8.4	3.6	15545	885	94%
2016-11-28 23:00	IX-5-096	39.0	6.0	4.8	11104	602	95%
2016-11-30 19:30	IX-5-097	35.8	6.0	6.0	11104	1383	88%
2017-03-24 04:40	IX-5-098	116.5	16.2	6.0	29980	10782	64%
2017-03-30 16:50	IX-5-099	88.2	22.2	8.4	41084	31609	23%
2017-04-03 21:20	IX-5-100	51.5	21.4	19.2	39603	25458	36%
2017-04-06 01:00	IX-5-101	82.7	31.4	6.0	58109	41240	29%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2017-04-15 10:40	IX-5-102	36.0	4.2	4.8	7773	662	91%
2017-04-20 09:10	IX-5-103	56.0	28.6	8.4	52927	31886	40%
2017-04-25 07:30	IX-5-104	32.8	2.6	3.6	4812	193	96%
2017-04-27 17:30	IX-5-105	41.2	6.8	10.8	12584	3690	71%
2017-04-30 17:00	IX-5-106	92.0	41.4	24.0	76615	52057	32%
2017-05-04 13:10	IX-5-107	102.8	51.2	4.8	94751	67865	28%
2017-05-21 06:20	IX-5-108	55.5	15.4	13.2	28499	8574	70%
2017-05-24 21:00	IX-5-109	85.7	52.6	14.4	97342	60559	38%
2017-05-30 16:40	IX-5-110	57.0	9.6	13.2	17766	2570	86%
2017-06-04 05:30	IX-5-111	102.2	14.8	15.6	27389	5256	81%
2017-06-20 19:30	IX-5-112	37.0	5.4	8.4	9993	656	93%
2017-06-22 10:30	IX-5-113	79.2	23.0	13.2	42564	14672	66%
2017-06-27 04:00	IX-5-114	72.0	8.6	6.0	15915	1132	93%
2017-06-30 04:10	IX-5-115	82.0	30.8	45.6	56999	27070	53%
2017-07-13 06:40	IX-5-116	51.8	10.2	6.0	18876	1660	91%
2017-07-16 16:00	IX-5-117	38.0	3.8	6.0	7032	583	92%
2017-07-20 10:10	IX-5-118	51.0	13.0	49.2	24058	7809	68%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2017-07-26 19:10	IX-5-119	55.2	9.4	10.8	17396	3086	82%
2017-08-01 14:00	IX-5-120	0.7	2.2	7.2	4071	0	100%
2017-08-04 06:50	IX-5-121	47.8	14.2	18.0	26279	14125	46%
2017-08-12 10:10	IX-5-122	28.2	7.2	21.6	13324	585	96%
2017-08-15 03:10	IX-5-123	1.0	2.0	3.6	3701	0	100%
2017-08-17 14:00	IX-5-124	43.8	14.8	16.8	27389	19377	29%
2017-08-31 00:50	IX-5-125	2.5	4.2	4.8	7773	0	100%
2017-09-03 02:20	IX-5-126	79.3	19.0	12.0	35162	8932	75%
2017-09-29 10:00	IX-5-127	3.7	1.8	3.6	3331	0	100%
2017-10-09 01:00	IX-5-128	49.7	20.4	9.6	37752	55199	-46%
2017-10-11 16:50	IX-5-129	37.8	3.6	4.8	6662	2201	67%
2017-10-14 17:10	IX-5-130	52.7	11.4	13.2	21097	2643	87%
2017-10-23 15:10	IX-5-131	41.8	11.2	10.8	20727	9106	56%
2017-10-28 05:30	IX-5-132	29.2	5.2	2.4	9623	188	98%
2017-11-01 20:40	IX-5-133	62.3	18.2	6.0	33681	11446	66%
2017-11-04 22:30	IX-5-134	62.8	14.6	7.2	27019	12901	52%
2017-11-15 19:00	IX-5-135	29.8	4.0	2.4	7402	49	99%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2017-11-18 05:00	IX-5-136	56.2	24.6	8.4	45525	27781	39%
2017-12-04 22:50	IX-5-137	35.7	6.8	3.6	12584	592	95%
2018-03-27 08:50	IX-5-138	16.3	4.6	2.4	8513	0	100%
2018-03-29 10:10	IX-5-139	101.5	24.6	3.6	45525	24693	46%
2018-05-03 14:40	IX-5-140	56.2	15.8	14.4	29240	18857	36%
2018-05-10 01:50	IX-5-141	3.2	2.6	6.0	4812	0	100%
2018-05-15 02:30	IX-5-142	40.7	25.8	74.4	47746	27453	43%
2018-05-19 05:00	IX-5-143	38.7	10.0	6.0	18506	2334	87%
2018-05-22 02:10	IX-5-144	33.0	9.0	6.0	16655	3452	79%
2018-05-31 18:50	IX-5-145	0.2	3.4	20.4	6292	0	100%
2018-06-03 15:50	IX-5-146	33.8	13.0	34.8	24058	17603	27%
2018-06-22 22:00	IX-5-147	81.8	55.0	24.0	101784	100428	1%
2018-06-27 03:10	IX-5-148	49.3	14.8	25.2	27389	19473	29%
2018-07-05 16:40	IX-5-149	32.3	37.6	70.8	69583	43052	38%
2018-07-16 18:10	IX-5-150	22.0	9.8	40.8	18136	3571	80%
2018-07-22 00:40	IX-5-151	38.0	24.40	10.8	45155	27388	0.39
2018-08-08 05:30	IX-5-152	48.0	29.20	46.8	54038	65795	-0.22

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2018-08-16 15:20	IX-5-153	13.2	5.80	27.6	10734	151	0.99
2018-08-21 06:10	IX-5-154	45.0	30.2	44.4	55888	54464	3%
2018-08-25 13:20	IX-5-155	2.0	4.6	7.2	8513	0	100%
2018-08-25 22:40	IX-5-156	57.0	9.2	22.8	17026	2449	86%
2018-09-03 12:20	IX-5-157	5.7	2.0	9.6	3701	0	100%
2018-09-10 01:30	IX-5-158	36.5	23.2	9.6	42934	18543	57%
2018-09-24 22:40	IX-5-159	44.2	19.8	18.0	36642	17028	54%
2018-09-28 20:00	IX-5-160	4.8	3.4	3.6	6292	0	100%
2018-09-30 20:10	IX-5-161	58.3	45.8	37.2	84758	30478	64%
2018-10-04 04:30	IX-5-162	6.3	3.2	12.0	5922	69	99%
2018-10-06 06:10	IX-5-163	21.0	7.0	4.8	12954	0	100%
2018-10-12 21:20	IX-5-164	7.2	2.6	2.4	4812	0	100%
2018-10-27 04:10	IX-5-165	32.0	7.8	1.2	14435	0	100%
2018-10-30 22:10	IX-5-166	27.0	13.2	8.4	24428	6034	75%
2018-11-01 09:30	IX-5-167	45.7	42.0	10.8	77726	35931	54%
2018-11-06 03:10	IX-5-168	21.0	7.2	3.6	13324	1601	88%
2018-11-26 06:20	IX-5-169	29.8	23.4	4.8	43304	15339	65%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2018-12-01 17:50	IX-5-170	43.2	12.6	7.2	23318	1482	94%

Table 5: IX-6 storm event data.

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2014-04-04 11:50	IX-6-001	10.33	5.8	4.8	7510	0	100%
2014-04-07 18:00	IX-6-002	13.33	16.0	6.0	20717	0	100%
2014-04-12 23:20	IX-6-003	2.67	8.0	6.0	10358	0	100%
2014-04-14 12:40	IX-6-004	2.33	7.0	4.8	9064	0	100%
2014-04-14 23:50	IX-6-005	9.83	10.8	8.4	13984	0	100%
2014-04-25 15:30	IX-6-006	3.67	5.6	4.8	7251	0	100%
2014-04-29 07:10	IX-6-007	8.50	34.0	12.0	44023	8768	80%
2014-04-30 03:10	IX-6-008	24.83	11.6	8.4	15020	0	100%
2014-05-13 03:20	IX-6-009	1.83	12.2	24.0	15796	0	100%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2014-05-13 15:00	IX-6-010	7.17	6.4	25.2	8287	0	100%
2014-05-14 17:10	IX-6-011	6.83	10.6	12.0	13725	0	100%
2014-05-15 11:00	IX-6-012	16.67	18.6	4.8	24083	0	100%
2014-05-20 08:40	IX-6-013	12.50	5.4	12.0	6992	0	100%
2014-05-23 13:40	IX-6-014	0.50	2.4	8.4	3107	0	100%
2014-06-02 22:20	IX-6-015	7.33	8.4	6.0	10876	0	100%
2014-06-11 05:20	IX-6-016	3.67	2.8	4.8	3625	0	100%
2014-06-11 21:10	IX-6-017	3.83	13.6	21.6	17609	0	100%
2014-06-17 18:00	IX-6-018	0.83	14.4	42.0	18645	0	100%
2014-06-23 16:50	IX-6-019	1.50	2.8	6.0	3625	0	100%
2014-06-24 17:30	IX-6-020	2.50	4.4	7.2	5697	0	100%
2014-06-25 14:20	IX-6-021	9.33	3.6	9.6	4661	0	100%
2014-07-07 02:20	IX-6-022	4.50	14.0	9.6	18127	0	100%
2014-07-08 11:30	IX-6-023	2.50	8.6	25.2	11135	0	100%
2014-07-13 05:40	IX-6-024	1.33	2.4	7.2	3107	0	100%
2014-07-15 01:30	IX-6-025	13.17	9.8	18.0	12689	0	100%
2014-07-16 14:00	IX-6-026	2.17	3.6	16.8	4661	0	100%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2014-07-19 14:00	IX-6-027	7.83	13.0	8.4	16832	0	100%
2014-07-20 14:00	IX-6-028	1.33	3.6	9.6	4661	0	100%
2014-07-23 01:00	IX-6-029	1.33	5.6	14.4	7251	0	100%
2014-07-27 19:00	IX-6-030	14.83	66.0	44.4	85456	33775	60%
2014-08-04 07:40	IX-6-031	15.83	16.0	18.0	20717	0	100%
2014-08-05 19:30	IX-6-032	0.50	8.6	38.4	11135	0	100%
2014-08-11 22:20	IX-6-033	7.67	26.6	21.6	34441	851	98%
2014-08-19 23:10	IX-6-034	9.50	3.6	6.0	4661	0	100%
2014-08-20 19:10	IX-6-035	2.33	6.8	21.6	8805	0	100%
2014-09-02 11:40	IX-6-036	3.67	9.4	31.2	12171	0	100%
2014-09-05 19:10	IX-6-037	11.00	36.8	24.0	47648	5402	89%
2014-09-10 15:50	IX-6-038	13.50	21.2	13.2	27450	0	100%
2014-09-13 07:10	IX-6-039	7.33	4.2	6.0	5438	0	100%
2014-09-15 15:30	IX-6-040	10.00	4.2	3.6	5438	0	100%
2014-09-21 05:50	IX-6-041	3.00	17.2	24.0	22270	0	100%
2014-10-03 13:30	IX-6-042	16.67	10.6	7.2	13725	0	100%
2014-10-06 22:10	IX-6-043	10.17	4.4	6.0	5697	0	100%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2014-10-07 16:20	IX-6-044	6.83	15.8	12.0	20458	0	100%
2014-10-15 00:00	IX-6-045	4.67	2.6	3.6	3366	0	100%
2014-10-20 16:20	IX-6-046	3.17	2.0	3.6	2590	0	100%
2014-10-21 06:30	IX-6-047	15.33	3.8	6.0	4920	0	100%
2014-10-31 05:30	IX-6-048	28.83	14.2	4.8	18386	0	100%
2014-11-04 16:10	IX-6-049	8.50	4.0	2.4	5179	0	100%
2014-11-06 19:00	IX-6-050	5.67	4.4	2.4	5697	0	100%
2014-11-16 17:10	IX-6-051	25.50	5.4	2.4	6992	0	100%
2015-04-02 18:30	IX-6-052	0.83	2.4	4.8	3107	0	100%
2015-04-03 18:00	IX-6-053	2.50	3.0	2.4	3884	0	100%
2015-04-08 08:00	IX-6-054	11.50	15.2	9.6	19681	0	100%
2015-04-09 13:10	IX-6-055	21.50	15.8	15.6	20458	4937	76%
2015-04-13 16:50	IX-6-056	1.17	4.8	7.2	6215	0	100%
2015-04-19 22:30	IX-6-057	16.50	25.2	6.0	32629	0	100%
2015-04-21 12:10	IX-6-058	7.17	4.4	4.8	5697	0	100%
2015-05-11 20:00	IX-6-059	1.33	4.8	12.0	6215	0	100%
2015-05-30 12:50	IX-6-060	32.33	58.8	34.8	76134	3865	95%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2015-06-07 21:20	IX-6-061	12.33	21.6	19.2	27967	0	100%
2015-06-12 03:40	IX-6-062	15.00	10.4	10.8	13466	0	100%
2015-06-14 08:00	IX-6-063	8.17	6.4	8.4	8287	0	100%
2015-06-16 02:50	IX-6-064	3.50	8.6	27.6	11135	0	100%
2015-06-22 18:10	IX-6-065	9.00	3.4	4.8	4402	0	100%
2015-06-27 10:40	IX-6-066	30.67	64.2	22.8	83126	7850	91%
2015-08-19 22:10	IX-6-067	0.67	4.6	14.4	5956	0	100%
2015-08-20 09:10	IX-6-068	2.83	10.0	31.2	12948	0	100%
2015-09-11 18:20	IX-6-069	13.00	19.6	6.0	25378	0	100%
2015-09-12 14:10	IX-6-070	7.17	8.4	6.0	10876	0	100%
2015-09-13 04:30	IX-6-071	12.67	7.6	3.6	9840	0	100%
2015-09-19 14:10	IX-6-072	0.67	4.4	10.8	5697	0	100%
2015-09-29 12:20	IX-6-073	5.50	41.0	38.4	53086	11671	78%
2015-10-08 20:30	IX-6-074	5.67	7.0	6.0	9064	0	100%
2015-10-15 16:40	IX-6-075	5.17	5.2	6.0	6733	0	100%
2015-10-24 10:40	IX-6-076	12.00	13.0	13.2	16832	0	100%
2015-10-28 02:10	IX-6-077	27.17	59.6	13.2	77169	23273	70%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2015-10-31 23:10	IX-6-078	4.50	4.4	4.8	5697	0	100%
2015-11-06 01:00	IX-6-079	9.33	2.0	2.4	2590	0	100%
2015-11-10 12:50	IX-6-080	15.33	12.6	3.6	16314	0	100%
2015-11-12 06:50	IX-6-081	6.83	3.2	4.8	4143	0	100%
2015-11-21 20:50	IX-6-082	3.00	2.8	2.4	3625	0	100%
2015-11-27 10:30	IX-6-083	14.83	3.6	2.4	4661	0	100%
2016-04-21 21:50	IX-6-084	4.83	2.2	3.6	2849	0	100%
2016-04-25 19:30	IX-6-085	13.83	19.6	27.6	25378	0	100%
2016-05-01 02:40	IX-6-086	17.83	6.6	3.6	8546	0	100%
2016-05-13 00:30	IX-6-087	6.33	12.6	8.4	16314	0	100%
2016-05-14 04:00	IX-6-088	6.00	4.6	4.8	5956	0	100%
2016-05-26 12:30	IX-6-089	2.67	28.4	70.8	36772	8333	77%
2016-06-04 22:40	IX-6-090	20.17	23.0	40.8	29780	10	100%
2016-06-06 11:50	IX-6-091	7.83	8.4	9.6	10876	0	100%
2016-06-26 21:10	IX-6-092	4.00	3.2	7.2	4143	0	100%
2016-06-28 17:40	IX-6-093	1.17	2.2	6.0	2849	0	100%
2016-07-01 08:00	IX-6-094	5.33	8.4	22.8	10876	0	100%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2016-07-13 23:50	IX-6-095	7.50	9.8	22.8	12689	0	100%
2016-07-14 18:10	IX-6-096	4.67	17.6	40.8	22788	2109	91%
2016-07-25 04:10	IX-6-097	1.00	17.4	51.6	22529	0	100%
2016-08-12 11:30	IX-6-098	0.33	3.8	14.4	4920	0	100%
2016-08-13 00:40	IX-6-099	0.50	2.2	8.4	2849	0	100%
2016-08-13 11:10	IX-6-100	10.00	12.6	30.0	16314	0	100%
2016-08-16 01:20	IX-6-101	11.67	22.0	36.0	28485	0	100%
2016-08-18 21:40	IX-6-102	0.67	10.0	43.2	12948	0	100%
2016-08-20 01:30	IX-6-103	1.50	6.4	13.2	8287	0	100%
2016-08-25 00:40	IX-6-104	0.83	3.8	9.6	4920	0	100%
2016-08-25 11:30	IX-6-105	6.67	22.2	42.0	28744	2778	90%
2016-09-07 18:20	IX-6-106	8.33	12.8	58.8	16573	0	100%
2016-09-10 09:00	IX-6-107	1.00	3.0	8.4	3884	0	100%
2016-09-17 04:30	IX-6-108	13.50	13.0	21.6	16832	0	100%
2016-09-26 10:40	IX-6-109	2.00	15.4	21.6	19940	0	100%
2016-09-29 07:30	IX-6-110	14.83	27.6	14.4	35736	2198	94%
2016-10-01 07:30	IX-6-111	2.17	2.4	2.4	3107	0	100%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2016-10-01 20:40	IX-6-112	15.17	15.0	22.8	19422	0	100%
2016-10-20 02:30	IX-6-113	37.00	15.2	3.6	19681	0	100%
2016-10-27 00:10	IX-6-114	17.00	5.4	3.6	6992	0	100%
2016-11-02 11:10	IX-6-115	19.83	30.0	15.6	38844	4699	88%
2016-11-19 11:10	IX-6-116	2.67	5.0	4.8	6474	0	100%
2016-11-24 00:10	IX-6-117	14.83	4.4	3.6	5697	0	100%
2016-11-26 01:30	IX-6-118	4.50	3.2	2.4	4143	0	100%
2016-11-28 23:00	IX-6-119	4.67	5.0	4.8	6474	0	100%
2016-11-30 19:30	IX-6-120	4.00	6.0	6.0	7769	0	100%
2017-03-24 04:40	IX-6-121	2.17	6.6	6.0	8546	0	100%
2017-03-24 23:10	IX-6-122	12.83	7.0	3.6	9064	0	100%
2017-03-26 21:40	IX-6-123	9.00	2.4	2.4	3107	0	100%
2017-03-30 16:50	IX-6-124	31.50	22.2	8.4	28744	0	100%
2017-04-03 21:20	IX-6-125	18.83	21.4	19.2	27709	1297	95%
2017-04-06 01:00	IX-6-126	24.67	31.2	6.0	40397	1507	96%
2017-04-15 10:40	IX-6-127	2.83	4.2	4.8	5438	0	100%
2017-04-20 09:10	IX-6-128	12.83	28.4	8.4	36772	5809	84%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2017-04-25 07:30	IX-6-129	8.00	2.6	3.6	3366	0	100%
2017-04-27 17:30	IX-6-130	2.00	6.6	10.8	8546	0	100%
2017-04-30 17:00	IX-6-131	24.17	41.0	24.0	53086	8050	85%
2017-05-04 13:10	IX-6-132	29.83	51.0	4.8	66034	13	100%
2017-05-21 06:20	IX-6-133	18.17	15.4	13.2	19940	0	100%
2017-05-24 21:00	IX-6-134	32.33	52.2	14.4	67588	25632	62%
2017-05-30 16:40	IX-6-135	7.33	7.0	13.2	9064	0	100%
2017-05-31 13:30	IX-6-136	0.33	2.6	9.6	3366	0	100%
2017-06-04 05:30	IX-6-137	3.83	5.4	4.8	6992	0	100%
2017-06-05 02:50	IX-6-138	3.67	4.6	15.6	5956	0	100%
2017-06-06 06:50	IX-6-139	11.50	3.8	4.8	4920	0	100%
2017-06-20 19:30	IX-6-140	2.33	5.2	8.4	6733	0	100%
2017-06-22 10:30	IX-6-141	6.33	2.6	3.6	3366	0	100%
2017-06-23 00:40	IX-6-142	10.83	18.6	13.2	24083	0	100%
2017-06-27 04:00	IX-6-143	16.00	3.6	6.0	4661	0	100%
2017-06-29 00:20	IX-6-144	2.83	3.6	3.6	4661	0	100%
2017-06-30 04:10	IX-6-145	3.50	19.8	45.6	25637	6655	74%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2017-07-01 14:10	IX-6-146	2.00	10.4	21.6	13466	0	100%
2017-07-13 06:40	IX-6-147	4.00	8.6	6.0	11135	0	100%
2017-07-16 16:00	IX-6-148	2.17	3.8	6.0	4920	0	100%
2017-07-20 10:10	IX-6-149	1.00	11.8	49.2	15279	0	100%
2017-07-26 19:10	IX-6-150	20.17	9.4	10.8	12171	0	100%
2017-08-01 14:00	IX-6-151	0.67	2.2	7.2	2849	0	100%
2017-08-04 06:50	IX-6-152	11.50	14.2	18.0	18386	0	100%
2017-08-12 10:10	IX-6-153	5.17	7.0	21.6	9064	0	100%
2017-08-15 03:10	IX-6-154	1.00	2.0	3.6	2590	0	100%
2017-08-17 14:00	IX-6-155	6.33	14.6	16.8	18904	0	100%
2017-08-31 00:50	IX-6-156	2.50	4.2	4.8	5438	0	100%
2017-09-03 02:20	IX-6-157	3.33	10.8	7.2	13984	0	100%
2017-09-04 18:20	IX-6-158	2.50	6.6	12.0	8546	0	100%
2017-10-04 12:10	IX-6-159	6.00	3.8	16.8	4920	0	100%
2017-10-09 01:00	IX-6-160	7.17	20.2	9.6	26155	0	100%
2017-10-11 16:50	IX-6-161	3.00	3.6	4.8	4661	0	100%
2017-10-14 17:10	IX-6-162	10.17	8.4	3.6	10876	0	100%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2017-10-15 10:30	IX-6-163	4.67	3.0	13.2	3884	0	100%
2017-10-23 15:10	IX-6-164	9.67	10.0	10.8	12948	0	100%
2017-10-28 05:30	IX-6-165	9.33	5.2	2.4	6733	0	100%
2017-11-01 20:40	IX-6-166	13.67	10.8	4.8	13984	0	100%
2017-11-02 23:50	IX-6-167	6.33	7.4	6.0	9581	0	100%
2017-11-04 22:30	IX-6-168	24.83	14.6	7.2	18904	0	100%
2017-11-15 19:00	IX-6-169	7.33	4.0	2.4	5179	0	100%
2017-11-18 05:00	IX-6-170	1.67	2.6	2.4	3366	0	100%
2017-11-18 12:50	IX-6-171	14.00	22.0	8.4	28485	0	100%

Table 6: IX-7 storm event data.

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2014-04-04 11:50	IX-7-001	47.5	5.8	4.8	2421	714	71%
2014-04-07 18:00	IX-7-002	34.5	16.0	6.0	6679	596	91%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2014-04-12 23:20	IX-7-003	2.7	8.0	6.0	3339	0	100%
2014-04-14 12:40	IX-7-004	34.2	17.8	8.4	7430	667	91%
2014-04-25 15:30	IX-7-005	3.7	5.6	4.8	2338	0	100%
2014-04-29 07:10	IX-7-006	57.8	45.6	12.0	19034	6022	68%
2014-05-13 03:20	IX-7-007	26.3	18.6	25.2	7764	225	97%
2014-05-14 17:10	IX-7-008	51.2	29.2	12.0	12189	1741	86%
2014-05-20 08:40	IX-7-009	12.5	5.4	12.0	2254	0	100%
2014-05-23 13:40	IX-7-010	0.5	2.4	8.4	1002	0	100%
2014-06-02 22:20	IX-7-011	7.3	8.4	6.0	3506	0	100%
2014-06-11 05:20	IX-7-012	3.7	2.8	4.8	1169	0	100%
2014-06-11 21:10	IX-7-013	13.0	13.6	21.6	5677	255	96%
2014-06-17 18:00	IX-7-014	8.0	14.4	42.0	6011	1042	83%
2014-06-23 16:50	IX-7-015	1.5	2.8	6.0	1169	0	100%
2014-06-24 17:30	IX-7-016	2.5	4.4	7.2	1837	0	100%
2014-06-25 14:20	IX-7-017	9.3	3.6	9.6	1503	0	100%
2014-07-08 11:30	IX-7-018	6.8	8.6	25.2	3590	77	98%
2014-07-13 05:40	IX-7-019	1.3	2.4	7.2	1002	0	100%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2014-07-15 01:30	IX-7-020	13.2	9.8	18.0	4091	8	100%
2014-07-16 14:00	IX-7-021	2.2	3.6	16.8	1503	0	100%
2014-07-19 14:00	IX-7-022	13.2	13.0	8.4	5426	64	99%
2014-07-20 14:00	IX-7-023	1.3	3.6	9.6	1503	0	100%
2014-07-23 01:00	IX-7-024	1.3	5.6	14.4	2338	5	100%
2014-07-27 19:00	IX-7-025	15.5	66.0	44.4	27549	7821	72%
2014-08-04 07:40	IX-7-026	15.8	16.0	18.0	6679	15	100%
2014-08-05 19:30	IX-7-027	9.8	8.8	38.4	3673	359	90%
2014-08-11 22:20	IX-7-028	14.3	26.6	21.6	11103	1623	85%
2014-08-19 23:10	IX-7-029	9.5	3.6	6.0	1503	0	100%
2014-08-20 19:10	IX-7-030	2.3	6.8	21.6	2838	0	100%
2014-09-02 11:40	IX-7-031	3.7	9.4	31.2	3924	7	100%
2014-09-05 19:10	IX-7-032	14.2	36.8	24.0	15361	2989	81%
2014-09-10 15:50	IX-7-033	13.5	21.2	13.2	8849	293	97%
2014-09-13 07:10	IX-7-034	7.3	4.2	6.0	1753	0	100%
2014-09-15 15:30	IX-7-035	10.0	4.2	3.6	1753	0	100%
2014-09-21 05:50	IX-7-036	5.3	17.2	24.0	7180	311	96%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2014-10-03 13:30	IX-7-037	16.7	10.6	7.2	4425	0	100%
2014-10-06 22:10	IX-7-038	10.2	4.4	6.0	1837	0	100%
2014-10-07 16:20	IX-7-039	7.2	15.8	12.0	6595	145	98%
2014-10-15 00:00	IX-7-040	4.7	2.6	3.6	1085	0	100%
2014-10-20 16:20	IX-7-041	3.2	2.0	3.6	835	0	100%
2014-10-21 06:30	IX-7-042	15.3	3.8	6.0	1586	0	100%
2014-10-31 05:30	IX-7-043	28.8	14.2	4.8	5927	81	99%
2014-11-04 16:10	IX-7-044	8.5	4.0	2.4	1670	0	100%
2014-11-06 19:00	IX-7-045	5.7	4.4	2.4	1837	0	100%
2014-11-16 17:10	IX-7-046	25.5	5.4	2.4	2254	0	100%
2015-04-08 08:00	IX-7-047	18.8	15.2	9.6	6345	505	92%
2015-04-09 13:10	IX-7-048	23.3	15.8	15.6	6595	1802	73%
2015-04-13 16:50	IX-7-049	1.2	4.8	7.2	2004	0	100%
2015-04-19 22:30	IX-7-050	27.3	25.2	6.0	10519	826	92%
2015-04-21 12:10	IX-7-051	7.2	4.4	4.8	1837	0	100%
2015-05-11 20:00	IX-7-052	1.3	4.8	12.0	2004	0	100%
2015-05-30 12:50	IX-7-053	42.5	58.8	34.8	24544	6674	73%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2015-06-07 21:20	IX-7-054	20.0	21.6	19.2	9016	358	96%
2015-06-12 03:40	IX-7-055	15.0	10.4	10.8	4341	0	100%
2015-06-14 08:00	IX-7-056	8.2	6.4	8.4	2671	0	100%
2015-06-16 02:50	IX-7-057	7.8	8.6	27.6	3590	44	99%
2015-06-22 18:10	IX-7-058	9.0	3.4	4.8	1419	0	100%
2015-06-27 10:40	IX-7-059	40.2	64.2	22.8	26798	5317	80%
2015-07-07 12:40	IX-7-060	11.3	15.4	33.6	6428	129	98%
2015-07-14 08:00	IX-7-061	6.0	2.0	2.4	835	0	100%
2015-07-17 10:40	IX-7-062	4.7	5.2	3.6	2171	0	100%
2015-07-19 16:10	IX-7-063	0.3	2.2	9.6	918	0	100%
2015-08-02 17:20	IX-7-064	15.8	27.4	44.4	11437	2885	75%
2015-08-04 16:30	IX-7-065	1.3	2.0	7.2	835	0	100%
2015-08-10 12:10	IX-7-066	8.5	22.6	28.8	9434	648	93%
2015-08-14 06:00	IX-7-067	2.2	2.8	3.6	1169	0	100%
2015-08-19 22:10	IX-7-068	0.7	4.6	14.4	1920	0	100%
2015-08-20 09:10	IX-7-069	9.0	10.0	31.2	4174	166	96%
2015-09-11 18:20	IX-7-070	52.5	35.6	6.0	14860	165	99%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2015-10-24 10:40	IX-7-071	14.8	13.0	13.2	5426	313	94%
2015-10-28 02:10	IX-7-072	27.2	59.6	13.2	24878	6597	73%
2015-10-31 23:10	IX-7-073	4.5	4.4	4.8	1837	0	100%
2015-11-06 01:00	IX-7-074	9.3	2.0	2.4	835	0	100%
2015-11-10 12:50	IX-7-075	24.2	12.8	3.6	5343	130	98%
2015-11-12 06:50	IX-7-076	6.8	3.2	4.8	1336	0	100%
2015-11-21 20:50	IX-7-077	3.0	2.8	2.4	1169	0	100%
2015-11-27 10:30	IX-7-078	14.8	3.6	2.4	1503	0	100%
2015-12-14 14:10	IX-7-079	5.2	3.0	4.8	1252	0	100%
2015-12-21 07:30	IX-7-080	20.5	3.6	2.4	1503	0	100%
2015-12-26 22:40	IX-7-081	8.3	5.2	3.6	2171	0	100%
2016-03-14 01:50	IX-7-082	43.0	16.8	8.4	7013	288	96%
2016-03-28 03:20	IX-7-083	12.8	10.2	10.8	4258	22	99%
2016-03-31 02:20	IX-7-084	33.8	26.6	30.0	11103	1418	87%
2016-04-21 21:50	IX-7-085	4.8	2.2	3.6	918	0	100%
2016-04-25 19:30	IX-7-086	38.7	19.6	27.6	8181	486	94%
2016-05-01 02:40	IX-7-087	17.8	6.6	3.6	2755	0	100%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2016-05-13 00:30	IX-7-088	7.3	12.6	8.4	5259	7	100%
2016-05-14 04:00	IX-7-089	6.0	4.6	4.8	1920	0	100%
2016-06-04 22:40	IX-7-090	20.2	23.0	40.8	9601	1061	89%
2016-06-06 11:50	IX-7-091	8.8	8.4	9.6	3506	33	99%
2016-06-26 21:10	IX-7-092	4.0	3.2	7.2	1336	0	100%
2016-06-28 17:40	IX-7-093	1.2	2.2	6.0	918	0	100%
2016-07-01 08:00	IX-7-094	6.8	8.4	22.8	3506	15	100%
2016-07-13 23:50	IX-7-095	7.5	9.8	22.8	4091	31	99%
2016-07-14 18:10	IX-7-096	6.3	17.6	40.8	7347	1827	75%
2016-07-25 04:10	IX-7-097	8.2	17.4	51.6	7263	882	88%
2016-08-12 11:30	IX-7-098	0.3	3.8	14.4	1586	0	100%
2016-08-13 00:40	IX-7-099	0.5	2.2	8.4	918	0	100%
2016-08-13 11:10	IX-7-100	17.5	12.6	30.0	5259	387	93%
2016-08-16 01:20	IX-7-101	18.0	22.0	36.0	9183	1607	83%
2016-08-18 21:40	IX-7-102	2.2	10.0	43.2	4174	137	97%
2016-08-20 01:30	IX-7-103	2.0	6.4	13.2	2671	6	100%
2016-08-25 00:40	IX-7-104	0.8	3.8	9.6	1586	0	100%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2016-08-25 11:30	IX-7-105	9.2	22.2	42.0	9267	2582	72%
2016-09-07 18:20	IX-7-106	8.3	12.8	58.8	5343	116	98%
2016-09-10 09:00	IX-7-107	1.0	3.0	8.4	1252	0	100%
2016-09-17 04:30	IX-7-108	13.5	13.0	21.6	5426	0	100%
2016-09-26 10:40	IX-7-109	8.2	15.4	21.6	6428	180	97%
2016-09-29 07:30	IX-7-110	23.7	27.6	14.4	11521	1805	84%
2016-10-01 07:30	IX-7-111	2.2	2.4	2.4	1002	0	100%
2016-10-01 20:40	IX-7-112	25.3	15.0	22.8	6261	399	94%
2016-10-20 02:30	IX-7-113	37.0	15.2	3.6	6345	0	100%
2016-10-27 00:10	IX-7-114	17.0	5.4	3.6	2254	0	100%
2016-11-02 11:10	IX-7-115	21.8	30.0	15.6	12522	1802	86%
2016-11-19 11:10	IX-7-116	2.7	5.0	4.8	2087	0	100%
2016-11-24 00:10	IX-7-117	14.8	4.4	3.6	1837	0	100%
2016-11-26 01:30	IX-7-118	4.5	3.2	2.4	1336	0	100%
2016-11-28 23:00	IX-7-119	4.7	5.0	4.8	2087	0	100%
2016-11-30 19:30	IX-7-120	4.0	6.0	6.0	2504	0	100%
2017-03-30 16:50	IX-7-121	31.5	22.2	8.4	9267	260	97%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2017-04-03 21:20	IX-7-122	23.2	21.4	19.2	8933	665	93%
2017-04-06 01:00	IX-7-123	32.0	31.2	6.0	13023	1035	92%
2017-04-15 10:40	IX-7-124	2.8	4.2	4.8	1753	0	100%
2017-04-20 09:10	IX-7-125	24.3	28.4	8.4	11855	1635	86%
2017-04-25 07:30	IX-7-126	8.0	2.6	3.6	1085	0	100%
2017-04-27 17:30	IX-7-127	8.2	6.6	10.8	2755	34	99%
2017-04-30 17:00	IX-7-128	46.2	41.4	24.0	17281	3936	77%
2017-05-04 13:10	IX-7-129	42.5	51.0	4.8	21288	2333	89%
2017-05-24 21:00	IX-7-130	34.2	52.2	14.4	21789	8918	59%
2017-05-30 16:40	IX-7-131	9.5	7.0	13.2	2922	19	99%
2017-05-31 13:30	IX-7-132	2.5	2.6	9.6	1085	7	99%
2017-06-04 05:30	IX-7-133	3.8	5.4	4.8	2254	0	100%
2017-06-05 02:50	IX-7-134	11.0	4.6	15.6	1920	45	98%
2017-06-06 06:50	IX-7-135	11.5	3.8	4.8	1586	0	100%
2017-06-20 19:30	IX-7-136	2.3	5.2	8.4	2171	0	100%
2017-06-27 04:00	IX-7-137	16.0	3.6	6.0	1503	0	100%
2017-06-29 00:20	IX-7-138	2.8	3.6	3.6	1503	0	100%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2017-06-30 04:10	IX-7-139	8.3	19.8	45.6	8265	2865	65%
2017-07-01 14:10	IX-7-140	4.5	10.4	21.6	4341	543	87%
2017-07-13 06:40	IX-7-141	4.0	8.6	6.0	3590	0	100%
2017-10-14 17:10	IX-7-142	75.3	11.4	13.2	4759	681	86%
2017-10-23 15:10	IX-7-143	50.3	11.2	10.8	4675	1250	73%
2017-10-28 05:30	IX-7-144	12.7	5.2	2.4	2171	75	97%
2017-11-01 20:40	IX-7-145	13.7	10.8	4.8	4508	24	99%
2017-11-02 23:50	IX-7-146	6.3	7.4	6.0	3089	4	100%
2017-11-04 22:30	IX-7-147	24.8	14.6	7.2	6094	63	99%
2017-11-15 19:00	IX-7-148	23.8	4.0	2.4	1670	57	97%
2017-11-18 05:00	IX-7-149	23.0	24.6	8.4	10268	863	92%
2018-03-29 10:10	IX-7-150	15.2	19.0	3.6	7923	79	99%
2018-03-31 16:50	IX-7-151	5.0	5.6	3.6	2335	0	100%
2018-04-24 18:20	IX-7-152	52.8	21.2	7.2	8840	225	97%
2018-04-27 22:40	IX-7-153	15.0	8.8	9.6	3670	8	100%
2018-05-03 14:40	IX-7-154	68.2	15.8	14.4	6589	941	86%
2018-05-10 01:50	IX-7-155	3.2	2.6	6.0	1084	0	100%

Starting date and time	Event ID	Event duration (h)	Event precipitation total (mm)	Peak precipitation intensity (mm/h)	Runoff total (L)	Discharge total (L)	Runoff volume reduction (%)
2018-05-15 02:30	IX-7-156	27.2	25.8	74.4	10759	6886	36%
2018-05-19 05:00	IX-7-157	180.8	19.0	6.0	7923	1742	78%
2018-05-22 02:10	IX-7-158	111.7	9.0	6.0	3753	1177	69%
2018-05-31 18:50	IX-7-159	0.2	3.4	20.4	1418	0	100%

Appendix D:

Stormwater Quality Data
February 2022

Table 1: IX-2 non-metal chemistry results.

Starting date and time	Event ID	Alkalinity (Total as CaCO3) (mg/L)	Conductivity (µmho/cm)	Dissolved Chloride (mg/L)	Nitrate + Nitrite (mg/L)	Ortho-phosphate (mg/L)	Total Ammonia-N (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
2014-04-29 07:10	IX-2-005	50	580	110	0.71	0.034	0.18	304	1.4	0.074	12
2014-06-11 21:10	IX-2-015	68	380	35	0.71	0.09	0.09	240	2.9	0.16	15
2014-06-17 18:00	IX-2-016	58	440	47	1	0.027	0.07	302	2.4	0.24	37
2014-07-07 02:20	IX-2-020	67	280	19	0.44	0.025	0.11	156	0.87	0.07	10
2014-07-15 01:30	IX-2-023	72	310	14	0.59	0.036	0.08	190	0.9	0.072	21
2014-07-23 01:00	IX-2-027	85	290	9	0.67	0.06	0.05	186	0.72	0.041	8
2014-07-27 19:00	IX-2-028	43	230	19	0.6	0.039	0.13	178	1.4	0.16	19
2014-09-05 19:10	IX-2-035	66	250	11	0.46	0.003	0.14	222	<2	0.25	87
2015-04-08 08:00	IX-2-043	84	1200	270	0.54	0.22	0.3	726	1.3	0.26	56
2015-04-19 22:30	IX-2-046	67	360	45	0.52	0.13	0.12	260	0.77	0.16	18
2015-06-07 21:20	IX-2-050	83	350	29	0.51	0.063	0.11	224	1	0.15	28
2015-07-07 12:40	IX-2-056	76	410	39	0.85	0.23	0.04	300	0.89	0.096	23
2015-08-10 12:10	IX-2-062	63	260	13	0.47	0.04	0.02	210	0.45	0.14	17
2015-09-29 12:20	IX-2-068	44	180	8.5	0.34	0.005	0.08	142	0.24	0.2	74
2015-10-08 20:30	IX-2-069	80	260	11	0.46	0.016	0.03	160	0.28	0.045	6
2015-10-28 02:10	IX-2-071	43	160	9.3	0.31	-	0.03	112	0.24	0.12	17
2015-11-10 12:50	IX-2-074	84	260	16	0.17	0.03	0.02	132	0.21	0.021	2

Starting date and time	Event ID	Alkalinity (Total as CaCO3) (mg/L)	Conductivity (µmho/cm)	Dissolved Chloride (mg/L)	Nitrate + Nitrite (mg/L)	Ortho-phosphate (mg/L)	Total Ammonia-N (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
2016-03-14 01:50	IX-2-081	110	7700	2400	0.8	0.058	0.12	3940	0.59	0.12	10
2016-07-13 23:50	IX-2-089	91	300	14	1.47	0.089	0.04	218	0.87	0.087	16
2016-07-25 04:10	IX-2-091	49	200	8.2	0.82	0.032	0.06	138	0.61	0.09	21
2016-08-16 01:20	IX-2-095	83	240	8.2	0.37	0.051	0.02	190	0.56	0.083	9
2016-08-25 11:30	IX-2-100	52	210	8.3	0.55	0.14	0.02	142	1.6	0.18	11
2016-09-07 18:20	IX-2-101	-	-	-	1	0.019	0.04	142	1	0.078	20
2016-09-26 10:40	IX-2-104	63	180	6.1	0.47	0.035	0.03	124	0.5	0.049	8
2016-09-29 07:30	IX-2-105	62	160	3.6	0.2	0.065	0.03	102	0.39	0.038	4
2016-10-01 20:40	IX-2-107	72	190	5.5	0.35	0.19	0.02	130	0.43	0.14	8
2016-11-02 11:10	IX-2-110	65	160	5.1	0.31	0.094	0.02	104	0.27	0.095	4
2016-11-28 23:00	IX-2-114	120	3500	960	0.86	0.055	0.04	1940	0.46	0.08	6
2016-11-30 19:30	IX-2-115	130	900	160	0.7	0.11	0.07	454	0.33	0.09	6
2017-04-03 21:20	IX-2-120	85	1700	420	0.95	0.09	0.04	730	0.55	0.14	13
2017-05-04 13:10	IX-2-128	68	220	16	0.61	0.032	<0.01	114	0.34	0.055	2
2017-07-13 06:40	IX-2-144	97	270	11	1.7	<0.004	<0.05	176	0.65	0.046	4
2017-07-26 19:10	IX-2-147	130	360	18	0.59	0.009	<0.01	238	0.37	0.027	4
2017-10-14 17:10	IX-2-155	120	280	9.4	0.51	0.006	0.07	190	0.39	0.027	9

Starting date and time	Event ID	Alkalinity (Total as CaCO3) (mg/L)	Conductivity (µmho/cm)	Dissolved Chloride (mg/L)	Nitrate + Nitrite (mg/L)	Ortho-phosphate (mg/L)	Total Ammonia-N (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
2017-11-01 20:40	IX-2-159	92	210	3.6	0.37	0.005	<0.01	120	0.14	0.013	2
2017-11-18 05:00	IX-2-163	73	210	12	0.34	0.005	0.02	<10	0.29	0.025	2

Table 2: IX-2 metal chemistry results.

Starting date and time	Event ID	Aluminum (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Nickel (µg/L)	Uranium (µg/L)	Zinc (µg/L)
2014-04-29 07:10	IX-2-005	550	0.13	16000	15.0	630	19.0	2600	2.5	0.17	21.0
2014-06-11 21:10	IX-2-015	151	0.19	33000	12.6	454	17.2	4480	2.5	0.18	15.7
2014-06-17 18:00	IX-2-016	459	0.33	31100	13.4	691	52.1	6340	4.0	0.13	32.9
2014-07-07 02:20	IX-2-020	105	0.08	32400	3.7	350	8.4	3280	1.9	0.21	9.2
2014-07-15 01:30	IX-2-023	429	0.16	38700	10.7	497	12.8	4980	2.8	0.27	19.0
2014-07-23 01:00	IX-2-027	157	0.10	44400	10.7	183	6.4	3800	1.8	0.23	17.0
2014-07-27 19:00	IX-2-028	303	0.23	22300	11.8	432	27.6	3510	2.5	0.10	31.7
2014-09-05 19:10	IX-2-035	579	0.14	37900	25.6	623	7.5	4460	2.0	0.13	13.7
2015-04-08 08:00	IX-2-043	646	0.18	20600	16.0	829	24.0	4340	3.3	0.29	33.7
2015-04-19 22:30	IX-2-046	292	0.40	15700	7.6	441	10.5	2150	1.8	0.13	13.4
2015-06-07 21:20	IX-2-050	224	0.14	35500	11.6	293	7.3	3930	1.7	0.11	11.1
2015-07-07 12:40	IX-2-056	212	0.09	40600	11.0	296	13.1	4500	2.6	0.08	15.2

Starting date and time	Event ID	Aluminum (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Nickel (µg/L)	Uranium (µg/L)	Zinc (µg/L)
2015-08-10 12:10	IX-2-062	361	0.21	34500	14.8	491	7.7	3640	1.9	0.07	11.5
2015-09-29 12:20	IX-2-068	515	0.07	22600	14.0	565	13.9	3350	1.8	0.09	16.3
2015-10-08 20:30	IX-2-069	150	0.37	34900	12.0	203	4.7	4070	1.1	0.12	7.2
2015-10-28 02:10	IX-2-071	353	0.11	20000	16.5	398	7.2	2270	1.4	0.08	9.8
2015-11-10 12:50	IX-2-074	75	0.09	31500	11.9	90	2.4	3020	0.7	0.10	4.5
2016-03-14 01:50	IX-2-081	463	<0.5	38900	11.0	540	8.5	2310	12.0	<0.5	25.0
2016-07-13 23:50	IX-2-089	127	0.13	33400	27.3	223	10.8	2890	2.3	0.06	12.4
2016-07-25 04:10	IX-2-091	700	0.23	24900	8.1	518	19.5	3390	2.0	0.09	15.5
2016-08-16 01:20	IX-2-095	126	0.41	31400	13.8	128	5.0	2240	1.2	0.05	8.1
2016-08-25 11:30	IX-2-100	151	0.12	25300	15.5	220	8.4	2480	1.4	0.05	16.9
2016-09-07 18:20	IX-2-101	175	0.08	32500	8.3	325	14.6	3350	1.9	0.07	12.8
2016-09-26 10:40	IX-2-104	176	0.06	26200	10.0	146	6.6	2160	1.0	0.05	7.9
2016-09-29 07:30	IX-2-105	137	0.07	22600	3.7	111	5.0	1490	0.8	0.05	5.8
2016-10-01 20:40	IX-2-107	122	0.13	26000	11.2	178	6.9	1950	1.0	0.07	12.4
2016-11-02 11:10	IX-2-110	130	0.07	22400	3.6	129	4.7	1660	0.6	0.07	5.8
2016-11-28 23:00	IX-2-114	211	0.10	141000	10.0	241	6.6	6710	2.0	0.20	11.0
2016-11-30 19:30	IX-2-115	203	0.14	38800	8.4	221	6.2	2290	1.5	0.15	11.8
2017-04-03 21:20	IX-2-120	658	0.07	15700	9.6	557	10.7	1520	2.0	0.19	14.8

Starting date and time	Event ID	Aluminum (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Nickel (µg/L)	Uranium (µg/L)	Zinc (µg/L)
2017-05-04 13:10	IX-2-128	150	0.07	24100	3.9	107	2.9	1420	0.6	0.07	5.1
2017-07-13 06:40	IX-2-144	92	0.09	40700	5.4	113	2.6	2460	1.1	0.05	6.3
2017-07-26 19:10	IX-2-147	81	0.06	54500	3.3	97	1.8	3020	0.9	0.07	4.8
2017-10-14 17:10	IX-2-155	102	0.04	43400	3.2	198	2.6	4420	1.1	0.07	6.9
2017-11-01 20:40	IX-2-159	84	0.11	32400	2.1	71	1.4	3240	0.8	0.06	4.1
2017-11-18 05:00	IX-2-163	151	0.04	26800	3.8	117	1.9	2570	0.5	0.07	4.0

Table 3: IX-3 non-metal chemistry results.

Starting date and time	Event ID	Alkalinity (Total as CaCO3) (mg/L)	Conductivity (µmho/cm)	Dissolved Chloride (mg/L)	Nitrate + Nitrite (mg/L)	Ortho-phosphate (mg/L)	Total Ammonia-N (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
2014-04-14 12:40	IX-3-002	110	2500	690	1.32	0.47	0.40	1420	2.20	0.48	16
2014-04-29 07:10	IX-3-005	90	1297	298	1.22	0.44	0.17	620	1.22	0.46	8
2014-05-20 08:40	IX-3-012	130	1000	160	1.95	0.16	0.10	554	1.30	0.25	6
2014-06-02 22:20	IX-3-014	98	770	140	1.25	0.12	0.12	446	5.30	0.16	6
2014-07-07 02:20	IX-3-023	73	320	33	0.91	0.17	0.09	202	1.50	0.19	8
2014-07-23 01:00	IX-3-031	100	370	35	1.16	0.18	0.03	244	0.91	0.19	6
2014-07-27 19:00	IX-3-032	66	260	31	1.24	0.44	0.06	192	1.40	0.51	32
2014-08-11 22:20	IX-3-035	67	220	21	0.60	0.24	0.04	164	0.76	0.23	18

Starting date and time	Event ID	Alkalinity (Total as CaCO3) (mg/L)	Conductivity (μmho/cm)	Dissolved Chloride (mg/L)	Nitrate + Nitrite (mg/L)	Ortho-phosphate (mg/L)	Total Ammonia-N (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
2014-09-10 15:50	IX-3-040	78	230	16	0.46	0.13	0.05	200	0.57	0.17	6
2014-09-21 05:50	IX-3-043	78	250	21	0.72	0.15	0.05	148	0.81	0.22	5
2014-10-07 16:20	IX-3-046	73	200	11	0.23	0.12	0.05	120	0.51	0.16	5
2015-04-08 07:50	IX-3-058	89	1851	472	<1	0.47	0.12	869	0.92	0.55	28
2015-04-19 22:30	IX-3-061	75	870	180	0.51	0.23	0.10	460	0.66	0.21	11
2015-06-07 21:20	IX-3-064	88	590	110	0.76	0.11	0.02	326	1.00	0.14	9
2015-06-27 10:40	IX-3-069	62	310	46	0.44	0.15	0.03	166	0.35	0.18	5
2015-07-07 12:40	IX-3-070	100	600	110	1.23	0.17	0.06	398	1.10	0.21	11
2015-08-10 12:10	IX-3-076	85	340	39	0.69	0.14	0.01	228	0.57	0.18	6
2015-09-29 12:20	IX-3-085	54	240	33	0.82	0.17	0.06	134	0.50	0.23	10
2015-10-08 20:30	IX-3-087	81	340	39	1.06	0.06	0.04	196	0.35	0.09	3
2015-10-15 16:40	IX-3-088	90	380	42	1.46	0.13	0.04	218	0.52	0.07	6
2015-10-28 02:10	IX-3-092	41	150	16	0.41	-	<0.01	90	0.22	0.14	5
2015-11-10 12:50	IX-3-095	59	190	17	0.36	0.04	0.02	96	0.21	0.06	<1
2016-06-26 21:10	IX-3-112	120	1000	170	7.21	0.06	0.09	632	1.90	0.17	7
2016-08-16 01:20	IX-3-120	90	600	110	0.45	0.09	0.02	346	0.57	0.12	9
2016-08-25 00:40	IX-3-124	100	333	42	1.61	0.13	<0.02	210	0.90	0.38	11
2016-09-07 18:20	IX-3-125	86	440	63	2.74	0.10	0.03	260	0.81	0.17	4

Starting date and time	Event ID	Alkalinity (Total as CaCO3) (mg/L)	Conductivity (µmho/cm)	Dissolved Chloride (mg/L)	Nitrate + Nitrite (mg/L)	Ortho-phosphate (mg/L)	Total Ammonia-N (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
2016-09-26 10:40	IX-3-128	71	260	28	0.92	0.09	0.02	170	0.57	0.11	4
2016-09-29 07:30	IX-3-129	65	190	14	0.57	0.09	0.01	132	0.33	0.10	1
2017-07-13 06:40	IX-3-157	74	330	40	1.95	0.02	0.05	192	0.58	0.06	2
2017-07-26 19:10	IX-3-160	100	380	36	1.67	0.05	<0.01	244	0.53	0.07	3
2017-08-17 14:00	IX-3-164	91	250	17	0.76	0.06	0.01	196	0.38	0.08	3
2017-10-23 15:10	IX-3-175	83	220	14	0.70	0.04	<0.01	130	0.20	0.06	3
2017-10-28 05:30	IX-3-176	97	280	22	0.67	0.04	<0.01	185	0.12	0.04	2
2017-11-18 05:00	IX-3-181	57	210	25	0.44	0.03	<0.01	<10	0.22	0.04	1

Table 4: IX-3 metal chemistry results.

Starting date and time	Event ID	Aluminum (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Nickel (µg/L)	Uranium (µg/L)	Zinc (µg/L)
2014-04-14 12:40	IX-3-002	680	0.24	27000	12.0	650	14.0	4200	2.5	0.86	15.0
2014-04-29 07:10	IX-3-005	494	0.19	13997	14.0	492	13.9	2306	2.1	0.59	17.0
2014-05-20 08:40	IX-3-012	77	0.20	50100	5.0	99	6.3	4000	2.0	0.50	9.0

Starting date and time	Event ID	Aluminum (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Nickel (µg/L)	Uranium (µg/L)	Zinc (µg/L)
2014-06-02 22:20	IX-3-014	96	0.29	43700	14.0	177	6.2	3310	2.4	0.37	11.0
2014-07-07 02:20	IX-3-023	80	0.09	35000	4.2	92	6.0	2140	1.9	0.12	8.9
2014-07-23 01:00	IX-3-031	25	0.17	47800	9.5	44	4.9	2540	1.4	0.17	11.0
2014-07-27 19:00	IX-3-032	409	0.23	21400	13.4	564	24.6	2680	2.8	0.16	24.8
2014-08-11 22:20	IX-3-035	103	0.13	26000	10.8	148	8.2	1960	1.4	0.09	16.4
2014-09-10 15:50	IX-3-040	51	0.15	34800	6.0	54	4.6	1640	1.0	0.10	7.6
2014-09-21 05:50	IX-3-043	37	0.11	33200	3.3	59	6.3	1860	1.1	0.10	8.6
2014-10-07 16:20	IX-3-046	116	0.12	30200	6.4	76	4.0	1480	0.9	0.16	9.2
2015-04-08 07:50	IX-3-058	337	0.24	17649	11.4	343	15.9	2756	1.9	0.53	19.3
2015-04-19 22:30	IX-3-061	215	0.11	13400	5.5	292	10.8	1710	1.9	0.37	12.9
2015-06-07 21:20	IX-3-064	61	0.14	32700	5.6	99	6.1	2240	2.5	0.19	9.0
2015-06-27 10:40	IX-3-069	64	0.19	23000	8.9	82	4.5	1200	1.0	0.10	7.1
2015-07-07 12:40	IX-3-070	76	0.12	40300	11.1	162	13.0	2970	2.3	0.19	17.0
2015-08-10 12:10	IX-3-076	57	0.09	33800	8.7	96	6.0	1940	1.6	0.11	11.2
2015-09-29 12:20	IX-3-085	91	0.13	21100	11.7	129	8.4	1740	1.4	0.08	13.0
2015-10-08 20:30	IX-3-087	46	0.19	32500	10.6	63	3.1	1760	1.1	0.20	8.3
2015-10-15 16:40	IX-3-088	90	0.17	40400	5.5	99	3.6	2290	1.2	0.27	9.6
2015-10-28 02:10	IX-3-092	126	0.05	14700	9.1	104	5.3	978	0.8	0.10	7.3

Starting date and time	Event ID	Aluminum (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Nickel (µg/L)	Uranium (µg/L)	Zinc (µg/L)
2015-11-10 12:50	IX-3-095	32	0.06	23500	7.5	37	1.9	1120	0.7	0.15	5.8
2016-06-26 21:10	IX-3-112	56	0.17	67900	9.0	134	5.7	3150	2.6	0.19	12.9
2016-08-16 01:20	IX-3-120	62	0.08	32400	8.5	79	4.5	1200	1.3	0.10	9.5
2016-08-25 00:40	IX-3-124	121	0.15	22665	12.7	157	9.2	1627	1.7	0.10	19.0
2016-09-07 18:20	IX-3-125	56	0.13	39900	14.1	99	7.5	2050	2.3	0.10	14.6
2016-09-26 10:40	IX-3-128	56	0.10	27000	10.8	65	3.3	1180	1.3	0.10	14.6
2016-09-29 07:30	IX-3-129	79	0.09	22800	3.6	64	3.4	906	0.9	0.10	9.2
2017-07-13 06:40	IX-3-157	34	0.20	31900	4.5	60	2.7	1060	1.2	0.07	8.3
2017-07-26 19:10	IX-3-160	41	0.09	38800	4.1	67	3.6	1330	1.3	0.10	9.6
2017-08-17 14:00	IX-3-164	59	0.13	31400	4.4	70	4.0	1110	1.3	0.08	11.5
2017-10-23 15:10	IX-3-175	57	0.22	30000	3.1	73	3.5	1220	0.9	0.13	9.2
2017-10-28 05:30	IX-3-176	57	0.21	30700	3.0	59	2.3	1360	0.8	0.25	6.5
2017-11-18 05:00	IX-3-181	75	0.12	19900	1.9	55	1.93	708	0.5	0.09	6.2

Table 5: IX-4 non-metal chemistry results.

Starting date and time	Event ID	Alkalinity (Total as CaCO3) (mg/L)	Conductivity (μmho/cm)	Dissolved Chloride (mg/L)	Nitrate + Nitrite (mg/L)	Ortho-phosphate (mg/L)	Total Ammonia -N (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
2014-05-13 03:20	IX-4-001	86	510	81	0.67	0.27	0.17	322	1.50	0.340	35
2014-05-20 08:40	IX-4-006	96	600	85	1.39	0.09	0.09	352	0.86	0.150	14
2014-06-02 22:20	IX-4-008	91	500	67	0.88	0.11	0.17	272	4.80	0.110	3
2014-06-23 16:50	IX-4-014	140	530	43	1.62	0.11	0.14	378	2.00	0.220	8
2014-06-24 17:30	IX-4-015	120	450	35	0.86	0.16	0.17	298	1.20	0.130	9
2014-07-07 02:20	IX-4-017	86	340	34	0.95	0.15	0.18	210	2.00	0.140	8
2014-07-15 01:30	IX-4-020	88	310	27	0.79	0.17	0.11	194	0.83	0.180	9
2014-07-23 01:00	IX-4-024	93	320	27	0.94	0.13	0.07	216	0.89	0.180	26
2014-08-11 22:20	IX-4-028	55	160	12	0.33	0.20	0.07	126	0.66	0.180	11
2014-09-05 19:10	IX-4-034	61	180	13	0.31	0.10	0.08	122	0.54	0.150	15
2014-09-10 15:50	IX-4-035	74	250	22	0.35	0.09	0.08	154	0.65	0.100	4

Starting date and time	Event ID	Alkalinity (Total as CaCO3) (mg/L)	Conductivity (µmho/cm)	Dissolved Chloride (mg/L)	Nitrate + Nitrite (mg/L)	Ortho-phosphate (mg/L)	Total Ammonia -N (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
2014-09-21 05:50	IX-4-038	68	260	28	0.46	0.10	0.07	140	0.82	0.150	15
2014-10-07 16:20	IX-4-042	64	200	17	0.12	0.09	0.07	112	0.35	0.110	4
2015-04-08 08:00	IX-4-055	100	1500	340	<1	0.40	0.14	794	1.20	0.460	15
2015-04-09 13:10	IX-4-056	85	1100	230	0.54	0.48	0.15	652	0.67	0.620	31
2015-04-19 22:30	IX-4-058	80	620	120	<0.5	0.15	0.05	322	0.56	0.150	12
2015-06-07 21:20	IX-4-062	77	350	45	0.49	0.14	0.05	208	0.96	0.120	8
2015-07-07 12:40	IX-4-068	98	470	71	1.19	0.15	0.03	332	0.93	0.190	17
2015-08-10 12:10	IX-4-074	75	240	21	0.54	0.10	0.02	172	0.46	0.110	6
2015-08-20 09:10	IX-4-078	67	250	22	0.41	0.20	0.03	168	0.49	0.100	21
2015-09-29 12:20	IX-4-083	46	150	16	0.41	0.10	0.07	100	0.36	0.160	14
2015-10-08 20:30	IX-4-084	93	270	15	0.86	0.07	0.03	164	0.41	0.110	2
2015-10-15 16:40	IX-4-085	95	280	16	1.00	0.06	0.07	180	0.72	0.093	5

Starting date and time	Event ID	Alkalinity (Total as CaCO3) (mg/L)	Conductivity (µmho/cm)	Dissolved Chloride (mg/L)	Nitrate + Nitrite (mg/L)	Ortho-phosphate (mg/L)	Total Ammonia -N (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
2015-10-28 02:10	IX-4-089	45	170	20	0.10		<0.01	12	0.19	0.064	4
2016-03-14 01:50	IX-4-101	160	3900	1100	0.76	0.33	0.093	2050	0.59	0.280	5
2016-03-31 02:20	IX-4-105	110	640	110	<0.5	0.31	0.09	340	0.45	0.410	50
2016-06-26 21:10	IX-4-110	110	520	40	4.84	0.03	0.08	552	2.20	0.190	26
2016-07-13 23:50	IX-4-114	94	340	29	1.43	0.09	0.03	212	0.59	0.120	11
2016-07-25 04:10	IX-4-116	56	190	16	0.97	0.18	0.15	142	0.74	0.190	17
2016-08-16 01:20	IX-4-120	79	220	13	0.25	0.10	0.01	150	0.48	0.130	7
2016-08-25 00:40	IX-4-124	120	300	12	0.48	0.05	0.04	226	0.58	0.092	8
2016-09-07 18:20	IX-4-126	69	250	21	1.26	0.10	0.09	140	0.83	0.180	15
2016-09-26 10:40	IX-4-129	67	200	15	0.55	0.11	0.02	114	0.43	0.081	7
2016-09-29 07:30	IX-4-130	63	160	7.5	0.25	0.06	0.02	94	0.29	0.059	3
2017-04-03 21:20	IX-4-149	68	890	190	0.60	0.08	0.03	410	0.42	0.110	18

Starting date and time	Event ID	Alkalinity (Total as CaCO3) (mg/L)	Conductivity (µmho/cm)	Dissolved Chloride (mg/L)	Nitrate + Nitrite (mg/L)	Ortho-phosphate (mg/L)	Total Ammonia -N (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
2017-05-04 13:10	IX-4-157	53	230	29	0.40	0.07	<0.01	158	0.13	0.120	10
2017-06-04 05:30	IX-4-161	120	380	28	1.14	0.02	<0.01	238	0.35	0.038	4
2017-07-13 06:40	IX-4-174	91	280	19	1.64	0.02	<0.05	188	0.55	0.066	5
2017-07-26 19:10	IX-4-179	130	380	24	0.83	0.06	0.02	230	0.50	0.073	4

Table 6: IX-4 metal chemistry results.

Starting date and time	Event ID	Aluminum (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Nickel (µg/L)	Uranium (µg/L)	Zinc (µg/L)
2014-05-13 03:20	IX-4-001	475	0.22	17900	13.4	491	12.4	2670	3.2	0.26	21.5
2014-05-20 08:40	IX-4-006	129	0.53	50800	9.5	121	3.4	3340	1.3	0.32	10.5
2014-06-02 22:20	IX-4-008	53	0.20	50000	6.4	63	2.6	2720	1.6	0.22	8.3
2014-06-23 16:50	IX-4-014	84	0.07	71500	10.5	108	4.5	3750	1.9	0.30	8.5

Starting date and time	Event ID	Aluminum (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Nickel (µg/L)	Uranium (µg/L)	Zinc (µg/L)
2014-06-24 17:30	IX-4-015	41	0.08	61100	9.4	75	4.8	3440	1.5	0.25	10.1
2014-07-07 02:20	IX-4-017	123	0.09	42000	4.1	128	5.2	2410	1.7	0.18	8.0
2014-07-15 01:30	IX-4-020	122	0.14	41500	11.9	111	4.9	2280	1.5	0.19	9.1
2014-07-23 01:00	IX-4-024	70	0.10	48300	10.2	133	5.5	2580	1.3	0.20	14.0
2014-08-11 22:20	IX-4-028	149	0.21	22600	10.2	164	4.6	1450	1.0	0.09	12.6
2014-09-05 19:10	IX-4-034	167	0.19	25100	11.9	178	4.5	1460	1.0	0.09	9.8
2014-09-10 15:50	IX-4-035	73	0.16	35100	3.3	62	2.7	1610	0.8	0.14	5.6
2014-09-21 05:50	IX-4-038	91	0.24	30000	2.6	117	4.2	1980	0.9	0.15	10.0
2014-10-07 16:20	IX-4-042	93	0.11	26000	11.1	71	2.5	1360	0.7	0.15	7.3
2015-04-08 08:00	IX-4-055	441	0.24	13400	14.0	396	10.3	1660	1.9	0.36	20.5
2015-04-09 13:10	IX-4-056	468	0.49	14000	11.0	371	13.0	2340	1.8	0.39	20.0
2015-04-19 22:30	IX-4-058	226	0.21	13200	6.4	312	6.9	1820	1.5	0.34	10.9

Starting date and time	Event ID	Aluminum (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Nickel (µg/L)	Uranium (µg/L)	Zinc (µg/L)
2015-06-07 21:20	IX-4-062	59	0.15	29800	7.0	76	4.3	1860	1.3	0.14	15.2
2015-07-07 12:40	IX-4-068	91	0.30	42100	18.9	199	9.6	2860	2.4	0.14	21.7
2015-08-10 12:10	IX-4-074	67	0.11	31500	4.7	102	4.7	1580	1.4	0.10	12.1
2015-08-20 09:10	IX-4-078	110	0.15	32600	6.4	188	4.9	1860	1.6	0.13	19.2
2015-09-29 12:20	IX-4-083	140	0.14	16700	5.8	158	6.0	1270	1.1	0.08	16.2
2015-10-08 20:30	IX-4-084	37	0.30	43400	9.4	42	2.3	1500	0.9	0.17	8.6
2015-10-15 16:40	IX-4-085	51	0.11	45700	4.4	62	2.6	1640	1.0	0.23	9.2
2015-10-28 02:10	IX-4-089	90	0.07	21300	15.6	86	1.9	882	0.5	0.09	5.0
2016-03-14 01:50	IX-4-101	323	0.10	33000	12.0	289	8.2	2000	2.0	0.40	18.0
2016-03-31 02:20	IX-4-105	752	0.31	14900	17.7	817	11.9	2320	2.0	0.26	36.2
2016-06-26 21:10	IX-4-110	114	0.29	65900	13.3	355	5.6	2990	3.4	0.14	17.3
2016-07-13 23:50	IX-4-114	58	0.30	39400	10.6	114	4.5	1740	1.7	0.10	12.2

Starting date and time	Event ID	Aluminum (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Nickel (µg/L)	Uranium (µg/L)	Zinc (µg/L)
2016-07-25 04:10	IX-4-116	256	0.55	24700	6.6	219	9.7	1870	1.7	0.12	18.1
2016-08-16 01:20	IX-4-120	78	0.34	32000	7.5	98	3.1	1210	1.2	0.10	11.0
2016-08-25 00:40	IX-4-124	51	0.17	52200	12.5	104	3.0	1760	1.2	0.16	10.6
2016-09-07 18:20	IX-4-126	106	0.13	30800	13.4	167	8.7	1860	5.3	0.08	20.0
2016-09-26 10:40	IX-4-129	73	0.08	27400	8.8	111	4.0	1190	1.2	0.10	11.3
2016-09-29 07:30	IX-4-130	77	0.06	23700	3.0	72	2.6	898	0.8	0.09	7.0
2017-04-03 21:20	IX-4-149	307	0.28	18000	4.9	326	4.2	1730	1.2	0.22	13.0
2017-05-04 13:10	IX-4-157	740	0.07	21900	3.9	547	3.4	1130	0.9	0.14	8.5
2017-06-04 05:30	IX-4-161	133	0.07	51000	3.8	153	1.6	2240	1.2	0.20	8.3
2017-07-13 06:40	IX-4-174	100	<0.05	41300	4.7	110	3.1	1690	1.3	0.10	9.5
2017-07-26 19:10	IX-4-179	73	0.08	49700	3.8	85	3.5	2090	1.3	0.17	12.1

Table 7: IX-5 non-metal chemistry results.

Starting date and time	Event ID	Alkalinity (Total as CaCO3) (mg/L)	Conductivity (µmho/cm)	Dissolved Chloride (mg/L)	Nitrate + Nitrite (mg/L)	Ortho-phosphate (mg/L)	Total Ammonia-N (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
2014-04-07 18:00	IX-5-002	150	39000	14000	0.85	0.041	0.94	23300	8.30	<0.1	38
2014-04-29 07:10	IX-5-005	160	6100	1600	0.57	0.006	0.19	3080	2.70	0.080	56
2014-05-20 08:40	IX-5-007	190	6000	1700	1.27	0.013	0.09	3360	0.47	0.010	59
2014-06-11 21:10	IX-5-011	160	4200	960	1.84	0.009	0.08	2300	0.53	0.060	34
2014-07-15 01:30	IX-5-018	150	3700	750	1.15	0.020	0.05	2050	0.85	0.014	23
2014-07-23 01:00	IX-5-020	160	2800	510	0.99	0.017	0.04	1680	0.33	0.035	13
2014-07-27 19:00	IX-5-021	96	1100	110	0.48	0.017	0.39	624	2.60	<0.01	22
2014-08-11 22:20	IX-5-023	110	1300	160	0.57	0.020	0.04	750	0.35	0.038	11
2014-09-05 19:10	IX-5-027	93	1200	130	0.50	0.004	0.03	704	0.20	0.031	23
2014-09-10 15:50	IX-5-028	100	1200	140	0.42	0.025	0.04	758	0.26	0.029	23
2014-10-07 16:20	IX-5-034	100	1200	140	0.42	0.010	0.06	710	0.32	0.012	18

Starting date and time	Event ID	Alkalinity (Total as CaCO3) (mg/L)	Conductivity (μmho/cm)	Dissolved Chloride (mg/L)	Nitrate + Nitrite (mg/L)	Ortho-phosphate (mg/L)	Total Ammonia-N (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
2014-11-24 00:00	IX-5-041	91	7500	2300	0.51	0.026	0.07	4260	0.22	0.046	35
2015-04-19 22:30	IX-5-045	220	10000	3000	1.31	0.091	0.18	5130	0.46	0.110	10
2015-05-30 12:50	IX-5-047	160	4300	1100	1.65	0.091	0.04	2410	<0.1	0.300	58
2015-06-27 10:40	IX-5-050	120	1800	330	0.90	0.051	0.04	976	<0.5	0.120	20
2015-07-07 12:40	IX-5-051	130	2200	440	0.51	0.036	<0.01	1200	<0.5	0.013	5
2015-08-10 12:10	IX-5-055	100	1700	280	0.67	0.018	<0.01	960	<0.5	0.010	3
2015-08-19 22:10	IX-5-058	120	1900	350	0.63	0.016	<0.01	1080	0.27	0.029	<2
2015-09-29 12:20	IX-5-061	96	1100	140	0.33	0.006	0.05	644	0.13	0.100	16
2015-10-28 02:10	IX-5-066	87	680	71	0.32	0.082	0.01	400	<0.5	0.037	19
2016-08-13 11:10	IX-5-084	120	2000	280	0.99	0.023	<0.01	1220	0.20	0.033	2
2016-08-16 01:20	IX-5-085	110	1400	130	1.01	<0.004	0.02	1030	0.50	0.040	2
2016-08-25 00:40	IX-5-087	98	1000	100	0.64	0.057	<0.01	600	0.18	0.076	2

Starting date and time	Event ID	Alkalinity (Total as CaCO3) (mg/L)	Conductivity (µmho/cm)	Dissolved Chloride (mg/L)	Nitrate + Nitrite (mg/L)	Ortho-phosphate (mg/L)	Total Ammonia-N (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
2016-09-07 18:20	IX-5-088	110	1400	180	0.55	0.024	0.03	778	<0.1	0.007	2
2016-09-26 10:40	IX-5-091	97	1300	150	0.73	0.022	<0.01	798	0.10	0.019	1
2017-03-24 04:40	IX-5-098	170	15000	4600	0.97	<0.04	0.05	8150	0.28	0.008	6
2017-03-30 16:50	IX-5-099	150	7200	5000	1.09	<0.04	0.06	8220	0.45	0.015	8
2017-04-03 21:20	IX-5-100	200	5000	1300	1.11	0.019	0.03	2620	0.29	0.040	7
2017-05-04 13:10	IX-5-107	120	900	130	0.96	0.038	<0.01	478	0.18	0.066	11
2017-07-13 06:40	IX-5-116	140	2000	400	0.98	<0.004	<0.05	1060	0.11	0.009	1
2017-07-26 19:10	IX-5-119	130	1800	310	1.09	<0.004	<0.01	980	0.11	<0.004	2
2017-10-14 17:10	IX-5-130	110	1300	160	0.73	0.008	<0.01	830	<0.1	<0.004	1
2017-10-23 15:10	IX-5-131	120	1300	160	0.65	0.004	<0.01	750	<0.1	<0.004	<1
2017-11-18 05:00	IX-5-136	110	720	67	0.47	<0.004	0.02	290	0.11	0.018	1

Table 8: IX-5 metal chemistry results.

Starting date and time	Event ID	Aluminum (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Nickel (µg/L)	Uranium (µg/L)	Zinc (µg/L)
2014-04-07 18:00	IX-5-002	1000	<2	150000	<20	<2000	<10	35000	<20	35.00	<100
2014-04-29 07:10	IX-5-005	7500	<0.5	25000	20	6100	9.7	8000	24	15.00	48
2014-05-20 08:40	IX-5-007	797	0.30	73400	13	1570	6.8	16100	41	13.10	41
2014-06-11 21:10	IX-5-011	548	0.20	45600	<5	1490	4.9	12600	35	10.90	27
2014-07-15 01:30	IX-5-018	262	0.20	59100	11	309	3.0	18000	9	10.00	22
2014-07-23 01:00	IX-5-020	216	0.35	59600	9	379	2.5	18500	12	10.10	26
2014-07-27 19:00	IX-5-021	747	0.15	29300	9	745	4.4	11600	5	5.03	26
2014-08-11 22:20	IX-5-023	166	0.25	43100	8	196	2.5	15000	4	6.10	34
2014-09-05 19:10	IX-5-027	309	0.14	49400	11	443	3.5	19800	7	5.96	31
2014-09-10 15:50	IX-5-028	356	0.09	49400	11	457	3.8	18500	7	6.14	25
2014-10-07 16:20	IX-5-034	253	<0.1	50800	7	366	3.0	20300	5	6.66	27

Starting date and time	Event ID	Aluminum (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Nickel (µg/L)	Uranium (µg/L)	Zinc (µg/L)
2014-11-24 00:00	IX-5-041	443	0.30	131000	6	662	6.0	54100	12	6.70	189
2015-04-19 22:30	IX-5-045	183	<0.5	30700	<10	<250	4.1	8080	<5	20.40	<25
2015-05-30 12:50	IX-5-047	3360	<0.5	23300	26	4730	7.9	7240	10	12.30	31
2015-06-27 10:40	IX-5-050	1230	0.17	19000	9	1500	3.7	5950	4	6.56	20
2015-07-07 12:40	IX-5-051	96	<0.1	27200	5	113	2.7	8190	2	6.50	15
2015-08-10 12:10	IX-5-055	98	0.10	35300	3	129	2.5	12100	2	5.74	16
2015-08-19 22:10	IX-5-058	63	0.20	41600	7	53	2.4	13900	2	6.14	19
2015-09-29 12:20	IX-5-061	391	0.41	34500	5	510	3.4	13300	3	4.93	33
2015-10-28 02:10	IX-5-066	889	0.28	24800	10	975	3.5	9740	4	3.50	33
2016-08-13 11:10	IX-5-084	31	0.17	43800	7	<25	1.0	14400	1	6.58	21
2016-08-16 01:20	IX-5-085	18	1.10	40600	7	<25	0.9	13900	1	5.89	38
2016-08-25 00:40	IX-5-087	52	0.13	37100	7	39	1.9	12600	1	4.61	26

Starting date and time	Event ID	Aluminum (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Nickel (µg/L)	Uranium (µg/L)	Zinc (µg/L)
2016-09-07 18:20	IX-5-088	38	0.09	44000	9	34	1.8	15200	1	5.08	29
2016-09-26 10:40	IX-5-091	40	0.06	52200	6	26	1.6	19400	1	6.40	31
2017-03-24 04:40	IX-5-098	79	<0.5	72300	7	<250	<2.5	15200	<5	12.70	73
2017-03-30 16:50	IX-5-099	531	<0.5	82400	<5	378	3.3	17400	<5	11.10	92
2017-04-03 21:20	IX-5-100	2270	<0.5	22200	5	1440	9.4	5180	<5	10.40	51
2017-05-04 13:10	IX-5-107	365	0.08	23800	3	357	3.5	4690	1	3.77	25
2017-07-13 06:40	IX-5-116	26	0.06	40300	3	<25	1.3	11300	1	5.58	27
2017-07-26 19:10	IX-5-119	21	0.10	43700	2	<25	1.2	12700	1	5.88	32
2017-10-14 17:10	IX-5-130	18	<0.05	48700	1	<25	1.1	16700	1	6.01	34
2017-10-23 15:10	IX-5-131	22	0.16	45800	1	<25	1.1	16200	1	6.06	37
2017-11-18 05:00	IX-5-136	95	0.06	31400	1	74	1.7	10900	1	3.76	46

Table 9: IX-6 non-metal chemistry results.

Starting date and time	Event ID	Alkalinity (Total as CaCO3) (mg/L)	Conductivity (μmho/cm)	Dissolved Chloride (mg/L)	Nitrate + Nitrite (mg/L)	Ortho-phosphate (mg/L)	Total Ammonia-N (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
2014-04-29 11:24	IX-6-007	190	5200	1400	0.83	0.095	0.12	2600	0.58	0.091	16
2014-07-28 02:54	IX-6-030	95	810	97	0.62	0.080	0.06	462	0.45	0.046	16
2014-08-12 01:04	IX-6-033	120	1200	170	1.14	0.068	0.19	726	0.74	0.100	31
2014-09-05 22:34	IX-6-037	97	1200	130	0.66	0.025	0.04	690	0.33	0.034	13
2015-06-27 16:28	IX-6-066	150	1800	320	0.68	0.096	0.01	954	0.16	0.052	5
2015-09-29 14:24	IX-6-073	88	920	120	0.60	0.059	0.02	506	0.13	0.140	9
2015-10-28 07:35	IX-6-077	87	650	81	0.30	N/A	0.04	366	0.19	0.048	7
2016-07-14 21:35	IX-6-096	110	1500	190	1.01	0.099	0.04	854	0.15	0.099	21
2016-08-25 16:49	IX-6-105	91	920	110	0.54	0.074	0.02	518	0.28	0.110	14
2016-09-29 17:46	IX-6-110	86	930	89	0.53	0.031	0.04	558	0.13	0.009	4
2017-04-04 07:47	IX-6-125	180	4500	1200	0.93	0.078	0.02	2120	0.24	0.088	10

Starting date and time	Event ID	Alkalinity (Total as CaCO3) (mg/L)	Conductivity (µmho/cm)	Dissolved Chloride (mg/L)	Nitrate + Nitrite (mg/L)	Ortho-phosphate (mg/L)	Total Ammonia-N (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
2017-06-30 05:18	IX-6-145	77	700	100	0.63	0.022	<0.01	398	0.19	0.030	16

Table 10: IX-6 metal chemistry results.

Starting date and time	Event ID	Aluminum (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Nickel (µg/L)	Uranium (µg/L)	Zinc (µg/L)
2014-04-29 11:24	IX-6-007	1100	0.19	17000	9.5	950	10.0	5300	3.9	20.00	23
2014-07-28 02:54	IX-6-030	305	0.07	15900	9.0	293	10.2	6670	2.5	4.85	20
2014-08-12 01:04	IX-6-033	1390	0.10	30100	9.0	1080	8.6	12200	4.5	5.83	34
2014-09-05 22:34	IX-6-037	172	0.27	43400	7.0	168	3.6	20200	3.2	5.60	22
2015-06-27 16:28	IX-6-066	169	0.15	12600	6.1	165	6.5	4350	2.5	8.77	27
2015-09-29 14:24	IX-6-073	119	0.11	27400	8.2	140	6.6	11900	2.0	3.93	32
2015-10-28 07:35	IX-6-077	95	0.07	19800	4.9	105	4.2	9210	1.1	3.34	18
2016-07-14 21:35	IX-6-096	206	0.11	28700	7.0	488	10.6	11900	44.7	5.42	35
2016-08-25 16:49	IX-6-105	76	0.10	34600	5.0	69	4.9	14800	3.5	3.18	27
2016-09-29 17:46	IX-6-110	51	0.08	44700	3.8	46	3.6	20200	2.2	3.89	25
2017-04-04 07:47	IX-6-125	577	<0.5	18000	10.0	395	8.6	4960	<5	9.20	26
2017-06-30 05:18	IX-6-145	113	0.14	27100	5.3	155	12.6	10000	1.6	2.46	31

Table 11: IX-7 non-metal chemistry results.

Starting date and time	Event ID	Alkalinity (Total as CaCO3) (mg/L)	Conductivity (µmho/cm)	Dissolved Chloride (mg/L)	Nitrate + Nitrite (mg/L)	Ortho-phosphate (mg/L)	Total Ammonia-N (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
2014-04-29 09:57	IX-7-006	99	46000	17000	0.77	0.027	1.9	25800	2.4	0.067	150
2014-06-11 23:57	IX-7-013	180	6000	1700	0.94	<0.002	1	3590	1.4	0.1	180
2014-06-17 18:07	IX-7-014	150	4000	960	0.81	0.072	0.37	2150	1.1	0.04	130
2014-07-28 00:37	IX-7-025	86	800	110	0.39	0.025	0.09	448	0.31	0.03	62
2014-08-11 23:27	IX-7-028	260	5800	1400	0.57	<0.002	1.8	2790	2	0.029	210
2014-09-05 19:28	IX-7-032	59	2500	640	0.74	0.005	0.73	1360	1.5	0.033	160
2014-09-10 19:08	IX-7-033	110	4100	1000	0.57	0.002	1.1	2050	1.6	0.046	260
2014-09-21 07:40	IX-7-036	1100	16000	3600	0.32	<0.002	4.6	7320	6.2	0.045	110
2014-10-07 18:00	IX-7-039	230	6800	1700	0.62	<0.002	2	3350	2.6	0.053	270
2015-04-08 11:28	IX-7-047	120	38000	13000	0.85	0.034	0.47	22000	0.9	0.071	17
2015-04-09 22:08	IX-7-048	170	23000	7700	0.73	0.024	0.29	12000	0.71	0.048	20
2015-04-20 03:08	IX-7-050	190	12000	4000	0.97	0.093	0.2	5640	0.57	0.1	14
2015-06-08 03:29	IX-7-054	160	5100	1400	0.91	0.014	0.17	2640	0.92	0.069	23
2015-06-27 14:11	IX-7-059	140	2400	530	0.78	0.041	0.05	1110	0.2	0.034	8
2015-08-10 13:40	IX-7-066	140	4000	980	0.71	0.078	0.5	2110	0.72	0.021	91
2015-10-24 21:26	IX-7-071	150	4900	1300	0.85	0.024	1	2560	1.3	0.051	220
2015-10-28 05:38	IX-7-072	80	720	110	0.18	0.075	0.04	330	<0.1	0.038	31

Starting date and time	Event ID	Alkalinity (Total as CaCO3) (mg/L)	Conductivity (µmho/cm)	Dissolved Chloride (mg/L)	Nitrate + Nitrite (mg/L)	Ortho-phosphate (mg/L)	Total Ammonia-N (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
2016-03-31 20:30	IX-7-084	120	7900	2500	0.39	0.021	0.09	4330	0.16	0.075	42
2016-07-25 04:29	IX-7-097	110	1700	300	0.86	0.054	0.11	966	0.27	0.06	15
2016-08-16 07:28	IX-7-101	110	1600	200	0.76	<0.004	0.03	1150	0.26	0.039	58
2016-08-25 16:28	IX-7-105	87	920	120	0.38	0.071	<0.01	506	0.2	0.11	28
2016-09-29 14:31	IX-7-110	89	920	110	0.5	0.17	0.01	532	<0.1	0.027	8
2016-10-02 02:06	IX-7-112	130	1200	150	0.43	0.098	0.11	672	0.26	0.066	8
2016-11-03 03:50	IX-7-115	93	720	86	0.34	0.039	0.03	382	0.19	0.017	8
2017-04-04 06:37	IX-7-122	160	5100	1400	0.54	0.012	0.03	2390	0.23	0.028	26
2017-05-04 18:17	IX-7-129	120	1200	230	0.46	0.02	0.03	644	0.16	0.043	18
2017-06-30 04:57	IX-7-139	69	720	110	0.65	0.019	0.05	402	0.22	0.032	48

Table 12: IX-7 metal chemistry results.

Starting date and time	Event ID	Aluminum (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Nickel (µg/L)	Uranium (µg/L)	Zinc (µg/L)
2014-04-29 09:57	IX-7-006	730	<1	270000	40	1100	12.0	11000	25.0	4.00	<50
2014-06-11 23:57	IX-7-013	389	<0.2	69600	24	557	8.0	6200	14.0	9.30	27.0

Starting date and time	Event ID	Aluminum (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Nickel (µg/L)	Uranium (µg/L)	Zinc (µg/L)
2014-06-17 18:07	IX-7-014	458	0.20	42000	14	782	25.5	9080	7.0	10.50	44.0
2014-07-28 00:37	IX-7-025	341	0.10	29700	9	506	13.6	7200	2.6	4.65	32.0
2014-08-11 23:27	IX-7-028	350	0.12	170000	20	360	9.8	5400	28.0	3.70	23.0
2014-09-05 19:28	IX-7-032	138	0.10	70600	11	173	5.7	9180	14.0	3.70	17.0
2014-09-10 19:08	IX-7-033	174	0.10	133000	14	277	6.6	8920	20.0	4.40	19.0
2014-09-21 07:40	IX-7-036	168	<0.5	507000	29	<250	8.7	2860	73.0	1.80	<25
2014-10-07 18:00	IX-7-039	196	<0.1	228000	17	269	7.4	7950	31.0	3.80	34.0
2015-04-08 11:28	IX-7-047	123	0.90	139000	<25	<250	8.3	33200	7.0	25.50	38.0
2015-04-09 22:08	IX-7-048	366	<0.5	63400	<25	434	20.5	16400	6.0	22.40	54.0
2015-04-20 03:08	IX-7-050	154	<0.5	37100	<10	<250	6.4	10400	<5	22.30	<25
2015-06-08 03:29	IX-7-054	148	<0.5	23200	7	261	7.4	6120	<5	11.10	<25
2015-06-27 14:11	IX-7-059	218	0.11	15000	4	198	5.4	4180	2.2	8.20	13.1
2015-08-10 13:40	IX-7-066	204	<0.1	51600	8	377	7.4	10800	6.0	6.60	24.0
2015-10-24 21:26	IX-7-071	374	0.40	95500	15	1300	12.7	14000	11.0	5.20	54.0
2015-10-28 05:38	IX-7-072	1130	0.08	22000	5	564	8.3	7120	1.5	2.93	24.0
2016-03-31 20:30	IX-7-084	370	<0.5	40800	<10	1140	36.2	12500	<5	8.30	72.0
2016-07-25 04:29	IX-7-097	335	0.37	29800	3	311	14.2	10900	2.4	3.68	33.1
2016-08-16 07:28	IX-7-101	278	0.13	49200	9	794	5.3	18600	2.9	4.12	35.4

Starting date and time	Event ID	Aluminum (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Nickel (µg/L)	Uranium (µg/L)	Zinc (µg/L)
2016-08-25 16:28	IX-7-105	269	0.18	31800	9	619	8.4	11600	2.4	2.72	31.0
2016-09-29 14:31	IX-7-110	122	0.13	32200	4	107	3.8	13400	1.5	3.20	19.0
2016-10-02 02:06	IX-7-112	157	0.08	29800	5	226	4.8	12000	1.5	3.19	18.2
2016-11-03 03:50	IX-7-115	95	0.13	25600	6	97	4.5	11000	1.5	2.92	18.0
2017-04-04 06:37	IX-7-122	1320	<0.5	29000	<5	878	22.7	7970	<5	7.50	62.0
2017-05-04 18:17	IX-7-129	1160	0.07	16700	3	498	5.0	3600	1.5	3.82	29.6
2017-06-30 04:57	IX-7-139	282	0.20	27900	12	611	24.2	9470	5.0	2.09	49.3

Appendix E:

Soil Quality Data
February 2022

Table 1: Soil nutrient chemistry results.

<table>
<tr><th rowspan="3">Parameter</th><th rowspan="3">Date</th><th colspan="4">IX-2</th><th colspan="4">IX-3</th><th colspan="4">IX-4</th></tr>
<tr><th colspan="2">Upstream</th><th colspan="2">Downstream</th><th colspan="2">Upstream</th><th colspan="2">Downstream</th><th colspan="2">Upstream</th><th colspan="2">Downstream</th></tr>
<tr><th>Shallow</th><th>Deep</th><th>Shallow</th><th>Deep</th><th>Shallow</th><th>Deep</th><th>Shallow</th><th>Deep</th><th>Shallow</th><th>Deep</th><th>Shallow</th><th>Deep</th></tr>
<tr><td rowspan="3">Phosphorus (µg/g)</td><td>2015-11-23</td><td>510</td><td>470</td><td>390</td><td>430</td><td>450</td><td>590</td><td>390</td><td>350</td><td>420</td><td>490</td><td>450</td><td>470</td></tr>
<tr><td>2017-12-06</td><td>470</td><td>530</td><td>510</td><td>450</td><td>540</td><td>640</td><td>640</td><td>400</td><td>420</td><td>620</td><td>510</td><td>560</td></tr>
<tr><td>2019-08-29</td><td>440</td><td>700</td><td>890</td><td>670</td><td>620</td><td>640</td><td>650</td><td>610</td><td>570</td><td>520</td><td>570</td><td>570</td></tr>
<tr><td rowspan="3">Ortho-phosphate (µg/g)</td><td>2015-11-23</td><td>4.2</td><td>2.3</td><td>3.3</td><td>2.5</td><td>2.7</td><td>2.2</td><td>2.9</td><td>3.2</td><td>2.4</td><td>1.2</td><td>1.3</td><td>1.5</td></tr>
<tr><td>2017-12-06</td><td>1.8</td><td>1.9</td><td>3.8</td><td>1.6</td><td>2</td><td>1.7</td><td>4.8</td><td>2.1</td><td>1.3</td><td>1.1</td><td>3.3</td><td>0.8</td></tr>
<tr><td>2019-08-29</td><td>2</td><td>1.3</td><td>2.9</td><td>3.2</td><td>2.2</td><td>1.8</td><td>2.7</td><td>2.5</td><td>1.3</td><td>1.7</td><td>2.3</td><td>1.2</td></tr>
<tr><td rowspan="3">Nitrate plus nitrite (µg/g)</td><td>2015-11-23</td><td><3</td><td><3</td><td><3</td><td><3</td><td><3</td><td>3</td><td><3</td><td><3</td><td><3</td><td><3</td><td><3</td><td><3</td></tr>
<tr><td>2017-12-06</td><td>3</td><td><3</td><td><3</td><td><3</td><td><3</td><td><3</td><td><3</td><td><3</td><td>3</td><td><3</td><td>5</td><td><3</td></tr>
<tr><td>2019-08-29</td><td>7</td><td>4</td><td><3</td><td><3</td><td>4</td><td>4</td><td>11</td><td>7</td><td><3</td><td><3</td><td>5</td><td><3</td></tr>
<tr><td rowspan="3">Total Kjeldahl Nitrogen (µg/g)</td><td>2015-11-23</td><td>1200</td><td>894</td><td>876</td><td>928</td><td>981</td><td>856</td><td>1460</td><td>949</td><td>494</td><td>547</td><td>546</td><td>755</td></tr>
<tr><td>2017-12-06</td><td>1230</td><td>1170</td><td>2570</td><td>1340</td><td>1070</td><td>1070</td><td>2530</td><td>1290</td><td>1010</td><td>979</td><td>2220</td><td>950</td></tr>
<tr><td>2019-08-29</td><td>1450</td><td>1040</td><td>1530</td><td>1450</td><td>1330</td><td>965</td><td>1530</td><td>1810</td><td>693</td><td>826</td><td>2070</td><td>875</td></tr>
</table>

Table 2: Soil metal chemistry results.

Parameter	Date	IX-2				IX-3				IX-4			
		Upstream		Downstream		Upstream		Downstream		Upstream		Downstream	
		Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep
Aluminum (µg/g)	2015-11-23	2800	1600	1700	1700	1900	2100	1500	1400	2200	1700	1600	1700
	2017-12-06	1400	1500	1600	1600	1700	1700	1800	1400	1700	1800	2000	1600
	2019-08-29	1600	1900	2200	1800	2100	3100	1800	1600	1700	1900	2100	1800
Copper (µg/g) Guideline: 91 µg/g	2015-11-23	13	4.4	5.8	5.7	7.1	7.9	4.4	3.6	9.4	4.7	4.3	5.8
	2017-12-06	5.2	5.5	6	5.8	6.5	6.6	13	4.6	7.7	7	9.9	5.6
	2019-08-29		6.7	9.3	7.1	8.3	9.9	6.3	4.3	5.9	5	8	5.2
Iron (µg/g)	2015-11-23	6600	5400	4400	4500	4900	6800	4800	3500	5600	5800	5300	5300
	2017-12-06	5000	6400	5900	5700	5800	8500	7300	4400	5400	8900	6800	7400
	2019-08-29	5600	9300	12000	7100	8100	11000	8200	6900	7600	6600	8000	7800
Lead (µg/g) Guideline: 260 µg/g	2015-11-23	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
	2017-12-06	2.5	2.9	3.1	2.9	3.5	5.9	4.7	2.2	3.5	2.9	4.4	2.7
	2019-08-29	2.7	5.1	4	3.1	4.2	4.5	3.1	2.3	2.8	2.6	3.8	2.6
Nicklel (µg/g) Guideline: 89 µg/g	2015-11-23	5.1	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
	2017-12-06	2.5	2.9	2.9	3.1	3.3	3.9	3.9	2.5	3.9	4	4.7	3.1
	2019-08-29	2.8	3.2	3.8	2.8	3.7	5.3	3	2.7	3	3	3.8	2.8
Sodium (µg/g)	2015-11-23	110	110	100	110	<100	100	<100	100	100	190	100	110
	2017-12-06	91	110	90	87	120	190	94	99	110	140	100	97
	2019-08-29	95	110	120	150	95	110	120	150	100	110	94	98
Zinc (µg/g) Guideline: 410 µg/g	2015-11-23	48	18	20	25	22	22	14	9.4	34	14	14	12
	2017-12-06	19	18	26	20	27	27	44	13	46	21	51	19
	2019-08-29	21	38	30	18	34	29	21	13	26	20	40	16

Appendix F:

Groundwater Quality Data
February 2022

Table 1: MW-5 groundwater chemistry results from 2012 to 2015.

Parameter	Units	MW-5 Sample Date						
		2012-06-11	2013-04-18	2013-11-12	2014-05-29	2014-10-22	2015-05-28	2015-11-24
Alkalinity (Total as CaCO3)	mg/L	580	520	530	520	570	520	650
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	570	520	530	520	570	520	650
Carb. Alkalinity (calc. as CaCO3)	mg/L	1.2	1.2	<1.0	<1.0	1.1	<1.0	1.3
Conductivity	umho/cm	6500	9900	5700	13000	7600	18000	11000
Dissolved Aluminum (Al)	mg/L	<0.0050	0.032	0.038	<0.025	0.0058	<0.050	<0.025
Dissolved Antimony (Sb)	mg/L	<0.00050	<0.0025	<0.00050	<0.0025	<0.00050	<0.0050	<0.0025
Dissolved Arsenic (As)	mg/L	<0.0020	<0.0050	<0.0020	<0.0050	<0.0050	<0.010	<0.0050
Dissolved Barium (Ba)	mg/L	0.28	0.28	0.18	0.32	0.17	0.48	0.21
Dissolved Beryllium (Be)	mg/L	<0.00050	<0.0025	<0.00050	<0.0025	<0.00050	<0.0050	<0.0025
Dissolved Bismuth (Bi)	mg/L	<0.0010	<0.0050	<0.0010	<0.0050	<0.0010	<0.010	<0.0050
Dissolved Boron (B)	mg/L	0.13	0.14	0.17	0.15	0.14	0.14	0.2
Dissolved Cadmium (Cd)	mg/L	<0.00010	<0.00050	0.0002	0.00051	<0.00010	0.0011	<0.00050
Dissolved Calcium (Ca)	mg/L	390	550	310	520	270	690	370
Dissolved Chloride (Cl)	mg/L	1900	2700	1500	4300	2000	6400	3100
Dissolved Chromium (Cr)	mg/L	<0.0050	<0.025	<0.010	<0.025	<0.025	<0.050	<0.025
Dissolved Cobalt (Co)	mg/L	<0.0010	<0.0025	<0.0010	<0.0025	0.00071	<0.0050	<0.0025
Dissolved Copper (Cu)	mg/L	0.0019	<0.0050	0.0018	<0.0050	0.0023	<0.010	<0.0050
Dissolved Inorganic Carbon (C)	mg/L	110	140	130	130	140	130	170
Dissolved Iron (Fe)	mg/L	<0.10	<0.50	<0.10	<0.50	<0.10	<1.0	<0.50
Dissolved Lead (Pb)	mg/L	0.0005	<0.0025	<0.00050	<0.0025	<0.00050	<0.0050	<0.0025
Dissolved Lithium (Li)	mg/L	0.046	0.059	0.045	0.049	0.029	0.056	0.045
Dissolved Magnesium (Mg)	mg/L	180	240	130	220	100	250	140
Dissolved Manganese (Mn)	mg/L	0.034	0.093	0.85	1.2	3.2	4.4	3.6
Dissolved Molybdenum (Mo)	mg/L	0.00081	<0.0025	0.0042	0.0073	0.0086	<0.0050	0.0045
Dissolved Nickel (Ni)	mg/L	<0.0020	<0.0050	0.0082	<0.0050	0.0047	<0.010	0.0052
Dissolved Organic Carbon	mg/L	4.9	4.1	3.9	4.5	5.9	4.8	5.9
Dissolved Phosphorus (P)	mg/L	<0.10	<0.50	<0.10	<0.50	<0.10	<1.0	<0.50
Dissolved Potassium (K)	mg/L	8.4	22	17	20	14	21	15

Parameter	Units	MW-5 Sample Date						
		2012-06-11	2013-04-18	2013-11-12	2014-05-29	2014-10-22	2015-05-28	2015-11-24
Dissolved Selenium (Se)	mg/L	<0.0020	<0.010	<0.0020	<0.010	<0.0020	<0.020	<0.010
Dissolved Silicon (Si)	mg/L	4.5	3.9	4.3	3.8	4.2	3.9	4.9
Dissolved Silver (Ag)	mg/L	<0.00010	<0.00050	<0.00010	<0.00050	<0.00010	<0.0010	<0.00050
Dissolved Sodium (Na)	mg/L	770	1400	680	2200	1400	3200	1800
Dissolved Strontium (Sr)	mg/L	9	13	8.7	14	6.7	18	9.4
Dissolved Sulphate (SO4)	mg/L	110	290	230	230	220	280	290
Dissolved Tellurium (Te)	mg/L	<0.0010	<0.0050	<0.0010	<0.0050	<0.0010	<0.010	<0.0050
Dissolved Thallium (Tl)	mg/L	0.0001	<0.00025	<0.000050	<0.00025	0.00005	<0.00050	<0.00025
Dissolved Tin (Sn)	mg/L	<0.0010	<0.0050	<0.0010	<0.0050	<0.0010	<0.010	<0.0050
Dissolved Titanium (Ti)	mg/L	<0.0050	<0.025	<0.0050	<0.025	<0.0050	<0.050	<0.025
Dissolved Tungsten (W)	mg/L	<0.0010	<0.0050	<0.0010	<0.0050	<0.0010	<0.010	<0.0050
Dissolved Uranium (U)	mg/L	0.016	0.015	0.012	0.016	0.015	0.017	0.017
Dissolved Vanadium (V)	mg/L	<0.0025	<0.0025	<0.0010	<0.0050	<0.0025	<0.0050	<0.0025
Dissolved Zinc (Zn)	mg/L	<0.0050	<0.025	0.0088	<0.025	0.011	<0.050	<0.025
Dissolved Zirconium (Zr)	mg/L	<0.0010	<0.0050	<0.0010	<0.0050	<0.0010	<0.010	<0.0050
Fluoride (F-)	mg/L	0.14	0.16	0.39	0.37	0.48	0.21	0.3
Hardness (CaCO3)	mg/L	1700	2400	1300	2200	1100	2800	1500
Nitrate (N)	mg/L	0.99	2.5	<0.10	0.21	<0.10	<0.10	<0.10
Nitrate + Nitrite	mg/L	0.99	2.5	<0.10	0.22	<0.10	<0.10	<0.10
Nitrite (N)	mg/L	<0.010	<0.010	<0.010	0.011	<0.010	<0.010	0.021
Orthophosphate (P)	mg/L	<0.010	<0.010	<0.010	<0.010	0.004	0.027	0.019
pH	pH	7.33	7.37	7.07	7.11	7.31	7.28	7.32
Reactive Silica (SiO2)	mg/L	9.8	8.1	9	7.4	8.7	7.7	11
Total Ammonia-N	mg/L	<0.050	0.13	0.08	0.22	0.23	0.24	0.23
Total Dissolved Solids	mg/L	4870	7030	3490	9950	4430	12300	6260
Total Kjeldahl Nitrogen (TKN)	mg/L	1	1.7	1	2.6	<2.0	1	0.58
Total Phosphorus	mg/L	0.23	0.067	0.059	0.091	0.17	0.47	0.8

Table 2: MW-5 groundwater chemistry results from 2016 to 2018.

Parameter	Units	MW-5 Sample Date						
		2016-06-09	2016-10-26	2017-01-13	2017-03-30	2017-11-15	2018-05-24	2018-11-08
Alkalinity (Total as CaCO3)	mg/L	610	690	670	630	740	650	740
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	610	690	670	630	740	650	740
Carb. Alkalinity (calc. as CaCO3)	mg/L	1.8	1.4	<1.0	1.2	1.3	1.1	1.2
Conductivity	umho/cm	13000	8600	11000	12000	9600	10000	9400
Dissolved Aluminum (Al)	mg/L	<0.025	<0.0050	<0.0050	<0.0050		<0.0050	0.0064
Dissolved Antimony (Sb)	mg/L	<0.0025	<0.00050	0.00061	<0.00050		<0.00050	<0.00050
Dissolved Arsenic (As)	mg/L	<0.0050	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Barium (Ba)	mg/L	0.29	0.18	0.22	0.28		0.2	0.19
Dissolved Beryllium (Be)	mg/L	<0.0025	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050
Dissolved Bismuth (Bi)	mg/L	<0.0050	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Boron (B)	mg/L	0.21	0.18	0.19	0.18		0.18	0.19
Dissolved Cadmium (Cd)	mg/L	<0.00050	0.0002	0.00021	0.0002		0.0001	<0.00010
Dissolved Calcium (Ca)	mg/L	480	290	480	530		460	330
Dissolved Chloride (Cl)	mg/L	4000	2400	3400	3800	2700	3300	2700
Dissolved Chromium (Cr)	mg/L	<0.025	<0.0050	<0.0050	<0.0050		<0.0050	<0.0050
Dissolved Cobalt (Co)	mg/L	<0.0025	0.00061	<0.0010	<0.00050		<0.00050	<0.00050
Dissolved Copper (Cu)	mg/L	<0.010	0.0025	0.0016	0.0016		0.0017	0.0022
Dissolved Inorganic Carbon (C)	mg/L	160	170	160	150	190	180	190
Dissolved Iron (Fe)	mg/L	<0.50	0.1	0.12	<0.10		<0.10	<0.10
Dissolved Lead (Pb)	mg/L	<0.0025	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050
Dissolved Lithium (Li)	mg/L	0.06	0.046	0.06	0.07		0.064	0.063
Dissolved Magnesium (Mg)	mg/L	200	110	190	230		190	150
Dissolved Manganese (Mn)	mg/L	3.1	4.4	0.7	1.3		1.8	2.4
Dissolved Molybdenum (Mo)	mg/L	0.003	0.0047	0.0016	0.002		0.0024	0.0033
Dissolved Nickel (Ni)	mg/L	<0.0050	0.0048	0.0027	0.0039		0.0034	0.0039
Dissolved Organic Carbon	mg/L	4.7	7.7	5	4.4	5.6	4.4	5.1
Dissolved Phosphorus (P)	mg/L	<0.50	<0.10	<0.10	0.13		<0.10	<0.10
Dissolved Potassium (K)	mg/L	15	13	15	15		16	15

Parameter	Units	MW-5 Sample Date						
		2016-06-09	2016-10-26	2017-01-13	2017-03-30	2017-11-15	2018-05-24	2018-11-08
Dissolved Selenium (Se)	mg/L	<0.010	<0.0020	<0.0020	<0.0020		<0.0020	<0.0020
Dissolved Silicon (Si)	mg/L	4.7	5.6	5	5.2		5.6	5.7
Dissolved Silver (Ag)	mg/L	<0.00050	<0.00010	<0.00010	<0.00010		<0.00010	<0.00010
Dissolved Sodium (Na)	mg/L	1800	1400	1600	1800		1600	1500
Dissolved Strontium (Sr)	mg/L	13	7.7	11	14		11	9.4
Dissolved Sulphate (SO4)	mg/L	210	340	220	210	230	210	180
Dissolved Tellurium (Te)	mg/L	<0.0050	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Thallium (Tl)	mg/L	<0.00025	<0.000050	<0.000050	<0.000050		<0.000050	<0.000050
Dissolved Tin (Sn)	mg/L	<0.0050	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Titanium (Ti)	mg/L	<0.025	<0.0050	<0.0050	<0.0050		<0.0050	<0.0050
Dissolved Tungsten (W)	mg/L	<0.0050	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Uranium (U)	mg/L	0.013	0.012	0.013	0.013		0.011	0.011
Dissolved Vanadium (V)	mg/L	<0.0050	<0.0025	<0.0025	<0.00050		<0.00050	<0.00050
Dissolved Zinc (Zn)	mg/L	<0.025	0.01	0.0056	0.01		0.011	0.0078
Dissolved Zirconium (Zr)	mg/L	<0.0050	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Fluoride (F-)	mg/L	0.23	0.31	0.2	0.18	0.24	0.28	0.23
Hardness (CaCO3)	mg/L	2000	1200	2000	2300	1100	1900	1400
Nitrate (N)	mg/L	<0.10	<0.10	1.79	1.15	<0.10	0.34	<0.10
Nitrate + Nitrite	mg/L	<0.10	<0.10	1.79	1.15	<0.10	0.34	<0.10
Nitrite (N)	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Orthophosphate (P)	mg/L	<0.02	<0.004	0.013	0.06	0.029	0.012	0.016
pH	pH	7.5	7.33	7.19	7.31	7.29	7.26	7.22
Reactive Silica (SiO2)	mg/L	9.7	10	9.9	10	10	9.8	11
Total Ammonia-N	mg/L	0.22	0.25	0.072	0.075	0.09	0.25	0.22
Total Dissolved Solids	mg/L	7810	5050	6820	7370	4870	6800	5440
Total Kjeldahl Nitrogen (TKN)	mg/L	0.22	0.67	0.45	0.19	0.29	0.4	0.23
Total Phosphorus	mg/L	0.62	0.15	0.59	0.33	0.18	0.28	0.15

Table 3: MW-6 groundwater chemistry results from 2012 to 2015.

Parameter	Units	MW-6 Sample Date						
		2012-06-11	**2013-04-18**	**2013-11-12**	**2014-05-29**	**2014-10-22**	**2015-05-28**	**2015-11-24**
Alkalinity (Total as CaCO3)	mg/L			720	670	670	660	620
Bicarb. Alkalinity (calc. as CaCO3)	mg/L			710	670	670	660	620
Carb. Alkalinity (calc. as CaCO3)	mg/L			1.2	1.4	1.2	1.4	1.5
Conductivity	umho/cm			5100	4500	5200	5900	6400
Dissolved Aluminum (Al)	mg/L			<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Dissolved Antimony (Sb)	mg/L			0.00067	<0.00050	<0.00050	<0.00050	<0.00050
Dissolved Arsenic (As)	mg/L			0.0034	<0.0020	<0.0020	<0.0010	<0.0010
Dissolved Barium (Ba)	mg/L			0.26	0.11	0.12	0.12	0.14
Dissolved Beryllium (Be)	mg/L			<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Dissolved Bismuth (Bi)	mg/L			<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Dissolved Boron (B)	mg/L			0.48	0.39	0.47	0.41	0.51
Dissolved Cadmium (Cd)	mg/L			0.00019	<0.00010	<0.00010	<0.00010	<0.00010
Dissolved Calcium (Ca)	mg/L			340	330	370	410	450
Dissolved Chloride (Cl)	mg/L			1300	1000	1300	1600	1700
Dissolved Chromium (Cr)	mg/L			<0.010	<0.0050	<0.010	<0.0050	<0.0050
Dissolved Cobalt (Co)	mg/L			0.0041	<0.0010	<0.0010	<0.0010	<0.0010
Dissolved Copper (Cu)	mg/L			0.0029	0.055	0.096	0.17	0.22
Dissolved Inorganic Carbon (C)	mg/L			180	160	160	170	140
Dissolved Iron (Fe)	mg/L			0.39	2	3.4	3	2.5
Dissolved Lead (Pb)	mg/L			<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Dissolved Lithium (Li)	mg/L			0.097	0.091	0.094	0.09	0.11
Dissolved Magnesium (Mg)	mg/L			240	250	280	280	310
Dissolved Manganese (Mn)	mg/L			1.2	0.11	0.14	0.17	0.17
Dissolved Molybdenum (Mo)	mg/L			0.008	0.002	0.002	0.0014	0.0023
Dissolved Nickel (Ni)	mg/L			0.0029	<0.0050	<0.0020	<0.0020	<0.0020
Dissolved Organic Carbon	mg/L			5	3.4	4.2	3.4	3.6
Dissolved Phosphorus (P)	mg/L			<0.10	<0.10	<0.10	<0.10	<0.10

Parameter	Units	MW-6 Sample Date						
		2012-06-11	2013-04-18	2013-11-12	2014-05-29	2014-10-22	2015-05-28	2015-11-24
Dissolved Potassium (K)	mg/L			37	27	30	30	33
Dissolved Selenium (Se)	mg/L			<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Dissolved Silicon (Si)	mg/L			7.6	6.3	7.1	5.8	6.6
Dissolved Silver (Ag)	mg/L			<0.00010	<0.00010	0.00012	<0.00010	<0.00010
Dissolved Sodium (Na)	mg/L			300	290	340	340	390
Dissolved Strontium (Sr)	mg/L			15	15	16	17	19
Dissolved Sulphate (SO4)	mg/L			130	150	150	170	180
Dissolved Tellurium (Te)	mg/L			<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Dissolved Thallium (Tl)	mg/L			<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Dissolved Tin (Sn)	mg/L			<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Dissolved Titanium (Ti)	mg/L			<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Dissolved Tungsten (W)	mg/L			<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Dissolved Uranium (U)	mg/L			0.013	0.0091	0.0088	0.0079	0.01
Dissolved Vanadium (V)	mg/L			<0.0010	<0.0010	0.0012	<0.0010	<0.0025
Dissolved Zinc (Zn)	mg/L			0.0064	<0.0050	<0.0050	<0.0050	<0.0050
Dissolved Zirconium (Zr)	mg/L			0.0027	0.0015	0.0013	0.0014	0.0016
Fluoride (F-)	mg/L			0.14	0.11	0.12	0.11	0.13
Hardness (CaCO3)	mg/L			1800	1800	2100	2200	2400
Nitrate (N)	mg/L			<0.10	0.14	0.14	0.14	<0.10
Nitrate + Nitrite	mg/L			<0.10	0.14	0.14	0.15	0.13
Nitrite (N)	mg/L			0.012	<0.010	<0.010	0.013	0.046
Orthophosphate (P)	mg/L			<0.010	<0.010	0.003	<0.02	0.015
pH	pH			7.26	7.34	7.27	7.34	7.42
Reactive Silica (SiO2)	mg/L			16	12	13	12	14
Total Ammonia-N	mg/L			0.78	0.9	1.1	0.73	0.97
Total Dissolved Solids	mg/L			3430	4060	3700	4060	4310
Total Kjeldahl Nitrogen (TKN)	mg/L			17	9.5	3.2	1.8	1.4
Total Phosphorus	mg/L			3.3	0.25	0.82	4.8	1.3

Table 4: MW-6 groundwater chemistry results from 2016 to 2018.

Parameter	Units	MW-6 Sample Date						
		2016-06-09	2016-10-26	2017-01-13	2017-03-30	2017-11-15	2018-05-24	2018-11-08
Alkalinity (Total as CaCO3)	mg/L	600	640	630	630	650	620	640
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	600	640	630	630	650	620	640
Carb. Alkalinity (calc. as CaCO3)	mg/L	2.3	1.3	<1.0	1.3	1.1	1.2	1
Conductivity	umho/cm	7100	7100	7400	7600	7800	7700	7300
Dissolved Aluminum (Al)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050		<0.0050	<0.0050
Dissolved Antimony (Sb)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050
Dissolved Arsenic (As)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Barium (Ba)	mg/L	0.15	0.14	0.14	0.14		0.13	0.11
Dissolved Beryllium (Be)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050
Dissolved Bismuth (Bi)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Boron (B)	mg/L	0.39	0.5	0.47	0.43		0.38	0.4
Dissolved Cadmium (Cd)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010		0.00011	<0.00010
Dissolved Calcium (Ca)	mg/L	470	460	480	490		480	480
Dissolved Chloride (Cl)	mg/L	2100	2000	2100	2200	2200	2400	2200
Dissolved Chromium (Cr)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050		<0.0050	<0.0050
Dissolved Cobalt (Co)	mg/L	0.0011	<0.0010	<0.0010	<0.00050		<0.00050	<0.00050
Dissolved Copper (Cu)	mg/L	0.071	0.24	0.22	0.24		0.16	0.12
Dissolved Inorganic Carbon (C)	mg/L	160	160	160	160	190	170	180
Dissolved Iron (Fe)	mg/L	<0.10	1.8	1.6	1.6		<0.10	1.3
Dissolved Lead (Pb)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050
Dissolved Lithium (Li)	mg/L	0.11	0.11	0.12	0.12		0.12	0.13
Dissolved Magnesium (Mg)	mg/L	350	350	360	380		390	390
Dissolved Manganese (Mn)	mg/L	0.23	0.18	0.17	0.16		0.13	0.12
Dissolved Molybdenum (Mo)	mg/L	0.0025	0.0021	0.0025	0.0025		0.0022	0.0025
Dissolved Nickel (Ni)	mg/L	<0.0020	<0.0020	<0.0020	<0.0010		0.0011	0.0011
Dissolved Organic Carbon	mg/L	3.2	3.7	3.1	3.2		3	3
Dissolved Phosphorus (P)	mg/L	<0.10	<0.10	<0.10	0.11		<0.10	<0.10
Dissolved Potassium (K)	mg/L	28	34	32	32		29	34

Parameter	Units	MW-6 Sample Date						
		2016-06-09	2016-10-26	2017-01-13	2017-03-30	2017-11-15	2018-05-24	2018-11-08
Dissolved Selenium (Se)	mg/L	<0.0020	<0.0020	<0.0020	<0.0020		<0.0020	<0.0020
Dissolved Silicon (Si)	mg/L	5.8	6.9	6.6	6.6		6.1	6.6
Dissolved Silver (Ag)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010	<0.00010
Dissolved Sodium (Na)	mg/L	440	460	470	510		580	590
Dissolved Strontium (Sr)	mg/L	22	21	21	23		22	23
Dissolved Sulphate (SO4)	mg/L	190	190	190	200	200	210	200
Dissolved Tellurium (Te)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Thallium (Tl)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050	<0.000050
Dissolved Tin (Sn)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Titanium (Ti)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050		<0.0050	<0.0050
Dissolved Tungsten (W)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Uranium (U)	mg/L	0.015	0.011	0.012	0.014		0.015	0.013
Dissolved Vanadium (V)	mg/L	<0.0025	<0.0025	<0.0025	<0.00050		<0.00050	<0.00050
Dissolved Zinc (Zn)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050		0.006	<0.0050
Dissolved Zirconium (Zr)	mg/L	0.0019	0.0016	0.0015	0.0018		0.0018	0.0016
Fluoride (F-)	mg/L	0.16	0.12	0.12	0.14	0.11	0.13	0.12
Hardness (CaCO3)	mg/L	2600	2600	2700	2800	2600	2800	2800
Nitrate (N)	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	1	<0.10
Nitrate + Nitrite	mg/L	0.11	<0.10	<0.10	<0.10	<0.10	1	<0.10
Nitrite (N)	mg/L	0.054	0.023	0.027	<0.010	<0.010	<0.010	<0.010
Orthophosphate (P)	mg/L	0.03	0.009	0.022	0.06	0.017	0.013	0.011
pH	pH	7.6	7.33	7.19	7.33	7.26	7.32	7.22
Reactive Silica (SiO2)	mg/L	11	13	13	13	13	11	12
Total Ammonia-N	mg/L	0.57	0.97	0.63	0.53	0.85	0.54	0.79
Total Dissolved Solids	mg/L	4320	6300	5070	4960	4050	5550	4460
Total Kjeldahl Nitrogen (TKN)	mg/L	0.63	1.7	0.56	0.62	1.2	0.82	0.71
Total Phosphorus	mg/L	14	1.1	4.8	0.8	0.99	0.5	0.41

Table 5: MW-7 groundwater chemistry results from 2012 to 2015.

Parameter	Units	MW-7 Sample Date						
		2012-06-11	2013-04-18	2013-11-12	2014-05-29	2014-10-22	2015-05-28	2015-11-24
Alkalinity (Total as CaCO3)	mg/L	370	270	300	220	280	260	300
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	370	270	300	220	280	260	300
Carb. Alkalinity (calc. as CaCO3)	mg/L	2.5	2.2	1.6	<1.0	1.2	<1.0	1.2
Conductivity	umho/cm	1500	3700	2000	13000	8600	8800	6300
Dissolved Aluminum (Al)	mg/L	<0.0050	<0.0050	2.8	<0.025	0.054	<0.0050	<0.025
Dissolved Antimony (Sb)	mg/L	0.00083	<0.00050	<0.00050	<0.0025	<0.0025	<0.00050	<0.0025
Dissolved Arsenic (As)	mg/L	<0.0010	<0.0020	0.0022	<0.0050	<0.0050	<0.0010	<0.0050
Dissolved Barium (Ba)	mg/L	0.096	0.044	0.1	0.3	0.16	0.2	0.17
Dissolved Beryllium (Be)	mg/L	<0.00050	<0.00050	<0.00050	<0.0025	<0.0025	<0.00050	<0.0025
Dissolved Bismuth (Bi)	mg/L	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.0010	<0.0050
Dissolved Boron (B)	mg/L	0.26	0.12	0.2	0.15	0.26	0.19	0.26
Dissolved Cadmium (Cd)	mg/L	<0.00010	<0.00010	<0.00010	<0.00050	<0.00050	0.00021	<0.00050
Dissolved Calcium (Ca)	mg/L	81	140	130	670	390	450	270
Dissolved Chloride (Cl)	mg/L	190	850	270	4400	2600	2800	1800
Dissolved Chromium (Cr)	mg/L	<0.0050	<0.010	<0.0050	<0.025	<0.025	<0.0050	<0.025
Dissolved Cobalt (Co)	mg/L	<0.00050	<0.00050	0.0039	<0.0025	<0.0025	<0.0010	<0.0025
Dissolved Copper (Cu)	mg/L	0.0017	<0.0010	0.0062	<0.0050	<0.0050	<0.0010	<0.0050
Dissolved Inorganic Carbon (C)	mg/L	92	67	67	53	68	64	75
Dissolved Iron (Fe)	mg/L	<0.10	<0.10	4.8	<0.50	<0.50	<0.10	<0.50
Dissolved Lead (Pb)	mg/L	<0.00050	<0.00050	0.0024	<0.0025	<0.0025	<0.00050	<0.0025
Dissolved Lithium (Li)	mg/L	0.039	0.04	0.054	0.13	0.11	0.12	0.1
Dissolved Magnesium (Mg)	mg/L	68	78	69	470	290	300	180
Dissolved Manganese (Mn)	mg/L	0.078	<0.0020	0.21	<0.010	0.014	0.0023	<0.010
Dissolved Molybdenum (Mo)	mg/L	0.016	0.039	0.017	0.0093	0.012	0.0068	0.0076
Dissolved Nickel (Ni)	mg/L	<0.0010	0.0016	0.0077	<0.0050	<0.0050	<0.0020	<0.0050
Dissolved Organic Carbon	mg/L	2.3	1.8	1.5	1.3	2	1.5	1.5
Dissolved Phosphorus (P)	mg/L	<0.10	<0.10	0.34	<0.50	<0.50	<0.10	<0.50
Dissolved Potassium (K)	mg/L	22	64	30	42	37	27	22

Parameter	Units	MW-7 Sample Date						
		2012-06-11	2013-04-18	2013-11-12	2014-05-29	2014-10-22	2015-05-28	2015-11-24
Dissolved Selenium (Se)	mg/L	<0.0020	<0.0020	<0.0020	<0.010	<0.010	<0.0020	<0.010
Dissolved Silicon (Si)	mg/L	6	3.2	7.7	4.5	5.7	4.2	4.6
Dissolved Silver (Ag)	mg/L	<0.00010	<0.00010	0.00012	0.00059	0.00099	0.00024	<0.00050
Dissolved Sodium (Na)	mg/L	120	640	160	1300	960	870	770
Dissolved Strontium (Sr)	mg/L	3.9	10	9.4	38	21	25	14
Dissolved Sulphate (SO4)	mg/L	99	380	290	220	250	210	250
Dissolved Tellurium (Te)	mg/L	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.0010	<0.0050
Dissolved Thallium (Tl)	mg/L	0.00008	0.00018	0.00006	<0.00025	<0.00025	<0.000050	<0.00025
Dissolved Tin (Sn)	mg/L	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.0010	<0.0050
Dissolved Titanium (Ti)	mg/L	<0.0050	<0.0050	0.0062	<0.025	<0.025	<0.0050	<0.025
Dissolved Tungsten (W)	mg/L	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.0010	<0.0050
Dissolved Uranium (U)	mg/L	0.01	0.013	0.012	0.017	0.016	0.012	0.013
Dissolved Vanadium (V)	mg/L	0.00091	0.0015	0.0063	<0.0050	0.011	<0.0025	<0.0025
Dissolved Zinc (Zn)	mg/L	0.0096	<0.0050	0.019	<0.025	<0.025	<0.0050	0.029
Dissolved Zirconium (Zr)	mg/L	<0.0010	<0.0010	0.0019	<0.0050	<0.0050	<0.0010	<0.0050
Fluoride (F-)	mg/L	0.34	1.58	1.17	0.33	0.37	0.28	0.42
Hardness (CaCO3)	mg/L	480	670	600	3600	2200	2400	1400
Nitrate (N)	mg/L	0.8	1.2	0.88	0.72	0.22	0.43	0.15
Nitrate + Nitrite	mg/L	0.82	1.2	0.88	0.72	0.22	0.45	0.15
Nitrite (N)	mg/L	0.019	<0.010	<0.010	<0.010	<0.010	0.021	<0.010
Orthophosphate (P)	mg/L	<0.010	<0.010	<0.010	<0.010	0.002	0.02	0.007
pH	pH	7.86	7.94	7.74	7.41	7.66	7.59	7.64
Reactive Silica (SiO2)	mg/L	13	6.8	9.4	7.8	10	8.1	10
Total Ammonia-N	mg/L	<0.050	0.12	<0.050	0.089	0.073	<0.050	<0.050
Total Dissolved Solids	mg/L	844	2230	1240	9750	6870	6150	3870
Total Kjeldahl Nitrogen (TKN)	mg/L	1.9	3.5	2.3	8.7	<2.0	0.57	0.53
Total Phosphorus	mg/L	0.8	1.7	0.96	0.72	0.73	0.4	2.5

Table 6: MW-7 groundwater chemistry results from 2016 to 2018.

Parameter	Units	MW-7 Sample Date						
		2016-06-09	2016-10-26	2017-01-13	2017-03-30	2017-11-15	2018-05-24	2018-11-08
Alkalinity (Total as CaCO3)	mg/L	290	310	300	290	330	650	740
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	290	310	300	290	330	650	740
Carb. Alkalinity (calc. as CaCO3)	mg/L	1.7	1.3	1.3	1.3	2.1	1.1	1.2
Conductivity	umho/cm	7200	5400	5400	6200	4200	10000	9400
Dissolved Aluminum (Al)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050		<0.0050	0.0064
Dissolved Antimony (Sb)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050
Dissolved Arsenic (As)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Barium (Ba)	mg/L	0.15	0.13	0.12	0.13		0.2	0.19
Dissolved Beryllium (Be)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050
Dissolved Bismuth (Bi)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Boron (B)	mg/L	0.18	0.24	0.18	0.14		0.18	0.19
Dissolved Cadmium (Cd)	mg/L	<0.00010	<0.00010	<0.00010	0.00028		0.0001	<0.00010
Dissolved Calcium (Ca)	mg/L	320	220	240	260		460	330
Dissolved Chloride (Cl)	mg/L	2200	1500	1500	1700	1000	3300	2700
Dissolved Chromium (Cr)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050		<0.0050	<0.0050
Dissolved Cobalt (Co)	mg/L	<0.0010	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050
Dissolved Copper (Cu)	mg/L	<0.0010	<0.0050	<0.0010	0.001		0.0017	0.0022
Dissolved Inorganic Carbon (C)	mg/L	73	76	73	69	79	180	190
Dissolved Iron (Fe)	mg/L	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10
Dissolved Lead (Pb)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050
Dissolved Lithium (Li)	mg/L	0.1	0.1	0.088	0.083		0.064	0.063
Dissolved Magnesium (Mg)	mg/L	200	150	150	160		190	150
Dissolved Manganese (Mn)	mg/L	<0.0020	0.0064	0.0039	<0.0020		1.8	2.4
Dissolved Molybdenum (Mo)	mg/L	0.0067	0.011	0.0082	0.0059		0.0024	0.0033
Dissolved Nickel (Ni)	mg/L	0.0022	0.0019	0.0011	<0.0010		0.0034	0.0039
Dissolved Organic Carbon	mg/L	1.5	1.3	1.2	1.1	1.4	4.4	5.1
Dissolved Phosphorus (P)	mg/L	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10
Dissolved Potassium (K)	mg/L	22	22	17	16		16	15

Parameter	Units	MW-7 Sample Date						
		2016-06-09	2016-10-26	2017-01-13	2017-03-30	2017-11-15	2018-05-24	2018-11-08
Dissolved Selenium (Se)	mg/L	<0.0020	<0.0020	<0.0020	<0.0020		<0.0020	<0.0020
Dissolved Silicon (Si)	mg/L	4.6	5.4	4.3	4		5.6	5.7
Dissolved Silver (Ag)	mg/L	0.00011	<0.00010	<0.00010	<0.00010		<0.00010	<0.00010
Dissolved Sodium (Na)	mg/L	870	630	630	720		1600	1500
Dissolved Strontium (Sr)	mg/L	15	11	10	11		11	9.4
Dissolved Sulphate (SO4)	mg/L	220	220	210	190	190	210	180
Dissolved Tellurium (Te)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Thallium (Tl)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050	<0.000050
Dissolved Tin (Sn)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Titanium (Ti)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050		<0.0050	<0.0050
Dissolved Tungsten (W)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Uranium (U)	mg/L	0.011	0.011	0.011	0.01		0.011	0.011
Dissolved Vanadium (V)	mg/L	<0.0025	<0.0010	<0.0025	<0.00050		<0.00050	<0.00050
Dissolved Zinc (Zn)	mg/L	0.0062	<0.0050	<0.0050	<0.0050		0.011	0.0078
Dissolved Zirconium (Zr)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Fluoride (F-)	mg/L	0.36	0.53	0.35	0.36	0.44	0.28	0.23
Hardness (CaCO3)	mg/L	1600	1200	1200	1300	790	1900	1400
Nitrate (N)	mg/L	0.56	0.35	0.46	0.75	0.62	0.34	<0.10
Nitrate + Nitrite	mg/L	0.56	0.35	0.46	0.75	0.62	0.34	<0.10
Nitrite (N)	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Orthophosphate (P)	mg/L	0.05	0.006	0.006	0.1	0.009	0.012	0.016
pH	pH	7.81	7.66	7.65	7.67	7.82	7.26	7.22
Reactive Silica (SiO2)	mg/L	8.6	11	8.5	8.2	8.9	9.8	11
Total Ammonia-N	mg/L	0.065	<0.050	<0.050	<0.050	0.02	0.25	0.22
Total Dissolved Solids	mg/L	4200	3770	3310	3810	2190	6800	5440
Total Kjeldahl Nitrogen (TKN)	mg/L	0.18	0.22	0.11	<0.10	0.26	0.4	0.23
Total Phosphorus	mg/L	1.3	0.14	7.6	0.59	0.8	0.28	0.15

Table 7: MW-8 groundwater chemistry results from 2012 to 2015.

Parameter	Units	MW-8 Sample Date						
		2012-06-11	2013-04-18	2013-11-12	2014-05-29	2014-10-22	2015-05-28	2015-11-24
Alkalinity (Total as CaCO3)	mg/L	340	320	290	320	350	320	340
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	340	310	290	320	340	320	340
Carb. Alkalinity (calc. as CaCO3)	mg/L	3	2.7	1.4	2	2.6	2.5	2.9
Conductivity	umho/cm	780	760	1600	750	860	790	940
Dissolved Aluminum (Al)	mg/L	<0.0050	0.0051	<0.0050	0.018	<0.0050	0.67	<0.0050
Dissolved Antimony (Sb)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Dissolved Arsenic (As)	mg/L	0.0038	0.0056	0.004	0.0035	0.0053	0.0069	0.0073
Dissolved Barium (Ba)	mg/L	0.041	0.035	0.1	0.04	0.045	0.052	0.049
Dissolved Beryllium (Be)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Dissolved Bismuth (Bi)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Dissolved Boron (B)	mg/L	1.5	1.3	1.2	1.5	1.9	1.6	2
Dissolved Cadmium (Cd)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Dissolved Calcium (Ca)	mg/L	42	45	88	38	45	41	46
Dissolved Chloride (Cl)	mg/L	13	23	270	17	32	29	62
Dissolved Chromium (Cr)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Dissolved Cobalt (Co)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00085	<0.00050
Dissolved Copper (Cu)	mg/L	<0.0010	0.0012	0.0015	<0.0010	<0.0010	0.002	<0.0010
Dissolved Inorganic Carbon (C)	mg/L	85	78	65	75	84	81	86
Dissolved Iron (Fe)	mg/L	0.33	<0.10	<0.10	<0.10	0.1	1	<0.10
Dissolved Lead (Pb)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00079	<0.00050
Dissolved Lithium (Li)	mg/L	0.096	0.074	0.062	0.095	0.098	0.094	0.099
Dissolved Magnesium (Mg)	mg/L	21	17	43	18	24	17	21
Dissolved Manganese (Mn)	mg/L	0.03	0.014	0.077	0.027	0.024	0.069	0.021
Dissolved Molybdenum (Mo)	mg/L	0.01	0.0096	0.01	0.01	0.01	0.0082	0.01
Dissolved Nickel (Ni)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0018	<0.0010
Dissolved Organic Carbon	mg/L	1.2	2.7	6.8	2.1	2	2.3	1.5
Dissolved Phosphorus (P)	mg/L	<0.10	0.32	<0.10	<0.10	<0.10	0.12	<0.10
Dissolved Potassium (K)	mg/L	20	26	34	18	22	17	21

Parameter	Units	MW-8 Sample Date						
		2012-06-11	2013-04-18	2013-11-12	2014-05-29	2014-10-22	2015-05-28	2015-11-24
Dissolved Selenium (Se)	mg/L	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Dissolved Silicon (Si)	mg/L	4.9	4.1	5.3	4.7	5.7	5	5
Dissolved Silver (Ag)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Dissolved Sodium (Na)	mg/L	98	88	100	99	110	110	120
Dissolved Strontium (Sr)	mg/L	7.6	4.2	9.6	6.4	7.3	5.8	7.1
Dissolved Sulphate (SO4)	mg/L	52	49	48	47	53	49	55
Dissolved Tellurium (Te)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Dissolved Thallium (Tl)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Dissolved Tin (Sn)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Dissolved Titanium (Ti)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Dissolved Tungsten (W)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Dissolved Uranium (U)	mg/L	0.00051	0.00073	0.0053	0.00026	0.00036	0.00056	0.00052
Dissolved Vanadium (V)	mg/L	<0.00050	0.0015	0.0015	<0.00050	0.0021	0.0018	<0.00050
Dissolved Zinc (Zn)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0066	<0.0050
Dissolved Zirconium (Zr)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Fluoride (F-)	mg/L	0.53	0.44	0.31	0.52	0.53	0.52	0.53
Hardness (CaCO3)	mg/L	190	180	400	170	210	170	200
Nitrate (N)	mg/L	<0.10	1.3	0.58	<0.10	0.26	0.6	0.21
Nitrate + Nitrite	mg/L	<0.10	1.5	0.67	0.14	0.41	0.67	0.35
Nitrite (N)	mg/L	0.026	0.15	0.096	0.048	0.153	0.066	0.144
Orthophosphate (P)	mg/L	<0.010	0.34	0.085	0.027	0.026	0.044	0.029
pH	pH	7.97	7.96	7.7	7.82	7.9	7.92	7.95
Reactive Silica (SiO2)	mg/L	11	9.2	10	9.7	11	8.8	11
Total Ammonia-N	mg/L	1.7	1.7	1	1.8	2	1.6	1.8
Total Dissolved Solids	mg/L	456	524	932	562	540	574	574
Total Kjeldahl Nitrogen (TKN)	mg/L	2.4	16	34	17	5.1	2.1	1.9
Total Phosphorus	mg/L	1	8.1	14	0.87	1.3	1.5	1.1

Table 8: MW-8 **g**roundwater chemistry results from 2016 to 2018.

Parameter	Units	MW-8 Sample Date						
		2016-06-09	2016-10-26	2017-01-13	2017-03-30	2017-11-15	2018-05-24	2018-11-08
Alkalinity (Total as CaCO3)	mg/L	330	350	280	320	360	330	340
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	320	350	280	320	350	330	340
Carb. Alkalinity (calc. as CaCO3)	mg/L	3.8	3	1.9	2.3	3.1	2.4	2.3
Conductivity	umho/cm	790	840	910	1100	900	880	870
Dissolved Aluminum (Al)	mg/L	0.066	<0.0050	0.0086	0.006		0.22	<0.0050
Dissolved Antimony (Sb)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050
Dissolved Arsenic (As)	mg/L	0.0038	0.0065	0.0041	0.0031		0.0026	0.0042
Dissolved Barium (Ba)	mg/L	0.042	0.046	0.037	0.045		0.056	0.044
Dissolved Beryllium (Be)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050
Dissolved Bismuth (Bi)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Boron (B)	mg/L	1.7	2	1.2	1.6		1.6	1.6
Dissolved Cadmium (Cd)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010	<0.00010
Dissolved Calcium (Ca)	mg/L	39	42	43	49		47	43
Dissolved Chloride (Cl)	mg/L	25	24	87	130	37	46	43
Dissolved Chromium (Cr)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050		<0.0050	<0.0050
Dissolved Cobalt (Co)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050
Dissolved Copper (Cu)	mg/L	<0.0010	<0.0010	0.003	0.0016		0.0015	0.0014
Dissolved Inorganic Carbon (C)	mg/L	78	86	66	77	83	79	82
Dissolved Iron (Fe)	mg/L	<0.10	<0.10	<0.10	<0.10		0.23	<0.10
Dissolved Lead (Pb)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050
Dissolved Lithium (Li)	mg/L	0.097	0.11	0.068	0.093		0.12	0.11
Dissolved Magnesium (Mg)	mg/L	17	19	18	21		24	21
Dissolved Manganese (Mn)	mg/L	0.026	0.02	0.0065	0.01		0.016	0.019
Dissolved Molybdenum (Mo)	mg/L	0.011	0.011	0.0086	0.01		0.01	0.0096
Dissolved Nickel (Ni)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Organic Carbon	mg/L	2.1	1.1	6.1	3.1	1.4	1.4	2.5
Dissolved Phosphorus (P)	mg/L	<0.10	<0.10	<0.10	0.13		<0.10	<0.10
Dissolved Potassium (K)	mg/L	18	23	15	18		18	22

Parameter	Units	MW-8 Sample Date						
		2016-06-09	2016-10-26	2017-01-13	2017-03-30	2017-11-15	2018-05-24	2018-11-08
Dissolved Selenium (Se)	mg/L	<0.0020	<0.0020	<0.0020	<0.0020		<0.0020	<0.0020
Dissolved Silicon (Si)	mg/L	4.9	5.6	4.1	4.8		5.3	5
Dissolved Silver (Ag)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010	<0.00010
Dissolved Sodium (Na)	mg/L	97	110	120	130		110	110
Dissolved Strontium (Sr)	mg/L	6.1	7	4.6	6.3		6.1	7.1
Dissolved Sulphate (SO4)	mg/L	50	55	51	56	59	52	58
Dissolved Tellurium (Te)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Thallium (Tl)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050	<0.000050
Dissolved Tin (Sn)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Titanium (Ti)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050		<0.0050	<0.0050
Dissolved Tungsten (W)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Dissolved Uranium (U)	mg/L	0.00039	0.00034	0.0013	0.0011		0.0016	0.00096
Dissolved Vanadium (V)	mg/L	0.00058	<0.00050	0.001	0.00068		0.00085	<0.00050
Dissolved Zinc (Zn)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050		0.011	<0.0050
Dissolved Zirconium (Zr)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Fluoride (F-)	mg/L	0.6	0.59	0.46	0.5	0.54	0.48	0.54
Hardness (CaCO3)	mg/L	170	180	180	210	180	220	190
Nitrate (N)	mg/L	1.09	0.15	1.45	1.68	0.13	<1.0	0.25
Nitrate + Nitrite	mg/L	1.39	0.28	1.54	1.75	0.15	1.1	0.37
Nitrite (N)	mg/L	0.293	0.133	0.09	0.067	0.022	0.11	0.12
Orthophosphate (P)	mg/L	0.08	0.015	0.16	0.54	0.021	0.04	0.058
pH	pH	8.09	7.95	7.87	7.88	7.98	7.89	7.85
Reactive Silica (SiO2)	mg/L	9.7	11	8.6	11	10	9.7	11
Total Ammonia-N	mg/L	1.8	1.9	0.94	1.2	1.8	1.5	1.9
Total Dissolved Solids	mg/L	550	486	680	1070	340	770	530
Total Kjeldahl Nitrogen (TKN)	mg/L	1.6	2	1.4	1.6	2	1.7	1.8
Total Phosphorus	mg/L	6.7	0.48	2.1	1.6	0.51	1.1	0.2

Appendix G:

Inspection Forms
February 2022

LID Inspection Checklist

Site: IX-2 Bioswale and Sorptive Media
Inspector: ______________________
Date: __________________________

Site Characteristics:

IX-2 Bioswale and Sorptive Media	
Drainage Area	South-west corner of parking lot
Soil Media	Engineered bioretention mix
Pretreatment	Bioswale
Hydraulic Configuration	Online
Inlet Type	Curb cuts from parking lot

Contributing Drainage Area:		**Category:**	**Notes:**
% of Trash/Debris Present	0% --- 5% --- 10% --- 15% --- 20% +		
% of Sediment Accumulation	0% --- 5% --- 10% --- 15% --- 20% +		
Inlets to Bioswale:			
% of Trash/Debris Present	0% --- 5% --- 10% --- 15% --- 20% +		
% of Sediment Accumulation	0% --- 5% --- 10% --- 15% --- 20% +		
% of Erosion	0% --- 5% --- 10% --- 15% --- 20% +		
Structural damage?	Yes or No		
Is inlet clear and able to accept incoming flow?	Yes or No		
Facility:			
% of Trash/Debris Present	0% --- 5% --- 10% --- 15% --- 20% +		
Evidence of Ponding	Yes or No		
% of Area Ponding	0% --- 5% --- 10% --- 15% --- 20% +		
Approximate Depth of Ponding	______________________		
% of Bare/Exposed Soil	0% --- 5% --- 10% --- 15% --- 20% +		

% of Sediment Accumulation	0% --- 5% --- 10% --- 15% --- 20% +
% of Erosion	0% --- 5% --- 10% --- 15% --- 20% +

Inlets to Sorptive Media:

% of Trash/Debris Present	0% --- 5% --- 10% --- 15% --- 20% +		
% of Sediment Accumulation	0% --- 5% --- 10% --- 15% --- 20% +		
% of Erosion	0% --- 5% --- 10% --- 15% --- 20% +		
Structural damage?	Yes	or	No
Is inlet clear and able to accept incoming flow?	Yes	or	No

Outlet:

% of Trash/Debris Present	0% --- 5% --- 10% --- 15% --- 20% +		
% of Erosion	0% --- 5% --- 10% --- 15% --- 20% +		
% of Sediment Accumulation	0% --- 5% --- 10% --- 15% --- 20% +		
Structural damage?	Yes	or	No
Is outlet clear and able to accept overflow?	Yes	or	No

Vegetation (changes seasonally):

% Vegetation Cover	0% --- 5% --- 10% --- 15% --- 20% +
% Dead Vegetation	0% --- 5% --- 10% --- 15% --- 20% +
% of Invasives/Weeds	0% --- 5% --- 10% --- 15% --- 20% +

Winter Conditions:

% Snow Cover	0% --- 5% --- 10% --- 15% --- 20% +
Approximate Depth of Snow	________________________

Maintenance:

Is maintenance required? Yes or No

What needs to be done? ______________________

How much time was spent on maintenance? ______________________

Regular maintenance, long-term maintenance or emergency maintenance? ______________________

Who is responsible? ______________________

How often is regular maintenance done? ______________________

Photos:

Number of Photo	Description/Notes

Site Comments:

LID Inspection Checklist

Site: IX-3 Bioswale and Jellyfish Unit
Inspector: ______________________
Date: __________________________

Site Characteristics:

IX-3 Bioswale and Jellyfish Unit	
Drainage Area	South middle section of parking lot
Soil Media	Engineered bioretention mix
Pretreatment	Bioswale
Hydraulic Configuration	Online
Inlet Type	Curb cuts from parking lot

Contributing Drainage Area: **Category:** **Notes:**

% of Trash/Debris Present 0% --- 5% --- 10% --- 15% --- 20% +

% of Sediment Accumulation 0% --- 5% --- 10% --- 15% --- 20% +

Inlets to Bioswale:

% of Trash/Debris Present 0% --- 5% --- 10% --- 15% --- 20% +

% of Sediment Accumulation 0% --- 5% --- 10% --- 15% --- 20% +

% of Erosion 0% --- 5% --- 10% --- 15% --- 20% +

Structural damage? Yes or No

Is inlet clear and able to accept incoming flow? Yes or No

Facility:

% of Trash/Debris Present 0% --- 5% --- 10% --- 15% --- 20% +

Evidence of Ponding Yes or No

% of Area Ponding 0% --- 5% --- 10% --- 15% --- 20% +

Approximate Depth of Ponding ______________________

% of Bare/Exposed Soil 0% --- 5% --- 10% --- 15% --- 20% +

% of Sediment Accumulation	0% --- 5% --- 10% --- 15% --- 20% +
% of Erosion	0% --- 5% --- 10% --- 15% --- 20% +

Inlets to Jellyfish Unit:

% of Trash/Debris Present	0% --- 5% --- 10% --- 15% --- 20% +
% of Sediment Accumulation	0% --- 5% --- 10% --- 15% --- 20% +
% of Erosion	0% --- 5% --- 10% --- 15% --- 20% +
Structural damage?	Yes or No
Is inlet clear and able to accept incoming flow?	Yes or No

Outlet:

% of Trash/Debris Present	0% --- 5% --- 10% --- 15% --- 20% +
% of Erosion	0% --- 5% --- 10% --- 15% --- 20% +
% of Sediment Accumulation	0% --- 5% --- 10% --- 15% --- 20% +
Structural damage?	Yes or No
Is outlet clear and able to accept overflow?	Yes or No

Vegetation (changes seasonally):

% Vegetation Cover	0% --- 5% --- 10% --- 15% --- 20% +
% Dead Vegetation	0% --- 5% --- 10% --- 15% --- 20% +
% of Invasives/Weeds	0% --- 5% --- 10% --- 15% --- 20% +

Winter Conditions:

% Snow Cover	0% --- 5% --- 10% --- 15% --- 20% +
Approximate Depth of Snow	____________________

Maintenance:

Is maintenance required? Yes or No

What needs to be done? ____________________

How much time was spent on maintenance? ____________________

Regular maintenance, long-term maintenance or emergency maintenance? ____________________

Who is responsible? ____________________

How often is regular maintenance done? ____________________

Photos:

Number of Photo	Description/Notes

Site Comments:

LID Inspection Checklist

Site: IX-4 Bioswale
Inspector: ______________________
Date: __________________________

Site Characteristics:

IX-4 Bioswale	
Drainage Area	South-east middle section of parking lot
Soil Media	Engineered bioretention mix
Pretreatment	N/A
Hydraulic Configuration	Online
Inlet Type	Curb cuts from the parking lot

Contributing Drainage Area: **Category:** **Notes:**

% of Trash/Debris Present 0% --- 5% --- 10% --- 15% --- 20% +

% of Sediment Accumulation 0% --- 5% --- 10% --- 15% --- 20% +

Inlets:

% of Trash/Debris Present 0% --- 5% --- 10% --- 15% --- 20% +

% of Sediment Accumulation 0% --- 5% --- 10% --- 15% --- 20% +

% of Erosion 0% --- 5% --- 10% --- 15% --- 20% +

Structural damage? Yes or No

Is inlet clear and able to accept incoming flow? Yes or No

Facility:

% of Trash/Debris Present 0% --- 5% --- 10% --- 15% --- 20% +

Evidence of Ponding Yes or No

% of Area Ponding 0% --- 5% --- 10% --- 15% --- 20% +

Approximate Depth of Ponding ______________________

% of Bare/Exposed Soil	0% --- 5% --- 10% --- 15% --- 20% +
% of Sediment Accumulation	0% --- 5% --- 10% --- 15% --- 20% +
% of Erosion	0% --- 5% --- 10% --- 15% --- 20% +

Outlet:

% of Trash/Debris Present	0% --- 5% --- 10% --- 15% --- 20% +
% of Erosion	0% --- 5% --- 10% --- 15% --- 20% +
% of Sediment Accumulation	0% --- 5% --- 10% --- 15% --- 20% +
Structural damage?	Yes or No
Is outlet clear and able to accept overflow?	Yes or No

Vegetation (changes seasonally):

% Vegetation Cover	0% --- 5% --- 10% --- 15% --- 20% +
% Dead Vegetation	0% --- 5% --- 10% --- 15% --- 20% +
% of Invasives/Weeds	0% --- 5% --- 10% --- 15% --- 20% +

Winter Conditions:

% Snow Cover	0% --- 5% --- 10% --- 15% --- 20% +
Approximate Depth of Snow	______________________

Maintenance:

Is maintenance required?	Yes or No
What needs to be done?	______________________
How much time was spent on maintenance?	______________________
Regular maintenance, long-term maintenance or emergency maintenance?	______________________
Who is responsible?	______________________

How often is regular maintenance done? ____________________

Photos:

Number of Photo	Description/Notes

Site Comments:

LID Inspection Checklist

Site: IX-5 Permeable Pavement with Granular "O"
Inspector: ______________________
Date: __________________________

Site Characteristics:

IX-5 Permeable Pavement with Granular "O"	
Drainage Area	North-west section of parking lot
Soil Media	N/A
Pretreatment	N/A
Hydraulic Configuration	Online
Inlet Type	Sheet flow/direct infiltration

Permeable Pavement:		**Category:**	**Notes:**
% of Trash/Debris Present	0% --- 5% --- 10% --- 15% --- 20% +		
% of Sediment Accumulation	0% --- 5% --- 10% --- 15% --- 20% +		
Structural damage?	Yes or No		
Area of broken/cracked/ heaving pavers or curbs?	0% --- 5% --- 10% --- 15% --- 20% +		
Evidence of Clogging	Yes or No		

Outlet:

% of Trash/Debris Present	0% --- 5% --- 10% --- 15% --- 20% +		
% of Erosion	0% --- 5% --- 10% --- 15% --- 20% +		
% of Sediment Accumulation	0% --- 5% --- 10% --- 15% --- 20% +		
Structural damage?	Yes or No		
Is outlet clear and able to accept overflow?	Yes or No		

Winter Conditions:

% Snow Cover	0% --- 5% --- 10% --- 15% --- 20% +		

Approximate Depth of Snow ______________________

Maintenance:

Is maintenance required? Yes or No

What needs to be done? ______________________

How much time was spent on maintenance? ______________________

Regular maintenance, long-term maintenance or emergency maintenance? ______________________

Who is responsible? ______________________

How often is regular maintenance done? ______________________

Photos:

Number of Photo	Description/Notes

Site Comments:

LID Inspection Checklist

Site: IX-6 Permeable Pavement with Clear Stone
Inspector: ______________________
Date: __________________________

Site Characteristics:

IX-6 Permeable Pavement with Clear Stone	
Drainage Area	North-east middle section of parking lot
Soil Media	N/A
Pretreatment	N/A
Hydraulic Configuration	Online
Inlet Type	Sheet flow/direct infiltration

Permeable Pavement:		**Category:**	**Notes:**
% of Trash/Debris Present	0% --- 5% --- 10% --- 15% --- 20% +		
% of Sediment Accumulation	0% --- 5% --- 10% --- 15% --- 20% +		
Structural damage?	Yes or No		
Area of broken/cracked/ heaving pavers or curbs?	0% --- 5% --- 10% --- 15% --- 20% +		
Evidence of Clogging	Yes or No		

Outlet:

% of Trash/Debris Present	0% --- 5% --- 10% --- 15% --- 20% +		
% of Erosion	0% --- 5% --- 10% --- 15% --- 20% +		
% of Sediment Accumulation	0% --- 5% --- 10% --- 15% --- 20% +		
Structural damage?	Yes or No		
Is outlet clear and able to accept overflow?	Yes or No		

Winter Conditions:

% Snow Cover	0% --- 5% --- 10% --- 15% --- 20% +		

Approximate Depth of Snow ____________________

Maintenance:

Is maintenance required? Yes or No

What needs to be done? ____________________

How much time was spent on maintenance? ____________________

Regular maintenance, long-term maintenance or emergency maintenance? ____________________

Who is responsible? ____________________

How often is regular maintenance done? ____________________

Photos:

Number of Photo	Description/Notes

Site Comments:

LID Inspection Checklist

Site: IX-7 Permeable Pavement with Clear Stone and Bentofix Liner
Inspector: ______________________
Date: __________________________

Site Characteristics:

IX-7 Permeable Pavement with Clear Stone and Bentofix Liner	
Drainage Area	North-east corner of parking lot
Soil Media	N/A
Pretreatment	N/A
Hydraulic Configuration	Online
Inlet Type	Sheet flow/direct infiltration

Permeable Pavement:		**Category:**	**Notes:**
% of Trash/Debris Present	0% --- 5% --- 10% --- 15% --- 20% +		
% of Sediment Accumulation	0% --- 5% --- 10% --- 15% --- 20% +		
Structural damage?	Yes or No		
Area of broken/cracked/ heaving pavers or curbs?	0% --- 5% --- 10% --- 15% --- 20% +		
Evidence of Clogging	Yes or No		

Outlet:

% of Trash/Debris Present	0% --- 5% --- 10% --- 15% --- 20% +		
% of Erosion	0% --- 5% --- 10% --- 15% --- 20% +		
% of Sediment Accumulation	0% --- 5% --- 10% --- 15% --- 20% +		
Structural damage?	Yes or No		
Is outlet clear and able to accept overflow?	Yes or No		

Winter Conditions:

% Snow Cover	0% --- 5% --- 10% --- 15% --- 20% +		

Approximate Depth of Snow ____________________

Maintenance:

Is maintenance required? Yes or No

What needs to be done? ____________________

How much time was spent on maintenance? ____________________

Regular maintenance, long-term maintenance or emergency maintenance? ____________________

Who is responsible? ____________________

How often is regular maintenance done? ____________________

Photos:

Number of Photo	Description/Notes

Site Comments:

LID Winter Inspection Checklist

Site: IX-2 Bioswale and Sorbtive Media
Inspector: ______________________
Date: __________________________

Site Characteristics:

IX-2 Bioswale and Sorbtive Media	
Drainage Area	South-west corner of parking lot
Soil Media	Engineered bioretention mix
Pretreatment	Bioswale
Hydraulic Configuration	Online
Inlet Type	Curb cuts from parking lot

Most recent precipitation event: Date: _________ Depth: _________ Type: _________

Contributing Drainage Area:		**Notes:**
Snow/Ice Cover		
Snow cover	0% --- 25% --- 50% --- 75% +	
Approximate depth of snow	____________________	
Ice cover	0% --- 5% --- 10% --- 15% +	
Approximate depth of ice	____________________	
Is snow being stored on the contributing drainage area?	Yes or No	
Salt		
Is road salt present?	Yes or No	
Type of salt	____________________	
% of area covered by salt granules	0% --- 15% --- 30% --- 45% +	
% of area stained by salt	0% --- 25% --- 50% --- 75% +	
Inlets to bioswale and sorbtive media:		
% of inlet blocked by snow	0% --- 25% --- 50% --- 75% +	

Is inlet able to accept incoming flow? Yes or No

Bioswale: **Notes:**

Snow cover 0% --- 25% --- 50% --- 75% +

Approximate depth of snow ____________________

Is snow being stored in the bioswale? Yes or No

Outlets in bioswale:

% of outlet blocked by snow 0% --- 25% --- 50% --- 75% +

Is outlet able to accept overflow? Yes or No

Structural Damage

Is there structural damage from winter maintenance? (i.e. scraping of asphalt caused by plowing, curb cracks, corrosion/rusting from road salt, etc.) Yes or No

Maintenance:

Is maintenance required? Yes or No

What needs to be done? ____________________

Photos:

Number of Photo	Description/Notes

Site Comments:

LID Winter Inspection Checklist

Site: IX-3 Bioswale and Jellyfish Unit
Inspector: ______________________
Date: __________________________

Site Characteristics:

IX-3 Bioswale and Jellyfish Unit	
Drainage Area	South middle section of parking lot
Soil Media	Engineered bioretention mix
Pretreatment	Bioswale
Hydraulic Configuration	Online
Inlet Type	Curb cuts from parking lot

Most recent precipitation event: Date: _________ Depth: _________ Type: _________

Contributing Drainage Area:

Notes:

Snow/Ice Cover

Snow cover	0% --- 25% --- 50% --- 75% +
Approximate depth of snow	____________________
Ice cover	0% --- 5% --- 10% --- 15% +
Approximate depth of ice	____________________
Is snow being stored on the contributing drainage area?	Yes or No

Salt

Is road salt present?	Yes or No
Type of salt	____________________
% of area covered by salt granules	0% --- 15% --- 30% --- 45% +
% of area stained by salt	0% --- 25% --- 50% --- 75% +

Inlets to bioswale and jellyfish unit:

% of inlet blocked by snow	0% --- 25% --- 50% --- 75% +

Is inlet able to accept incoming flow? Yes or No

Bioswale: **Notes:**

Snow cover 0% --- 25% --- 50% --- 75% +

Approximate depth of snow ______________________

Is snow being stored in the bioswale? Yes or No

Outlets in bioswale:

% of outlet blocked by snow 0% --- 25% --- 50% --- 75% +

Is outlet able to accept overflow? Yes or No

Structural Damage

Is there structural damage from winter maintenance? (i.e. scraping of asphalt caused by plowing, curb cracks, corrosion/rusting from road salt, etc.) Yes or No

Maintenance:

Is maintenance required? Yes or No

What needs to be done? ______________________

Photos:

Number of Photo	Description/Notes

Site Comments:

LID Winter Inspection Checklist

Site: IX-4 Bioswale
Inspector: ______________________
Date: __________________________

Site Characteristics:

IX-4 Bioswale	
Drainage Area	South-east middle section of parking lot
Soil Media	Engineered bioretention mix
Pretreatment	N/A
Hydraulic Configuration	Online
Inlet Type	Curb cuts from the parking lot

Most recent precipitation event: Date: _________ Depth: _________ Type: _________

Contributing Drainage Area:

Notes:

Snow/Ice Cover

Snow cover 0% --- 25% --- 50% --- 75% +

Approximate depth of snow ______________________

Ice cover 0% --- 5% --- 10% --- 15% +

Approximate depth of ice ______________________

Is snow being stored on the contributing drainage area? Yes or No

Salt

Is road salt present? Yes or No

Type of salt ______________________

% of area covered by salt granules 0% --- 15% --- 30% --- 45% +

% of area stained by salt 0% --- 25% --- 50% --- 75% +

Inlets to bioswale:

% of inlet blocked by snow 0% --- 25% --- 50% --- 75% +

Is inlet able to accept incoming flow? Yes or No

Bioswale: **Notes:**

Snow cover 0% --- 25% --- 50% --- 75% +

Approximate depth of snow ____________________

Is snow being stored in the bioswale? Yes or No

Outlets in bioswale:

% of outlet blocked by snow 0% --- 25% --- 50% --- 75% +

Is outlet able to accept overflow? Yes or No

Structural Damage

Is there structural damage from winter maintenance? (i.e. scraping of asphalt caused by plowing, curb cracks, corrosion/rusting from road salt, etc.) Yes or No

Maintenance:

Is maintenance required? Yes or No

What needs to be done? ____________________

Photos:

Number of Photo	Description/Notes

Site Comments:

LID Winter Inspection Checklist

Site: IX-5 Permeable Pavement with Granular "O"
Inspector: ______________________
Date: __________________________

Site Characteristics:

IX-5 Permeable Pavement with Granular "O"	
Drainage Area	North-west section of parking lot
Soil Media	N/A
Pretreatment	N/A
Hydraulic Configuration	Online
Inlet Type	Sheet flow/direct infiltration

Most recent precipitation event: Date: _________ Depth: _________ Type: _________

Permeable Pavement: **Notes:**

Snow/Ice Cover

Snow cover	0% --- 25% --- 50% --- 75% +
Approximate depth of snow	____________________
Ice cover	0% --- 5% --- 10% --- 15% +
Approximate depth of ice	____________________
Is snow being stored on the permeable pavement?	Yes or No
Is snow clogging permeable paver joints?	Yes or No

Salt

Is road salt present?	Yes or No
Type of salt	____________________
% of area covered by salt granules	0% --- 15% --- 30% --- 45% +
% of area stained by salt	0% --- 25% --- 50% --- 75% +
Is salt collecting in permeable paver joints?	Yes or No

Structural Damage **Notes:**

Is there structural damage from winter maintenance? (i.e. scraping/heaving of pavers caused by plowing, curb cracks, corrosion/rusting from road salt, etc) Yes or No

Maintenance:

Is maintenance required? Yes or No

What needs to be done? ______________________

Photos:

Number of Photo	Description/Notes

Site Comments:

LID Winter Inspection Checklist

Site: IX-6 Permeable Pavement with Clear Stone
Inspector: ______________________
Date: __________________________

Site Characteristics:

IX-6 Permeable Pavement with Clear Stone	
Drainage Area	North-east middle section of parking lot
Soil Media	N/A
Pretreatment	N/A
Hydraulic Configuration	Online
Inlet Type	Sheet flow/direct infiltration

Most recent precipitation event: Date: _________ Depth: _________ Type: _________

Permeable Pavement: **Notes:**

Snow/Ice Cover

Snow cover 0% --- 25% --- 50% --- 75% +

Approximate depth of snow ______________________

Ice cover 0% --- 5% --- 10% --- 15% +

Approximate depth of ice ______________________

Is snow being stored on the permeable pavement? Yes or No

Is snow clogging permeable paver joints? Yes or No

Salt

Is road salt present? Yes or No

Type of salt ______________________

% of area covered by salt granules 0% --- 15% --- 30% --- 45% +

% of area stained by salt 0% --- 25% --- 50% --- 75% +

Is salt collecting in permeable paver joints? Yes or No

Structural Damage

Notes:

Is there structural damage from winter maintenance? (i.e. scraping/heaving of pavers caused by plowing, curb cracks, corrosion/rusting from road salt, etc) Yes or No

Maintenance:

Is maintenance required? Yes or No

What needs to be done? ______________________

Photos:

Number of Photo	Description/Notes

Site Comments:

LID Winter Inspection Checklist

Site: IX-7 Permeable Pavement with Clear Stone and Bentofix Liner
Inspector: ______________________
Date: __________________________

Site Characteristics:

IX-7 Permeable Pavement with Clear Stone and Bentofix Liner	
Drainage Area	North-east corner of parking lot
Soil Media	N/A
Pretreatment	N/A
Hydraulic Configuration	Online
Inlet Type	Sheet flow/direct infiltration

Most recent precipitation event: Date: _________ Depth: _________ Type: _________

Permeable Pavement: **Notes:**

Snow/Ice Cover

Snow cover	0% --- 25% --- 50% --- 75% +
Approximate depth of snow	____________________
Ice cover	0% --- 5% --- 10% --- 15% +
Approximate depth of ice	____________________
Is snow being stored on the permeable pavement?	Yes or No
Is snow clogging permeable paver joints?	Yes or No

Salt

Is road salt present?	Yes or No
Type of salt	____________________
% of area covered by salt granules	0% --- 15% --- 30% --- 45% +
% of area stained by salt	0% --- 25% --- 50% --- 75% +
Is salt collecting in permeable paver joints?	Yes or No

Structural Damage

Notes:

Is there structural damage from winter maintenance? (i.e. scraping/heaving of pavers caused by plowing, curb cracks, corrosion/rusting from road salt, etc) Yes or No

Maintenance:

Is maintenance required? Yes or No

What needs to be done? ______________________

Photos:

Number of Photo	Description/Notes

Site Comments:
