NPDES PERMIT (NER210000) FOR SMALL MUNICIPAL STORM SEWER DISCHARGES TO WATERS OF THE STATE LOCATED IN DOUGLAS, SARPY, AND WASHINGTON COUNTIES OF NEBRASKA

NPDES PERMIT NUMBER 210003

2017 ANNUAL REPORT

Submitted by:

City of Papillion, Nebraska
122 East Third Street
Papillion, NE 68046

March 31, 2018

Report of Certification

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for known violations. See 18 U.S.C. 1001 and 33 U.S.C 1319, and Neb. Rev. Stat. 81-1508 thru 81-1508.02."

Signature of Authorized Representative or Cognizant Official

3/29/2018

Date

Jeffrey L. Thompson, PE, CPESC, CFM

Printed Name

Public Works Director/City Engineer

Title

A. BACKGROUND

On October 1, 2009 the Nebraska Department of Environmental Quality (NDEQ) issued a National Pollutant Discharge Elimination System (NPDES) permit NER210000 for Small Municipal Storm Sewer discharges to waters of the state located in Douglas, Sarpy, and Washington Counties of Nebraska. The co-permittees of the Papillion Creek Watershed Partnership (PCWP) currently authorized to discharge municipal storm water under this permit are Bellevue, Boys Town, La Vista, Papillion, Ralston, and Sarpy County.

The NPDES permit requires that the co-permittees submit by April 1 each year an Annual Report documenting the status of all the general programs and individual tasks contained in the Storm Water Management Plan (SWMP). This document is being submitted by the City of Papillion to meet that requirement and covers the period from January 1 – December 31, 2017.

B. COOPERATIVE AGREEMENT

The co-permittees entered into an interlocal agreement in 2001 and a continuation agreement in 2004, 2009, and 2014 that established a framework for meeting the permit requirements. The 2014 agreement was approved by the following entities Bellevue, Boys Town, La Vista, Papillion, Ralston, Sarpy County, Gretna, the Papio-Missouri Natural Resources District, and City of Omaha. These agreements identify the lead organization and the participating partners for each SWMP element and also establish a basis for cost-sharing to meet the Phase II permit requirements of the co-permittees. The 2017 annual report will address the SWMP from the 2009 permit as a new permit was established in July 2017 and the SWMP for the coordinated partners is waiting for public notice and approval.

C. PERMITTEE COORDINATION

In 2001, the PCWP began as a planning committee to assist the Phase II communities in addressing their permit application requirements. The focus of the continuation agreement reached in 2004 was on the implementation of the SWMP as incorporated in the general NPDES permit. The 2009 agreement focused on an overall watershed plan addressing water quality and water quantity for the participating members as well as a renewal of the NPDES permit and implementation of the updated SWMP. The 2014 agreement continues implementation of the watershed plan along with a renewal of the NPDES permit and an updated SWMP. A new permit was effective July 2017; however, the SWMP for the coordinated programs is waiting final approval and public notice.

The PCWP has held monthly meetings since August 2001. The meetings help to coordinate activities, identify needs consistent with the goals of the PCWP, and implement the NPDES permit's SWMP.

I. *Public Education and Outreach*

A. *Distribute informational brochures on the proper disposal of household hazardous waste and the availability of the Household Hazardous Waste Facility. Year 1-5: Print and distribute brochures.*

The Douglas-Sarpy County regional household hazardous waste (HHW) facility, UnderTheSink, opened June 1, 2005. Brochures are available at the facility for distribution and can be printed from the website www.underthesink.org. Brochures contain a variety of information about the site, including materials accepted and not accepted, hours of operation, and alternative use products. Ten (10) tours were conducted in 2017.

Keep Omaha Beautiful and the City of Omaha Stormwater staff assisted the PCWP with distribution of different types of brochures and educational information and materials throughout 2017. Brochure topics include pollution prevention, good housekeeping, pesticide, fertilizer, and household hazardous waste. They were present at community events and outreach activities where 4,856 brochures distributed on 21 various topics. Brochures and educational information were delivered to commercial and public locations around the area and presentations made to local groups, a list of locations and summary of presentations are provided in Attachment A.

In the 2017 calendar year, UnderTheSink, the household hazardous waste facility, had a total of 18,483 drop-offs resulting in a total 1,148,991 lbs. of material, an average of 5,745 lbs./day (of days accepting waste). A total weight of 185,081 lbs. of HHW was shipped offsite by the disposal contractor. Those drop-offs and that total weight can be further broken down into:

Recycling Totals in 2017:

Steel from paint and aerosol cans: 56,940 lbs.
Latex paint used with Posi-Shell at Sarpy County Landfill: 28,435 gal
Oil-based paint and flammable liquids used as industrial fuel: 13,805 gal
Antifreeze recycled: 2,940 gal
Automotive batteries: 12,935 lbs.
Fluorescent bulbs: 14,151 bulbs

Oil Totals in 2017:

Collected approximately 10,820 gal from 6,042 people
Sold a total of 4,380 gal during the summer to Tri-State Oil Reclaimers, Inc.
The remaining oil was/is being burned in the waste-oil boiler

ReStore Totals in 2017:

People who took free usable items for their own use: 11,804 persons
Weight of non-paint items taken: 226,976 lbs.
Gallons of free paint taken: 21,891 gal

This permit requirement has been met.

B. *Issue public service announcements related to stormwater protection on local TV, radio, or print outlet. Year 1-5: A summary of the activities will be included in the Annual Report.*

In addition to the distribution of educational brochures and public outreach events completed by Keep Omaha Beautiful, the City of Omaha, and PCWP entities, the Papio NRD aired public service announcements (PSAs) on local television and

radio throughout 2017 titled, “The Power of Partnership” and “It Happened Before”. These PSAs discuss the importance of working together in the watershed to address water quality and quantity. The PSAs can be viewed on the Papio NRD’s website.

This permit requirement has been met.

C. *Continue existing drain marking program to improve public awareness concerning illegal dumping utilizing volunteer services (e.g. Boy Scouts) which will address TMDL pollutants of concern. Year 1-5: Mark approximately 1,000 inlets annually and include a summary in the annual report.*

KOB continues to utilize a GIS tracking system to better direct the volunteers to areas that do not have storm drains marked. The City of Omaha has approximately 110,000 storm drains; using the GIS system should make tracking those inlets that have been marked or need marking easier to manage. KOB coordinated volunteers throughout 2017 to mark and clean storm sewer inlets. In 2017, 1,903 inlets were marked by 734 volunteers.

The City of Papillion did not mark inlets in 2017. All newly installed inlets are pre-marked.

This permit requirement has been met.

D. *Hold a Sediment and Erosion Control Seminar for the developers, builders, engineers, vendors, and graders which will address TMDL pollutants of concern. Year 1-5: Hold annual Sediment and Erosion Control Seminar. Include a summary of the approximate number of participants in the Annual Report.*

The annual Sediment and Erosion Control Seminar was held on February 2, 2017 hosted by the City of Omaha, PMRNRD, Douglas-Sarpy County Extension Office, NDEQ, NRCS, PCWP, and USACE. The seminar provided engineers, developers, and construction companies information on NPDES Phase II regulations, the PCWP’s grading permit program and sediment and erosion control BMPs. The seminar had 271 attendees.

This permit requirement has been met.

E. Work collaboratively with other community organizations to develop a campaign aimed at picking up pet waste that will address TMDL pollutants of concern. Year 1: Develop outreach material and partnerships. Year 2-5: Distribute information.

The City of Omaha hired a marketing firm, MINT Design Group, to assist in the development and implementation of pet waste campaign. Advertisements were developed and published in several area newspapers, billboard space was used, mass mailings distributed, theater advertising purchased, posters placed on litter cans, radio announcements broadcast, a television commercial produced, and other media printed. It was a very successful campaign and won the Silver Award in the Total Advertising Campaign category from the Eighth Annual Service

Industry Advertising Awards. For this reporting period, events where brochures on limiting pollution and pet waste bags were distributed are listed below:

Date	Location	Dispensers	Flyers	Activity
2/9/17	Century Link Center	0	10	Show & Garden Expo Wheeler Elementary
4/10/17	Wheeler Elementary	9	0	School Presentation
4/22/17	Elmwood Park	383	50	Earth Day Omaha
5/9/17	Elmwood Park	0	0	Together We Build a Better City
5/12/17	Zorinsky Lake	0	0	Spring into Summer
9/24/17	Nebraska Humane Society	562	15	Walk for the Animals
9/30/17	Youngman Park	0	1	Fly into Fall

In addition to the outreach activities, the City of Omaha has also collaborated with the Omaha Dog Park Advocates by installing pet waste dispensers and supplying pet waste bags for the two dog parks in Omaha. Twenty-two (22) cases of pet waste bags were used at the dog parks, equaling 70,400 bags used. The Papio NRD installed two pet waste dispensers and pet waste bags at Chalco Recreation Area in Sarpy County.

There are currently twenty-two (22) pet waste bag stations throughout the Papillion Park System.

This permit requirement has been met.

F. *Develop materials and displays associated with BMP demonstration projects installed with Stormwater Management Program Project funds from NDEQ. Year 1-5: Provide a narrative and examples of materials developed in annual report.*

Educational signage is located at the UnderTheSink Facility, Metropolitan Community College and the City of Omaha's Orchard Park, which are all accessible by the public. In 2016, signage was placed at the Creighton Prep demonstration project. Signage at these locations explains the design and function of the BMP's onsite.

The green and traditional roofs at the Saddlebrook Joint Use facility, located in Omaha's jurisdiction, have two weather monitoring stations installed. The public can view the differences between the two on two separate screens: one located in the library the other located in the stairwell outside of the indoor track. There are also webcams directed toward the green roof which will also be displayed on the screens. Information on the green roof is available through the website www.omahastormwater.org, which has a direct link from the PCWP website.

In collaboration with the US EPA Office of Research and Development, USGS, the Omaha CSO Program, and the University of Nebraska Extension, a kiosk was placed at the Douglas County Extension Office that shares real-time data of the Sewer Maintenance bio-retention and permeable pavement demonstration project installed in 2014. In 2016, the kiosk was removed from its location and stored in the EQCD offices until a program update was put onto the machine. During this time, the EPA transferred ownership of the kiosk to the University of Nebraska at

Omaha. The content on the kiosk is currently being updated and was placed on UNO's campus in 2017.

In 2016, three stormwater demonstration projects were constructed, a bio-swale and hydrodynamic separator were constructed at the City of Omaha's Vehicle Impound Lot, a sediment capture structure and drainage channel improvements were installed as part of the Hillsdale Channel Improvement project, and a green infrastructure classroom project at Dundee Elementary School was designed with construction completed in 2017.

Project fact sheets continue to be developed for Omaha Stormwater Program's demonstration projects and Omaha CSO Program green infrastructure projects to share basic information on each project with the community. Currently 15 Green Infrastructure fact sheets have been created and are available to the PCWP communities. These are shared with participants on tours and other outreach events.

The Omaha Stormwater Program's website, www.omahastormwater.org, features demonstration and other green infrastructure projects. Information provided includes photos, background information, and other specific information on them as they mature from year to year.

This permit requirement has been met.

G. *Develop a PCWP Stormwater Program Website including, but not limited to, storm water related information and provide educational information targeted for residents, children, and industries which will address TMDL pollutants of concern. Year 1-5: Develop, operate, and maintain a PCWP Stormwater website. Include narrative in the Annual Report describing the functions of the website. Ensure that the website is accessible from each community's website.*

The PCWP website, www.papiopartnership.org, includes, but is not limited to, the contact information for PCWP representatives (including links to the respective PCWP representative's websites) and the illegal dumping/illicit discharge report form, PCWP meeting minutes, upcoming meetings and outreach opportunities, PCWP permits, past reports, and studies are also available online as well as general information about the PCWP and about watersheds, best management practices, and stormwater management in general. Additional items located on the website are the current PCWP interlocal agreement, watershed management plan, implementation plan, and stormwater policies. All of which were adopted by the PCWP coordinated partners in 2014. These documents are included as Attachment B. A link is also included to the City of Omaha's stormwater website, www.omahastormwater.org.

The City of Omaha has developed and deployed a website, www.omahastormwater.org, dedicated to the City's Stormwater Management Program. From the website, industries within the PCWP can access the necessary documents to apply for stormwater permits.

Residents can access information from the City of Omaha's website as to how they can improve water quality through actions they take at home. Children's activities

are also available on the website. There is public information available on the demonstration storm water best management practices that have been implemented in areas of the city. The public can access information related to the monitoring program. Additionally, there is an online complaint or comment form available to the public. Attachment C provides the download statistics for the www.omahastormwater.org website and Omaha Stormwater Facebook Page for 2017.

The City of Papillion has a link on its website to the PCWP website at https://www.papillion.org/quicklinks.aspx?CID=95.

This permit requirement has been met.

II. ***Public Participation and Involvement***

A. *Operate a stormwater hotline and web-based complaint system for Watershed (general information, complaints, reports of illegal dumping, etc.). Year 1-5: Maintain system operation and include summary of received calls/emails in the Annual Report.*

The City of Omaha continues to maintain a phone line, 402-444-3908, for handling stormwater calls. Clerks are available during regular business hours to handle calls for the City and the PCWP member entities. The clerks answering the hotline are required to complete a form when answering the calls so that all the required information is collected. The form is tied to a database that stores all calls received and provide a mechanism for tracking calls. A representative from the City of Omaha will use the information stored in the database to direct the call to the appropriate PCWP representative or their designee.

There were zero (0) illicit discharge complaints received via the Papio Partnership website (www.papiopartnership.org) or the hotline in 2017 for our jurisdiction. Public complaints on sediment and erosion control can be logged into the erosion website (www.PCWPErosionControl.org).

This permit requirement has been met.

B. *Participate in organizing and hold open houses on Papillion Creek Watershed Partnership activities. Year 1-5: A summary of activities will be included in the Annual Report.*

The PCWP held four meetings in 2017, which are open to the public, and the minutes for those meetings are available on the PCWP website at www.papiopartnership.org.

This permit requirement has been met.

C. *Continue to implement a Stream Clean Up Day. Utilize KOB to identify stream segments in need of cleanup and request volunteers from the local area, public groups, and representatives from local area business and developments. Year 1-5: Conduct one clean-up day each year. A summary of the clean-up day activities will be included in the Annual Report.*

Keep Omaha Beautiful, Inc. (KOB) organized the 2017 Stream Clean ups. There were a total of 413 cleanup efforts throughout the year. 4,809 volunteers donated 11,914 hours collecting 3,276 bags of litter. In addition to the water courses, parks and trails were also targeted in the cleanup efforts.

This permit requirement has been met.

D. *Provide tours of UnderTheSink, household hazardous waste facility, for schools and neighborhood organizations to learn about the proper way to manage household chemicals and about stormwater treatment systems installed at the site. Year 1-5: Provide a summary of the tours conducted on an annual basis for the annual report. Document when BMPs are installed and included in the tour.*

Ten (10) tours were conducted in 2017 at UnderTheSink. Several BMPs including a series of rain gardens have been reconstructed and are included as part of the tour.

This permit requirement has been met.

E. *Hold World O! Water Festival focused on elementary school-aged children to celebrate clean water and engage in water quality-related activities. Year 1-5: Hold event annually. Report estimated number of participants in Annual Report.*

The World O! Water Festival was held on September 9, 2017 from 12 PM until 4PM at Wehrspann Lake / Chalco Hills Recreation Area. There were over 50 organizations that participated by handing out information, conducting an activity, or providing a demonstration. The number of visitors attending World O! Water in 2017 was 2,400. Information available at the event included water stewardship, recycling, water quality, and water conservation. Activities included a watershed pollution demonstrative model, canoe rides, nature hikes, science experiments, and more.

This permit requirement has been met.

F. *Participate in community organizations, conferences, workshops and web casts related to water quality and stormwater management. Year 1-5: Report number of staff attending, dates, location, and description of events.*

A Sediment and Erosion Control seminar was held on February 2, 2017 with 271 attendees. Many special interest group meetings were conducted in 2017 on topics regarding stormwater awareness education, pollution prevention and water conservation. This effort reached a number of school students and other individuals. The Papio NRD presented stormwater related information at the Omaha Home Show on April 7-9, 2017. Industry representatives were reached through interaction and presentations at several conferences and meetings such as the Spring Stormwater Symposium, 2017 National Watershed and several presentations. In addition, webcasts were offered throughout the year to PCWP members on a variety of topics from the Center of Watershed Protection and the Papio-Missouri River Natural Resources District held a number of presentations on water quantity and water quality to community organizations. A summary of outreach activities can be found in Attachment D.

This permit requirement has been met.

III. ***Illicit Discharge Detection and Elimination***

A. *Dry-weather inspections including Physical Characteristics Examinations of storm water outfalls 72" or greater and any outfalls with documented complaints. Year 1-5: Inspect and record observations. Include a count of outfalls inspected in the Annual Report.*

Staff from the City of Papillion inspected 19 outfalls that are 72" or greater in 2017.

This permit requirement has been met.

B. *Investigate and seek resolution concerning any dry weather discharges by notifying the source that they must discontinue discharging, and initiate enforcement action consistent with adopted ordinance which will also address any TMDL pollutants of concern. Any source that the applicant feels constitutes an immediate health or safety threat will be reported immediately to the NDEQ. Year 1-5: The following information will be included in the annual report: the number of process or potentially polluted wastewater sources found; the number of above resolved at local level; and the identity of any referred and/or unresolved discharge sources.*

The City of Papillion has no activity to report for 2017.

This permit requirement has been met.

C. *The applicant will perform dry weather inspection of storm water outfalls, including smaller outlets and those that discharge to lesser tributaries or other storm conduits, in response to suspect conditions and/or complaints. Year 1-5: Inspect and record observations. Include a count for outfalls inspected in the Annual Report.*

Staff from the City of Papillion inspected a total of 19 outfalls in 2017.

This permit requirement has been met.

D. *Enforce existing ordinances/regulations prohibiting illicit discharge connections to storm sewers. Year 1-5: Summarize code violations and enforcement actions taken in Annual Report.*

Dry weather discharges identified, as the outfalls are inspected will be investigated with respect to the source of the discharge. The Physical Characteristics Examination (PCE) will be completed as part of the inspection process and, if there is reason to believe that the discharge is allowable under the stormwater ordinance/regulation, the investigation will be terminated. If the PCE indicates that there may be an illicit connection, a more comprehensive investigation will be undertaken that may involve sampling the discharge, tracing the line upstream to identify potential sources, and questioning potential dischargers. If a potential

source is identified, information will be provided regarding the impact to human health and the environment to resolve the problem.

This permit requirement has been met.

E. *Maintain and prevent instances of sanitary sewer leakage into MS4 or waters of the state. Year 1-5: Summarize investigations of leakage and actions taken in Annual Report.*

There were no sanitary sewer leakage occurrences in the City of Papillion in 2017.

This permit requirement has been met.

F. *Maintain and update a sewer map of major storm water outfalls and identify the names of respective receiving waters. Year 1-5: Map will be maintained electronically on City or County GIS.*

Each community in the PCWP sends information to the Douglas or Sarpy County GIS departments where the outfall maps are maintained. The websites for Douglas and Sarpy Counties are https://www.dogis.org and http://maps.sarpy.com/html5viewer/index.html?Viewer=SIMS respectively.

This permit requirement has been met.

G. *Prevent, contain, and respond to spills in the MS4. Review, as necessary, interdepartmental SOPs with respect to spills dumping and illegal disposal that impacts the MS4. Year 1-5: Summarize number of reports of spills and actions taken in Annual Report. Identify respective Department SOP and review date in annual report*.

No spills were identified in Papillion in 2017.

This permit requirement has been met.

IV. *Construction Site Runoff Control*

A. *Maintain the PCWP construction site inspection and reporting web site and continue to make enhancements. Year 1-5: Include a narrative in the annual report about major website upgrades and the date implemented.*

The web site was upgraded for easier use in 2014 and is now able to merge information for grading and post construction permit information for the projects in the PCWP jurisdictions. The Permix website combines City of Omaha permit processes and benefits the PCWP communities by providing one location for uploading and storing information on post construction stormwater permits and grading permits.

This permit requirement has been met.

B. *Maintain a construction site inspection program that includes procedures for reporting, resolving deficiencies, and taking appropriate enforcement action*

consistent with adopted ordinances. Years 1-5: The Annual Report will contain the following information relative to this commitment: 1) the number of inspections conducted in each of the following size categories: < 5 acres and > 5 acres; and 2) the number of sites receiving enforcement actions.

Grading permits are required for all developments in the Papillion Creek Watershed and are tracked electronically on the PCWP's web based system, Permix. Omaha inspectors review weekly site inspection reports from the permittees, make periodic inspections to verify the permittee reports, notify the permittees when deficiencies are detected, and notify the permitting authority when enforcement is necessary. Priority sites are determined by the construction phase, with the initial site work being the highest priority. The goal of the construction site inspection program is to achieve voluntary compliance, but referrals will be made to NDEQ for non-complying sites not responding to local enforcement actions.

Violations processed in 2017 are referenced in Attachment E as well as a breakdown of permits and inspection reports by community. The table below summarizes PCWP construction inspections for 2017.

	City Inspection Reports	**Private Inspection Reports**
Phase I Sites (>5 acres)	1,247	7,812
Phase II Sites (<5 acres)	951	4,513
Total	2,198	12,325

This permit requirement has been met.

C. *Maintain regulations and design specifications for controlling erosion, sediment loss, and other TMDL pollutants of concern from construction sites that disturb areas of 1 acre or more. Year 1-5: Provide a narrative description of any changes implemented in sediment and erosion control regulations or design specifications in the annual report.*

In 2015, Chapters dealing with the post construction BMPs (Chapter 8) and Erosion and Sediment Control (Chapter 9) were updated in the Omaha Regional Stormwater Manual which is adopted by all members of the PCWP. The update of these chapters provides more detailed information on selection of BMPs for both post construction and erosion and sediment control as well as providing information on newer technologies and a wider variety of practices.

This permit requirement has been met.

D. *Maintain a program for performing review of Grading Permit applications to ensure compliance with applicable regulations and design specifications. Year 1 -5: Summarize the number of grading permit issued on an annual basis.*

In 2017, there were 75 Phase I grading permits and 98 Phase II grading permits issued in the PCWP communities. A breakdown of grading permits by community is shown in Attachment E.

The City of Papillion issued 10 grading permits in 2017.

This permit requirement has been met.

V. ***Post-Construction Runoff Control***

A. *Develop a guidance document for Post-Construction Stormwater Management Plan. Year 1: Revise ordinances as necessary to institute authority to require the use of post-construction stormwater controls. Year 2: Develop guidance document for Post Construction Stormwater Management Plan Year 2-5: Revise as necessary.*

Omaha has developed guidance documents and inspection forms for BMPs that are available to the PCWP members and are located on the PCWP website (www.papiopartnership.org). The post construction stormwater management web site, Permix, is active and makes the review process easier as well as provides a single location for plans, inspections, maintenance forms, etc. As mentioned earlier, chapters of the Omaha Regional Stormwater Manual have been updated to provide a more comprehensive list of BMP details and specifications. Guidance documents and the Stormwater Manual will continue to be analyzed and reviewed by all members of the PCWP to determine if updates are necessary.

This permit requirement has been met.

B. *Develop a database of existing structural BMPs (private and public) that reduce the impact of urbanization on storm water run-off and improve water quality and enhance other amenities and activities such as green space, parks and recreation, urban planning, aesthetics, and public safety. Year 2: Coordinate with engineering firms and the NRD to identify existing BMPs and their location. Year 3: Develop a database and GIS map of BMPs.*

The Permix software used for post construction stormwater permits and grading permits keeps a record of the location of each BMP installed with development by jurisdiction. This data can be used to create a GIS layer and database to identify BMPs installed.

This permit requirement has been met.

C. *Inspect annually and maintain (as necessary) the MS4 owned storm water BMP structures. Year 1 -5: List BMPs inspected and summarize maintenance activity in Annual Report.*

The City of Papillion inspected our 8 BMP structures in 2017.

This permit requirement has been met.

D. *Revise stormwater BMP maintenance and inspection plan as needed. Year 1-5: Review maintenance plan annually and include new structures. Make revisions as necessary. Report revisions and new structures in annual report.*

Stormwater BMP maintenance and inspections are ongoing in PCWP communities. The Permix website is in place to help the review process with post construction stormwater management in all the PCWP communities. This website provides a place to store documentation on the maintenance and inspections of the BMPs. The process continues to be monitored and any revisions will be reported.

This permit requirement has been met.

E. *Implement strategies, which include a combination of structural and/or non-structural BMPs appropriate for the watershed, which will address potential TMDL pollutants of concern. Non-structural BMP's, including improved planning and site design, shall be a priority. Evaluate these strategies and implement changes as necessary to improve water quality and address potential TMDL pollutants of concern. Year 1 -5: Summarize strategies in the annual report.*

The communities of the PCWP have adopted ordinances requiring the first half inch of runoff be controlled on site and that the 2-year peak flow be maintained on new development. These local ordinances are intended to address water quality in the watershed. Adopting these ordinances along with the Watershed Management Plan and Implementation Plan will address potential TMDL pollutants of concern. Stormwater policies adopted by the PCWP members also help provide strategies for improving water quality and addressing pollutants of concern. The Watershed Management Plan, Implementation Plan and Stormwater policies are included as Attachment B. Additional efforts include the development of a Natural Resources Inventory (NRI). The NRI is intended to be a tool to help the PCWP communities identify areas for preservation and priority areas for stream restoration. An initial phase of the NRI was completed in 2013 and the results presented to the PCWP. Recent efforts include a Basin wide Water Quality Management Plan for the Omaha Metro Area and larger Papio NRD basin which is funded by the PCWP, City of Omaha, Papio NRD and Nebraska Department of Environmental Quality. This plan will help identify target areas for water quality projects to address impaired waters and TMDL pollutants of concern. The plan is expected to be complete in June 2018.

This permit requirement has been met.

VI. ***Pollution Prevention/Good Housekeeping for Municipal Operations***

A. *Maintain Runoff Control Plans for all the MS4's maintenance facilities to identify BMPs implemented. Review Plan annually and update as necessary. Inspect all facilities annually. Year 1 -2: Develop Runoff Control Plan for maintenance facilities. Year 3-5: Review and Revise Runoff Control Plan. Summarize efforts in Annual Report.*

Evaluation documents for Facility Runoff Control Plans (FRCP) have been developed and templates shared with the members of the PCWP. These templates include a photo checklist, site questionnaire, facility profile sheet, hot spot checklist, photo log and a facility recommended BMP checklist. FRCPs are being developed for each facility in the PCWP communities.

This permit requirement has been met.

B. *Inspect storm sewer conduits, channels and catch basins and remove and properly dispose of sediment and debris as needed to maintain an efficient system within permitted area. Year 1 - 5: Report maintenance activities in the annual report*

In 2017, the City of Papillion cleaned the ditch at Glenwood Park, requiring 144 man hours and yielding 12 tons of debris, sand, and mud along with 1 to 2 dozen scrub trees, old growth trees, and dead trees that were ground up for mulch.

Eight man hours were spent in the northeast part of Papillion cleaning inlet throats and adjoining pipes, yielding 4 cubic yards of debris.

This permit requirement has been met.

C. *Provide training for employees to prevent pollutant runoff from municipal operations at the applicant's maintenance facilities and at field operations. Years 1 – 5: Provide training for employees and include summary in Annual Report of when training was held and number of attendees.*

Training was held for employees in all jurisdictions of the PCWP in past years. Community's facility managers were trained on Facility Runoff Control Plans and the implementation of those plans. Nineteen attendees were at the training meeting in 2012.

The City of Papillion conducts training for newly hired staff, and all staff has been through the training course.

This permit requirement has been met.

D. *Provide for street cleaning in the following areas: Residential; Business; Major Streets; and other areas in conjunction with special projects. Year 1-5: Summarize street cleaning activities in annual report.*

Miles of Streets Cleaned in 2017 (approx.)	2017 Expenditure		2018 Budget (proposed)	
780	Maint./Fuel	$7,266	Maint./Fuel	$5,000
	Labor	$4,290	Labor	$5,000
	Total	$11,556	Total	$10,000

This permit requirement has been met.

E. *The applicant's staff that applies pesticides will be trained in a certification program that complies with FIFRA regulations. Year 1-5: Report total number of Staff certified each year in the annual report.*

The City of Papillion has 9 employees who are certified in pesticide application.

This permit requirement has been met.

F. *The applicant will continue to minimize pesticide and fertilizer use on publically maintained properties. Year 1-5: Summarize efforts in annual report.*

This permit requirement has been met.

VII. ***Storm Water Monitoring Plan***

A. *The development and implementation of a BMP monitoring plan:*

Monitoring will be flow-based monitoring to assess the performance of different BMPs.

Monitoring Plan:

a. Monitoring of the BMPs is to provide more useful data than has been gathered in the past. This will provide for a more complete picture of the efficiency of various Best Management Practices in the watershed.

b. Consideration will be given to the following objectives:

i. Quantify the BMPs ability to reduce discharges to the storm sewer system.

ii. Evaluate if any improvements could be made to the BMP to increase the volume of water detained from the storm sewer system.

c. A record of the following information:

i. Narrative and quantitative data, as appropriate, for each event.

ii. A narrative description of the data and duration of the events sampled (either simulated event or real event).

The PCWP communities submitted an amendment to the SWMP element of their current permit in 2016 to allow for additional BMP monitoring in place of stream monitoring. The following two studies four studies in 2017 show the efforts in BMP monitoring, which provide base information to quantify BMP efficiency in infiltration and sediment and pollutant removal. The documents submitted to address Stormwater Monitoring Plan requirement are:

- 2017 monitoring update of infiltration report of existing bioretention, rain gardens and turf grass areas
- Poster of work done by Steve Rodie, UNO & Rachel Burns, Northwest High School of infiltration studying of rain gardens in Saddle Hills, third year
- Assessment of Green Infrastructure at Saddlebrook for 2017
- 2017 Stormwater BMP Monitoring Report

Full reports are included in the report as Attachment F.

This permit requirement has been met.

B. *Partner with local organizations, such as Nebraska Watershed Network, to evaluate the results of data collected that could provide water quality information on stream or urban aquatic fisheries.*

The Papillion Creek Partnership and the Nebraska Watershed Network continue to coordinate and support each other's efforts to obtain water quality information. Local partnerships with the University and professional community are evident in the studies included in Attachment F.

This permit requirement has been met.

C. *Use GIS to identify land use based on zoning and calculate pollutant loads from discharges of the MS4 based on literature values and precipitation data.*

In 2017, BMP monitoring occurred in several areas in an effort to gather data to better identify pollutant loads from discharges in regard to land use type. The reports in Attachment F describe varying infiltration rates and sediment and pollutant loading based on BMP location in the watershed and upstream land use. Information will continue to be gathered from the local studies and monitoring.

This permit requirement has been met.

VIII. *Fiscal Expenditures*

Pursuant to the Papillion Creek Watershed Partnership Interlocal Cooperation Agreement, the City of Papillion contributed $7,000 to the Partnership Watershed Fund in the current fiscal year (July 2017 through June 2018) and will contribute $7,000 in the upcoming fiscal year (July 2018 through June 2019). The Fund pays for the current cost of planning and implementation of Papillion's NPDES Phase II Stormwater Permit requirements.

	2017 Expenditures	2018 Planned
Administration		
Partnership Meetings/Coordination		
PCWP	$ 7,000.00	$ 7,000.00
SSWP	$ 19,000.00	$ 16,000.00
Public Education/Outreach		
Upstream	$ 11,108.00	$ -
Civic Reform	$ -	$ 5,000.00
Operation & Maintenance		
Sediment/Erosion Control Program		
Beehive	$ 4,000.00	$ 4,000.00
Material Disposal (Cleanup Days)		
Papillion Sanitation	$ 13,560.00	$ 15,000.00
Sarpy County Landfill	$ 5,548.16	$ 10,000.00
River City Recycling	$ 8,000.00	$ 8,000.00
Creek/Open Channel Maintenance		

Glenwood Hills	$ 3,600.00	$ 500.00
Lowes Ponds	$ 200.00	$ 200.00
Halleck RCB	$ 200.00	$ 200.00
Street Sweeping		
Labor	$ 4,290.00	$ 5,000.00
Maintenance/Fuel (RTA)	$ 7,266.00	$ 5,000.00
Unimproved Street Maintenance		
Husker Chem Sales/Dust Control	$ 6,640.00	$ 5,000.00
Bridge Maintenance & Rehab		
Speece Lewis	$ 20,425.00	$ 21,000.00
Sewer Maintenance		
Jochim	$ 21,166.00	$ 5,000.00
Neenah Foundry	$ 1,645.00	$ 1,500.00
Total Expenditures	$ 133,648.16	$ 118,400.00

IX. *Changes in MS4 Area*

The City of Papillion's MS4 Area expanded in 2017 due to an annexation. Please see Attachment G.

List of Attachments

Attachment A. Distribution of Brochures and Event Summary for Public Education and Outreach. Per SWMP item 1.A.

Attachment B. Interlocal Agreement, Watershed Management Plan, Implementation Plan and Stormwater Policies. Per SWMP item 1.G.

Attachment C. OmahaStormwater.org download statistics. Per SWMP item 1.G.

Attachment D. Summary of Outreach Activities. Per SWMP item 2.F.

Attachment E. Grading Permit Summary Report, Grading Inspection Reports, and Violations processed in 2017. Per SWMP item 4.B. and 4.C.

Attachment F. Evaluating Regional Rain Garden Environmental Conditions, Functional Attributes, and Plant Health: A Three-Year Study; Saddlebrook Green Infrastructure Assessment, 2017 Monitoring Summary; Saturated Hydraulic Conductivity (Infiltration) Assessment, 2017 Monitoring Executive Summary; and 2017 Stormwater BMP Monitoring Report for the City of Omaha. Per SWMP item 8. A., B. and C.

Attachment G. Map of changes in MS4 area.

Attachment H. Contract for Consultant Services Papillion - La Vista Storm Water Management 2017 Public Education & Outreach: 2017 Final Report

Attachment A

Various types of Brochures	Quantity Distributed by OSW	Quantity Distributed by KOB
OmahaPlants Postcard	64	
Bioretention Manuals	106	
Sustainable Landscapes Manual	105	
Landscape Brochure	39	
Stormwater Runoff & Pollution Brochure	847	986
Rain Barrel Brochures	548	
Storm Drain Awareness Program Brochures		
"10 Important Things" Flyer	5	
Stormwater & Dust Control Brochure	23	
Pressure Washing Brochures		
Metal Fabrication Brochure		
Proper Paint Disposal Brochures		
Restaurant Brochures		
Outdoor Event Brochures	2	
Concrete Brochures	30	
Pet Waste Flyer	76	
Rain Garden Fact Sheets	218	
Bioretention Garden Fact Sheets	67	
Bioswale Fact Sheets	32	
Green Roof Fact Sheets	59	
Downspout Disconnection Fact Sheets	106	
Permeable Pavement Fact Sheet	26	
Rain Harvesting Fact Sheets	20	
HHW: Guide to HHW	200	1,073
HHW: OmaGro	204	
HHW: Prepare Yourself for UTS & Locations	20	
Total Brochures distributed	**2,797**	**2,059**

Summary		
Total Pieces distributed	**2,797**	**2,059**
Total different brochures distributed	21	2

EVENT	DATE	ACTIVITY TYPE	LOCATION	TARGET AUDIENCE	# OF PEOPLE REACHED	# OF SEPARATE PRESENTATIONS
School Presentation	2/21/2017	Presentation/Demonstration	St. Margaret Mary's School (123 N 61st St)	Community	55	2
School Presentation	3/1/2017	Presentation/Demonstration	McMillan Junior High School (3802 Redick Ave)	Community	85	3
School Presentation	3/2/2017	Presentation/Demonstration	McMillan Junior High School (3802 Redick Ave)	Community	71	3
School Presentation	3/3/2017	Presentation/Demonstration	Wheeler Elementary (6707 S 178th St)	Community	208	2
School Presentation	3/3/17	Presentation/Demonstration	Wheeler Elementary (6707 S 178th St)	Community	104	1
School Presentation	3/8/2017	Presentation/Demonstration	Chandler View Elementary (7800 S 25th St, Bellevue - OPS)	Community	93	2
School Presentation	3/22/2017	Presentation/Demonstration	Oakdale Elementary (3534 S 108th St)	Community	46	1
School Presentation	3/24/2017	Presentation/Demonstration	St. Margaret Mary's School (123 N 61st St)	Community	63	2
School Presentation	4/3/2017	Presentation/Demonstration	McMillan Junior High School (3802 Redick Ave)	Community	67	3
School Presentation	4/4/2017	Presentation/Demonstration	McMillan Junior High School (3802 Redick Ave)	Community	77	3
UNO's 60 Minutes of Service	4/5/2017	Presentation/Demonstration	UNO Community Engagment Center (6400 So. University Dr.)	Community	58	1
School Presentation	4/7/2017	Presentation/Demonstration	Oakdale Elementary (3534 S 108th St)	Community	46	2
School Presentation	4/11/2017	Presentation/Demonstration	Northwest High School (8204 Crown Point Ave) with UNO students	Community	17	1
School Presentation	4/17/2017	Presentation/Demonstration	Oakdale Elementary (3534 S 108th St)	Community	48	2
Community Center Presentation (Preschool)	4/18/2017	Presentation/Demonstration	Kids Can (4860 Q St)	Community	32	1
School Presentation	4/19/2017	Presentation/Demonstration	House of Montessori (400 S 39th St,)	Community	35	2
School Presentation	4/25/2017	Presentation/Demonstration	Sacred Heart (2207 Wirt St)	Community	143	2
School Presentation	4/25/2017	Presentation/Demonstration	Castelar Elementary (2316 S 18th St)	Community	140	1
School Presentation	4/25/2017	Presentation/Demonstration	Legacy School (6860 N 166th Ave)	Community	40	1
UNMC Sustainability Fair	4/27/2017	Education Booth	UNMC (S 42nd St & Emile St)	Community	119	0
School Presentation	5/1/2017	Presentation/Demonstration	Burke High School (12200 Burke St)	Community	56	3
School Presentation	5/5/17	Presentation/Demonstration	Paddock Elementary (3535 Paddock Rd)	Community	12	1
School Presentation	5/16/2017	Presentation/Demonstration	Westgate Elementary (7802 Hascall St)	Community	23	1
School Presentation	5/17/17	Presentation/Demonstration	Joslyn Elementary (11220 Blondo St)	Community	69	1
School Presentation	5/19/17	Presentation/Demonstration	Mount View Elementary (5322 N 52nd St)	Community	82	4
School Presentation	5/22/17	Presentation/Demonstration	Uta Halee (10625 Calhoun Rd)	Community	5	1
School Presentation	6/9/17	Presentation/Demonstration	Boystown (13727 Flanagan Blvd)	Community	20	1
School Presentation	6/13/17	Presentation/Demonstration	Jefferson Elementary (4065 Vinton St)	Community	98	3
School Presentation	6/14/17	Presentation/Demonstration	Kellom Elementary (1311 N 24th St)	Community	7	1
School Presentation	6/16/17	Presentation/Demonstration	Dodge Elementary (3520 Maplewood Ave)	Community	98	2
School Presentation	6/19/17	Presentation/Demonstration	Boystown (13727 Flanagan Blvd)	Community	23	1
School Presentation	6/21/17	Presentation/Demonstration	Wilson Focus School (5141 F St)	Community	65	1
Metro Community College Summer Bridge Program	6/23/17	Presentation/Demonstration	Dewey Park (550 Turner Blvd)	Community	22	1
School Presentation	6/26/17	Presentation/Demonstration	Boystown (13727 Flanagan Blvd)	Community	30	1
School Presentation	6/27/17	Presentation/Demonstration	Sherman Elementary (5618 N 14th Ave)	Community	102	2
School Presentation	7/14/17	Presentation/Demonstration	Boystown (13727 Flanagan Blvd)	Community	36	1
School Presentation	7/17/2017	Presentation/Demonstration	Boystown (13727 Flanagan Blvd)	Community	35	1
General KOB Overview with Metro CC students	7/19/2017	Presentation/Demonstration	Keep Omaha Beautiful Office (1819 Farnam Street)	Community	4	1
School Presentation	7/19/2017	Presentation/Demonstration	Imagination Station (17908 Pierce Plaza)	Community	26	1
School Presentation	7/24/2017	Presentation/Demonstration	Boystown (13727 Flanagan Blvd)	Community	20	1
MavKids Camp	7/26/2017	Presentation/Demonstration	University of Nebraska Omaha (6001 Dodge St)	Community	88	2
School Presentation	7/31/2017	Presentation/Demonstration	Boystown (13727 Flanagan Blvd)	Community	36	1
School Presentation	8/7/2017	Presentation/Demonstration	Boystown (13727 Flanagan Blvd)	Community	38	1
School Presentation	8/8/2017	Presentation/Demonstration	Brownell Talbot (400 N Happy Hollow Blvd)	Community	25	1
UNO Volunteer Fair	8/23/2017	Education Booth	UNO Barbara Weitz Community Engagement Center (6400 South, U	Community	84	0
Metro Community College	8/29/2017	Presentation/Demonstration	Hanscom Park (3201 Woolworth)	Community	14	1
Northwest High School - Environmental Science Class	9/6/2017	Presentation/Demonstration	Northwest High School (8204 Crown Point Ave)	Community	31	1
Leadership Class	9/13/2017	Presentation/Demonstration	Nathan Hale Middle School (6143 Whitmore St)	Community	106	2
Volunteer Fair	9/13/2017	Education Booth	Creighton University (602 N 20th St.)	Community	55	0
Leadership Class	9/14/2017	Presentation/Demonstration	Nathan Hale Middle School (6143 Whitmore St)	Community	107	2
Northwest High School - Environmental Science Class	9/18/2017	Presentation/Demonstration	Northwest High School (8204 Crown Point Ave)	Community	26	1

IL UNO and Northwest High School	9/19/2017	Presentation/Demonstration	Northwest High School (8204 Crown Point Ave)	Community	35	1
Goldenrod Festival	9/21/2017	Education Booth	Lauritzen Gardens (100 Bancroft St)	Community	722	25
UNO Service Learning group	9/28/2017	Presentation/Demonstration	UNO Campus - Arts and Sciences Building (222 University Dr. Nort	Community	31	1
School Presentation	10/4/2017	Presentation/Demonstration	Norris Middle School (2235 S 46th St)	Community	24	1
UNO 60 Minutes of Service	10/4/2017	Presentation/Demonstration	UNO Barbara Weitz Community Engagement Center (6400 South, U	Community	34	1
School Presentation	10/9/2017	Presentation/Demonstration	Central High School (124 N 20th St)	Community	9	1
School Presentation	10/10/2017	Presentation/Demonstration	Chandler View Elementary (7800 S 25th St, Bellevue - OPS)	Community	20	1
King Science Zoology Class	10/11/2017	Presentation/Demonstration	King Science and Technology Center (3720 Florence Blvd)	Community	32	1
School Presentation	10/12/2017	Presentation/Demonstration	Sherman Elementary (5618 N 14th Ave)	Community	18	1
School Presentation	10/17/2017	Presentation/Demonstration	Chandler View Elementary (7800 S 25th St, Bellevue - OPS)	Community	96	2
School Presentation	10/18/2017	Presentation/Demonstration	Oakdale Elementary (3534 S 108th St)	Community	23	1
School Presentation	10/19/2017	Presentation/Demonstration	Ashland Park Robbins Elementary (5050 S 51st St)	Community	109	4
Norris All School Family Night	10/20/2017	Education Booth	Norris Middle School (2235 S 46th St)	Community	75	0
School Presentation	10/23/2017	Presentation/Demonstration	Spring Ridge Elementary (17830 Shadow Ridge Dr)	Community	26	1
School Presentation	10/25/2017	Presentation/Demonstration	Central High School (124 N 20th St)	Community	12	1
OPS Science Curriculum Leadership Team	11/6/2017	Presentation/Demonstration	Teacher Administrative Center (3215 Cuming St)	Community	4	1
School Presentation	11/8/2017	Presentation/Demonstration	Ashland Park Robbins Elementary (5050 S 51st St)	Community	109	4
School Presentation	11/16/2017	Presentation/Demonstration	Norris Middle School (2235 S 46th St)	Community	28	1
School Presentation	11/17/2017	Presentation/Demonstration	Norris Middle School (2235 S 46th St)	Community	29	1
Northwest Neighborhood Alliance Meeting	1/15/2017	Meeting Announcement	Saddlebrook Library (14850 Laurel Ave.)	Residential	25	1
Midtown Neighborhood Alliance Meeting	1/31/2017	Meeting Announcement	UNO's Community Engagement Center (6400 So. University Dr.)	Residential	13	1
South Omaha Neighborhood Alliance Meeting	2/2/2017	Meeting Announcement	The Salvation Army Kroc Center (2825 Y St.)	Residential	40	1
Omaha Home and Garden Expo	2/9/2017 - 2/12/2017	Education Booth	Centurylink Center Omaha (455 No. 10th St.)	Community	367	0
Downtown Kiwanis Club Meeting	2/17/2017	Presentation/Demonstration	UNO Scott Conference Center (6450 Pine St.)	Community	63	1
Kiwanis of Greater Omaha Meeting	2/20/2017	Presentation/Demonstration	German American Society (3717 S 120th St.)	Community	37	1
West Omaha Cosmpolitan Club	2/22/2017	Presentation/Demonstration	Garden Cafe Meeting Room (11040 Oak St.)	Community	23	1
North Omaha Neighborhood Alliance	2/23/2017	Meeting Announcement	Better Together Campus (3223 North 45th Street)	Residential	18	1
Omaha Spring Cleanup Kickoff Meeting	2/28/2017	Presentation/Demonstration	UNO Community Engagment Center (6400 So. University Dr.)	Residential	97	1
PEO Philanthropy Group	3/14/2017	Presentation/Demonstration	Living Faith Methodist Church (5310 S 182nd Ave)	Community	36	1
Omaha Association of Health Underwriters Meeting	3/29/2017	Presentation/Demonstration	Champions Run Golf Course (13800 Eagle Run Dr)	Commercial	84	1
Wells Fargo Volunteer Fair	3/29/2017	Education Booth	Scott Conference Center (6450 Pine St)	Community	38	0
Wells Fargo Green Team Board Meeting	4/13/2017	Presentation/Demonstration	Wells Fargo Bank (10010 Regency Cir)	Community	8	1
NE Scifest	4/20/2017	Education Booth	SAC Air Museum (28210 W Park Hwy, Ashland, NE 68003)	Community	370	0
NE Scifest	4/21/2017	Presentation/Demonstration	Durham Museum (801 S 10th St,)	Community	675	6
Earth Day Omaha	4/22/2017	Education Booth	Elmwood Park (802 S 60th St)	Community	750	0
Party for the Planet	4/22/2017	Education Booth	Henry Doorly Zoo (3701 S 10th St)	Community	350	0
TREEmendous Trees Celebration	4/27/2017	Education Booth	Lauritzen Gardens (100 Bancroft St)	Community	405	0
Work Training Class A	4/28/2017	Presentation/Demonstration	Ollie Webb Center (1941 S 42nd St #122)	Community	6	1
Downtown Omaha Inc. Membership Meeting	5/4/2017	Presentation/Demonstration	Scottish Rite Masonic Center (202 S 20th St)	Community	47	1
WCR Business Resource Luncheon	5/11/2017	Presentation/Demonstration	Champions Run Golf Course (13800 Eagle Run Dr)	Community	80	1
Spring into Summer	5/12/2017	Education Booth	Zorinsky Lake (3808 S 154th St)	Community	397	0
Work Training Class B	5/12/2017	Presentation/Demonstration	Ollie Webb Center (1941 S 42nd St #122)	Community	4	1
Omaha Jaycees Membership Meeting	5/17/2017	Presentation/Demonstration	DJ's Dugout (777 N. 114th Street)	Community	27	1
Wells Fargo Volunteer Week	6/12/17	Presentation/Demonstration	Wells Fargo Regency (10010 Regency Cir)	Community	15	1
Sustainable Spaces Community Potluck	6/22/17	Education Booth	3101 Florence Blvd.	Community	24	0
Service Learning Community Partner Fair	7/11/17	Education Booth	UNO Barbara Weitz Community Engagement Center (6400 South, U	Community	25	0
General KOB Overview with Partnership 4 Kids	7/20/2017	Presentation/Demonstration	Keep Omaha Beautiful Office (1819 Farnam Street)	Community	5	1
Girl Scout Volunteer Rally	7/24/2017	Education Booth	Ralston Arena (7300 Q St)	Community	163	0
Kinghorn Gardens Monthly Staff Meeting	8/7/2017	Presentation/Demonstration	St. Philip Neri Church (8200 N 30th St)	Community	35	1
Creighton CODA group	8/26/2017	Presentation/Demonstration	Carter Lake (809 Carter Lake Shore Dr)	Community	52	1
Boys Scouts Roundtable	9/5/2017	Meeting Announcement	Ralston High School (8969 Park Dr, Ralston)	Community	47	1
World O! Water	9/9/2017	Education Booth	Chalco Hills (8901 S 154th St)	Community	480	0
Farnam Festival	9/16/2017	Workshop	Blackstone District (39th & Farnam)	Community	350	0
Collective For Youth Site Directors Meeting	9/20/2017	Meeting Announcement	TAC Building (3215 Cuming St.)	Community	32	1
Aksarben Young Professionals Cleanup	9/22/2017	Presentation/Demonstration	Stinson Park (2285 South 67th Street)	Community	25	1

Heartland Workers Center Cleanup	9/30/2017	Presentation/Demonstration	Highland South Park (2512 D St)	Community	30	1
Durham Teacher's Night	10/6/2017	Education Booth	Durham Museum (801 S 10th St,)	Community	196	0
BIGS in Benson: Steps to a Stronger Community	10/12/2017	Education Booth	Benson Library	Community	25	1
Northwest Omaha Neighborhood Alliance Meeting	10/12/2017	Meeting Announcement	Saddlebrook Library (14850 Laurel Ave.)	Residential	15	1
Youth Fall Cleanup - Levi Carter Park Site	10/21/2017	Presentation/Demonstration	Levi Carter Park (4405 Carter Lake Shore Drive)	Community	65	1
Uta Hallee Roots and Shoots Club	11/17/2017	Presentation/Demonstration	Uta Halee (10625 Calhoun Rd)	Community	9	1
					9979	**159**

Attachment B

Attachment B

INTERLOCAL COOPERATION ACT AGREEMENT
FOR CONTINUATION OF THE
PAPILLION CREEK WATERSHED PARTNERSHIP

_____

THIS INTERLOCAL COOPERATION ACT AGREEMENT (hereinafter referred to as "**this Agreement**") is intended to create a voluntary mechanism for the purpose of addressing important subjects of concern to the interested governments (hereinafter referred to as "**the Interested Governments**") situated in whole or part within the watershed of the Papillion Creek (hereinafter referred to as "**the Watershed**"), the Interested Governments consisting of the following governmental entities, to-wit: the **CITY OF BELLEVUE**, Nebraska; the **VILLAGE OF BOYS TOWN**, Nebraska; the **CITY OF GRETNA**, Nebraska; the **CITY OF LAVISTA**, Nebraska; the **CITY OF OMAHA**, Nebraska; the **CITY OF PAPILLION**, Nebraska; the **CITY OF RALSTON**, Nebraska; the **COUNTY OF SARPY**, Nebraska; and, the **PAPIO-MISSOURI RIVER NATURAL RESOURCES DISTRICT**; provided, however, this Agreement is made and entered as an Interlocal Cooperation Act Agreement by and among only those of the Interested Governments which have duly executed this Agreement at the foot hereof, such signatory entities (hereinafter referred to collectively as "**the Parties,**" "**the Papillion Creek Watershed Partnership**" or "**the Partnership**"), thus signifying the intent of the Parties to act, and contribute their resources, as members of the "Papillion Creek Watershed Partnership," which is hereinafter defined and described.

WHEREAS, the Partnership originally was formed through an Interlocal Cooperation Act Agreement dated on August 1, 2001 (hereinafter referred to as the "**Initial Agreement**"), and expiring on July 31, 2004. An Interlocal

Cooperation Act Agreement for Continuation of the Papillion Creek Watershed Partnership was approved by the Parties in 2004 and 2009, effective July 1, 2004 and July 1, 2009 respectively, for a period of five years from and after their effective date.

WHEREAS, the Partnership has accomplished the assessment of existing water quality and quantity conditions, the cooperative preparation of NPDES Phase II Permit applications, the submittal of multiple grant applications, the analysis of additional flood control and the support of storm water utility legislation. The Partnership coordinated these issues at monthly meetings of its members' representatives. The progress of Partnership activities was presented to the public at meetings and on a website (www.papiopartnership.org);

WHEREAS, the Partnership was instrumental in the preparation of the "Partnership NPDES Phase II Storm Water Management Plan" for the Watershed, (hereinafter referred to as the **"SWMP**") a true and correct copy of which is attached to this Agreement as **Exhibit "A"** and incorporated herein by this reference;

WHEREAS, by the members of the Partnership continuing to act in concert and proposing, enacting and implementing common standards, there will be continued increases in effectiveness and in cost-sharing capability within the Partnership, particularly in the capability to implement the SWMP and to address federally-imposed requirements and mandates which are imminent and which must be funded locally;

WHEREAS, other premises that justify the continuation of the Partnership still exist, including, without limitation, that:

- The Papillion Creek does not meet water quality standards specified by the State of Nebraska;

- The City of Omaha has a current Federal mandate to reduce combined sewer overflows;
- The Watershed has not had a major widespread storm event since the 1960's;
- The hydrology of the Watershed for the Flood Insurance Study will continue to need to be updated;
- Urbanization of the Watershed and associated impervious area have increased dramatically since the 60's and 70's;
- Deposition is occurring in Watershed reservoirs at unacceptable rates;
- Currently there is inadequate funding to address storm water quantity and water quality problems within the Watershed;
- The benefits of reducing existing and future flood impacts in the Watershed include: decreased public and private property damages, reduced potential loss of life, lower flood insurance costs, decreased cost to taxpayers and public agencies for flood disaster relief;
- Improvement of water quality in streams and reservoirs will result in increased fish, aquatic, and riparian habitat; recreational improvements, reduction of reservoir operation and maintenance costs; and improved aesthetics;
- Potential increased recreational opportunities from the work of the Partnership could include: green spaces (picnic areas, outdoor activities), boating, canoeing, fishing, trail systems, riparian areas for bird watching, nature hikes, education, wildlife viewing, etc.;
- Techniques which could be employed by the Partnership include: implementation of low impact development techniques and other green infrastructure to address stormwater quality and quantity issues;

facilitation of multi-use storm water structures; pursuing establishment of stormwater utility enabling legislation; minimization of future fill and construction in the FEMA-designated floodplain/floodway in the Papillion Creek Watershed; implementing better site design that minimizes impervious surfaces, utilizes techniques to mimic natural hydrology, and approximates pre-development runoff conditions; updating hydrology to 2001 and 2040; formulating a master drainage plan for the Watershed; providing adequate construction and maintenance funding; buy-outs/relocations of structures in flood prone areas; providing increased upstream flood storage; enhancing public education and outreach; implementation of new construction site management practices; development of new development/redevelopment standards; implementation of an illicit discharge program; enhance environmental aspects of public street maintenance; reducing the environmental impacts of herbicide, pesticide, and fertilizer application; developing a water quality and quantity monitoring program; developing an industrial site inspection program; construction of retention/detention ponds designed for both water quantity and quality; restoration, creation and enhancement of wetlands; preservation of riparian areas; environmental restoration of streams; creation of buffer strips; use of grassed swales for drainageways; updating of design and construction standards; application of standardized ordinances/regulations throughout the Watershed; and, implementation of new set back ordinance/regulation and open drainage requirements;

- Standardization of the construction development permit process would reduce liability to landowners from flooding and erosion problems and reduce sediment runoff during construction;

- Continuation of a coordinated effort will improve compliance with federal, state, and local regulations,

WHEREAS, in carrying out its mission, the Partnership will work cooperatively with, but not limited to, the U.S. Army Corps of Engineers, the Metropolitan Area Planning Agency, the USDA Natural Resources Conservation Service, the Nebraska Game and Parks Commission, the Nebraska Department of Environmental Quality, the Nebraska Department of Natural Resources, the University of Nebraska, the University of Nebraska Cooperative Extension, and State and County Health Departments,

WHEREAS, as part of implementing the federally-imposed NPDES requirements where necessary, and to address stormwater management on a watershed-wide basis, a Watershed Management Plan, Implementation Plan and Stormwater Management Policies (hereinafter referred to collectively as the "**Plans and Policies**") were developed through a community-based process involving the development community, Partnership members, public agencies, non-profit organizations, other stakeholder groups and the general public. The Plans and Policies developed through the Partnership consist of six (6) Policy Groups, headed as follows:

#1 Water Quality
#2 Peak Flow Reduction
#3 Landscape Preservation, Restoration, and Conservation
#4 Erosion and Sediment Control and Other BMPs
#5 Floodplain Management
#6 Storm Water Management Financing

and the texts of the Stormwater Management Policies are attached hereto as **Exhibit "B"** and incorporated herein by this reference.

WHEREAS, The Plans and Policies are intended to be adopted, in total, by the respective members of the Partnership, using their respective land use review and adoption processes (typically reviewed by a Planning Commission or Board and then review and adoption by the elected Board or Council); provided this agreement is not meant to limit any jurisdiction from adopting comparable or more stringent Stormwater Management Policies, regulations, or ordinances.

NOW, THEREFORE, in consideration of the foregoing recitals and their mutual covenants hereinafter expressed, the members of the Partnership agree as follows:

1. **Authority**: This Agreement is an agreement for collective and cooperative action made pursuant to authority provided in the Nebraska Interlocal Cooperation Act (Neb. Rev. Stat. §13-801, R.R.S., 1943, et seq.), without a separate entity being created, and, whenever possible, this Agreement shall be construed in conformity therewith.

2. **Mission**: It shall be the mission of the Partnership to address issues related to surface water quality and storm water quantity in the Watershed by establishing and implementing regionally common goals and standards for the development of the Watershed through 2040.

3. **Applicability**: Members of the partnership having jurisdiction over land area outside the physical boundaries of the Watershed expect and intend that planning activities within the Watershed for projects of the Partnership will, insofar as feasible, apply universally to all such land areas as though they were located physically within the Watershed unless specifically excluded by the respective partnership member.

4. **Goals**: The Partnership shall have as its goals:

a) Assisting the parties that have NPDES stormwater permits in the implementation of those elements of the SWMP and other programs and projects that are reasonably and feasibly undertaken by collective action of the Partnership;

b) Compliance with Federal, State, and local storm water quality and quantity regulations;

c) Improvement of water quality in the Watershed's streams and reservoirs;

d) Increased water-based recreational opportunities that result from water quality improvements in existing streams and reservoirs and associated improvements in quality of life;

e) Standardization of the construction development process and evaluation of its effectiveness;

f) Assessment and characterization of current water quality and quantity conditions for the watershed;

g) Storm Water Management Plan update;

h) Environmental compliance;

i) Sediment and erosion control;

j) Floodplain management; and,

k) Development of and updates to the Plans and Policies.

5. Executive Committee: The members of the Partnership shall establish an Executive Committee consisting of one representative from each entity that is a member of the Partnership. Each representative shall have one vote and all actions of the Executive Committee shall require a recorded vote. A quorum (at least 50% of members) must be present for any action requiring a vote. Unless otherwise specified, a simple majority of those members present shall be required for approval of any proposed

action. It is understood that the authority of each Executive Committee member to act on behalf of his/her respective elected board or council shall be defined by that member's respective board or council.

6. Administering Agent: The Executive Committee designates the Papio-Missouri River Natural Resources District (hereinafter referred to as the "**NRD**"), or other member of the Partnership which is willing to serve in such capacity, as Administering Agent to administer this Agreement. The Administering Agent serves at the pleasure of the Executive Committee and performs duties assigned by the Executive Committee, which may include, without limitation:

a) Seeking any state legislation which a majority of the parties to this Agreement determine necessary to support the work of the Partnership;

b) Designating such personnel and assistance which shall be deemed desirable to support the work of the Partnership;

c) Preparing, presenting and distributing educational materials;

d) Organizing meetings of members of the Partnership and interested persons to share knowledge and compare projects and programs of all involved;

e) In July of each year, set meetings for one year and post those meeting dates to the Partnership website and email to the Partnership members and others.

f) Prepare written minutes of the action items and record votes for each meeting.

g) Post Partnership meeting agendas 7 days prior to meeting date on Partnership website. Action items involving an expenditure of funds may not be added to an agenda following its posting.

h) Preparing reports on the work of the Partnership;

i) Entering into contracts on behalf of the Partnership as the Executive Committee directs for the performance of specific actions consistent with both the goals of this Agreement and the respective missions of members of the Partnership;

j) Holding and maintaining the Partnership Fund, calculating the amount of money necessary to be raised by contributions each year in order to carry out the work of the Partnership, and making requests for contributions from the members of the Partnership, all as the Executive Committee directs;

k) Disbursing the Partnership Fund as directed by the Executive Committee and reimbursing members of the Partnership for expenditures made on behalf of the Partnership or for the reasonable value of activities performed on behalf of the Partnership, as reasonable value is determined by the Executive Committee.

Provided, however, and notwithstanding any provisions of this agreement to the contrary, when a member of the Partnership is acting as the Administering Agent under this Agreement and administering the directions, recommendations and requests of the Executive Committee, the governing body of the Administering Agent has the authority to make such determinations and take and implement such actions as such governing body, in its sole discretion, determines lawful, feasible and reasonable.

7. **Implementation**. The Partnership intends and agrees that the elements of the SWMP, the Plans and Policies, and other beneficial programs and projects meeting the mission and goals of this Agreement, will be implemented as follows:

a) Responsibility for implementation of an element of the SWMP therein identified solely for individual action by a Partner will rest with the respective member(s) of the Partnership upon whom the primary duty to implement such element has been imposed by law or regulation. Regulations or ordinances implementing elements of the SWMP and the Plans and Policies will be adopted by each member of the Partnership as appropriate. The provisions of such regulations or ordinances shall indicate the geographic jurisdictional limits to which such regulation or ordinance shall apply. This agreement is not meant to limit any jurisdiction from adopting comparable or more stringent Stormwater Management Policies, regulations, or ordinances.

b) Subject to the availability of funds, implementation of those elements of the SWMP therein identified for action by the Partnership or individual partners and identified in the table attached hereto as **Exhibit "C"** and incorporated herein by reference shall be voluntarily undertaken by the Partnership collectively; provided, however, no voluntary collective undertaking by the Partnership shall be deemed to relieve a member of the Partnership of a primary duty imposed upon such member by law or regulation.

c) Any elements of the SWMP, alternatively, may be voluntarily undertaken by the Partnership collectively if the Executive Committee determines that such course of action is reasonable and feasible.

d) If the Executive Committee determines that such course of action is reasonable and feasible, the Partnership may voluntarily and collectively undertake beneficial programs and projects meeting the mission and goals of this Agreement.

8. Funding: Funding shall be administered as follows:

a) The Partnership Fund, established by the Initial Agreement, shall continue to be held by the Administering Agent in an interest-bearing account in trust for the members contributing thereto, in proportion to their contributions, and shall be expended as the Executive Committee directs to meet the mission and goals of this Agreement, establishing mechanisms for long-term funding and authorization for additional planning and implementation of such programs and projects, and for performance of other activities described in this Agreement. The Partnership Fund shall be funded and administered as follows:

i) On or before the first day of July after the effective date of this Agreement, each member of the Partnership shall make a contribution to the Partnership Fund in the amount shown, opposite such member's name, in the second column of the table attached hereto as **Exhibit "D**" and incorporated herein by reference (such amount hereinafter being referred to as the "**Maximum Annual Contribution**" for such member). For subsequent years during the term of this Agreement, the Administering Agent shall request annual contributions from the members of the Partnership in the amounts necessary to carry out the work of the Partnership, the amounts of such subsequent-year contributions to be determined by the Administering Agent prior to the first day of June of such subsequent year and paid by the members of the Partnership before the first day of July of such subsequent year. These subsequent-year contributions shall be proportional to such

members' first year contributions to the Partnership Fund, provided, however, in no case shall any such requested annual contribution exceed the amount of such member's Maximum Annual Contribution.

ii) Each year during the term of this Agreement, and from time to time as any member of the Partnership may reasonably request, the Administering Agent shall furnish to the members of the Partnership written statements of the condition of the Partnership Fund.

iii) Grants or contributions made by non-members of the Partnership shall not be deemed to offset or diminish the obligations of the members of the Partnership under this Agreement.

iv) If any member of the Partnership fails to contribute to the Partnership Fund as requested pursuant to this Agreement, such member's involvement and membership in the Partnership shall be terminated upon written notice of termination given by the Administering Agent to such member.

b) The Watershed Fund shall be comprised of Watershed Management Fees and NRD general property tax dollars to equitably distribute the capital cost of implementing structural water quality and quantity controls among new development or significant redevelopment within the watershed and to the general public. Based on an initial framework and rates set for Watershed Management Fees (hereinafter referred to as "**Watershed Fees**") defined in Policy Group #6 in the Stormwater Management Policies, the Partnership

does hereby agree to implement the Watershed Management Plan and Implementation Plan, , attached hereto as **Exhibit "E"** and **Exhibit "F**" respectively, and both incorporated herein by reference, or as may be amended in three (3) to five (5) year increments through provisions in this Agreement, as follows:

i) The cities of BELLEVUE, GRETNA, LAVISTA, OMAHA, PAPILLION and RALSTON, and the County of SARPY (all hereinafter referred to collectively as "**zoning jurisdictions**") agree to collect Watershed Fees from new development or significant redevelopment within the Papillion Creek Watershed, such Watershed Fees to be collected and earmarked specifically for construction of regional detention structures and water quality basins, as follows, to-wit:

a) Each zoning jurisdiction shall adopt a regulation or ordinance authorizing the collection of the Watershed Fees, according to Exhibit G or as specified in a previous agreement, for new development and significant redevelopment and authorizing the transfer of such fees to the NRD, consistent with the provisions of this Agreement. Developing subdivisions platted prior to 2009 may be exempt from collection of Watershed Fees.

b)

c) On or before July 1st of each calendar year, each zoning jurisdiction shall remit to the NRD the Watershed Fees paid to or collected by such zoning jurisdiction on or before June 1st of such calendar year. Such Watershed Fees received by the NRD shall be held by the NRD in a

separate, interest-bearing account, to be known as the "Watershed Fund," in trust for the members of the Partnership contributing thereto in proportion to their contributions, earmarked specifically for construction by the NRD of regional detention structures and water quality basins and expended by the NRD as further provided in this Agreement.

d) Each zoning jurisdiction shall, in general, adopt a framework consisting of three Watershed Fee classifications, to-wit:

(1) "Single Family Residential Development" (generally consisting of single-family and multi-family dwelling units up to 4-plexes, or as otherwise determined by the zoning jurisdiction). It is assumed that the density of single family development will be 3.5 residential units per acre. Watershed Fees shall be assessed per dwelling unit or equivalent prorated average area of lot basis; as shown in the table in Exhibit G and,

(2) "High-Density Multi-Family Residential Development" (consisting of other multi-family residential dwelling units determined by the local zoning jurisdiction to represent High density development) shall be assessed per gross acre as shown in the table in Exhibit G and shall be proportionately indexed to "Single Family Residential Development" in terms of the

potential to generate stormwater surface runoff. Such "High-Density Development" Watershed Fees shall be 1.25 times "Single Family Residential Development" Watershed Fees when considered on an estimated dwelling unit per gross acre basis.

(3) Commercial/Industrial Development shall be assessed per gross acre as shown in the table in Exhibit G and shall be proportionately indexed to "Single Family Residential Development" in terms of the potential to generate stormwater surface runoff. Such Commercial/Industrial Watershed Fees shall be 1.5 times "Single Family Residential Development."

e) At approximately three (3) to five (5) year intervals, the Partnership and the development community shall review the Watershed Fees framework and rates, the Watershed Management Plan and the Implementation Plan with respect to availability of needed funds and rate of development within the Watershed. Subsequent changes to the Watershed Fees framework and rates, Watershed Management Plan and Implementation Plan, indicated by such review, shall be subject to formal approval by the respective local zoning jurisdictions and the NRD.

ii) The NRD agrees, subject to the availability of funding, to construct the regional detention structures and water quality

basins in accordance with the Watershed Management Plan and Implementation Plan as follows:

a) The NRD shall establish a Watershed Fund and utilize the Watershed Fees received to pay approximately one-third (1/3) of required capital costs of constructing the regional detention structures and water quality basins, including the cost of obtaining necessary land rights. The remaining approximately two-thirds (2/3) of such capital costs shall be paid by the NRD from the proceeds of its general property tax levying authority and from contributions from developers and other cooperators that the NRD may be able to obtain.

9. Title to Property. Title to any tangible property (e.g., monitoring equipment) obtained using funds contributed by members of the Partnership pursuant to this Agreement shall be held in the name of the Administering Agent in trust for the members of the Partnership in proportion to their total contributions to the Partnership Fund and Watershed Fee Fund.

10. Counterparts. This Agreement may be executed in two or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument. Counterpart copies of this Agreement, as executed, shall be maintained as part of the records of the Administering Agent.

11. Effective Date: This Agreement shall become effective on July 1, 2014.

12. Duration of Agreement: This Agreement shall be in effect for a period of five (5) years from and after its effective date.

13. **Termination**. Involvement of any member of the Partnership with the Partnership, and responsibilities under this Agreement, may be terminated by such member without cause effective upon 60 days written notice to the other members of the Partnership. Termination of a member's involvement with the Partnership pursuant to this Agreement shall not operate to terminate this Agreement nor shall it affect any rights obtained under this Agreement, prior to such notice of termination being given, for costs incurred or moneys advanced, or for actions taken or responsibilities assumed, by another member of the Partnership during the term of and pursuant to this Agreement.

14. **Additional Planning and Implementation**. The members of the Partnership may amend or supplement this Agreement from time to time as may be deemed necessary to provide long-term funding and authorization for additional planning and implementation of beneficial programs and projects to meet the mission and goals of this Agreement.

IN WITNESS WHEREOF, this Agreement is entered into by the members of the Partnership pursuant to resolutions duly adopted by their respective governing boards.

[Signature page(s) next]

INTERLOCAL COOPERATION ACT AGREEMENT
FOR CONTINUATION OF THE
PAPILLION CREEK WATERSHED PARTNERSHIP

SIGNATURE PAGE

Executed by the City of Bellevue, Nebraska on this ____ day of _____, 2014.

THE CITY OF BELLEVUE, NEBRASKA

BY _____
MAYOR

Attest:

_____
CITY CLERK

INTERLOCAL COOPERATION ACT AGREEMENT
FOR CONTINUATION OF THE
PAPILLION CREEK WATERSHED PARTNERSHIP

SIGNATURE PAGE

Executed by the Village of Boys Town, Nebraska on this ____ day of _____, 2014.

THE VILLAGE OF BOYS TOWN, NEBRASKA

BY _____
CHAIRMAN, VILLAGE BOARD

Attest:

_____
VILLAGE CLERK

INTERLOCAL COOPERATION ACT AGREEMENT
FOR CONTINUATION OF THE
PAPILLION CREEK WATERSHED PARTNERSHIP

SIGNATURE PAGE

Executed by the City of Gretna, Nebraska on this ____ day of _____, 2014.

THE CITY OF GRETNA, NEBRASKA

BY _____
MAYOR

Attest:

_____
CITY CLERK

INTERLOCAL COOPERATION ACT AGREEMENT
FOR CONTINUATION OF THE
PAPILLION CREEK WATERSHED PARTNERSHIP

SIGNATURE PAGE

Executed by the City of LaVista, Nebraska on this ____ day of _____, 2014.

THE CITY OF LAVISTA, NEBRASKA

BY_____
MAYOR

Attest:

_____
CITY CLERK

INTERLOCAL COOPERATION ACT AGREEMENT
FOR CONTINUATION OF THE

PAPILLION CREEK WATERSHED PARTNERSHIP

SIGNATURE PAGE

Executed by the City of Omaha, Nebraska on this ____ day of _____, 2014.

THE CITY OF OMAHA, NEBRASKA

BY _____
MAYOR

Attest:

_____
CITY CLERK

INTERLOCAL COOPERATION ACT AGREEMENT
FOR CONTINUATION OF THE

PAPILLION CREEK WATERSHED PARTNERSHIP

SIGNATURE PAGE

Executed by the City of Papillion, Nebraska on this ____ day of _____, 2014.

THE CITY OF PAPILLION, NEBRASKA

BY _____
MAYOR

Attest:

_____
CITY CLERK

INTERLOCAL COOPERATION ACT AGREEMENT
FOR CONTINUATION OF THE
PAPILLION CREEK WATERSHED PARTNERSHIP

SIGNATURE PAGE

Executed by the City of Ralston, Nebraska on this ____ day of _____, 2014.

THE CITY OF RALSTON, NEBRASKA

BY _____
MAYOR

Attest:

_____
CITY CLERK

INTERLOCAL COOPERATION ACT AGREEMENT
FOR CONTINUATION OF THE
PAPILLION CREEK WATERSHED PARTNERSHIP

SIGNATURE PAGE

Executed by the County of Sarpy, Nebraska on this ____ day of _____, 2014.

THE COUNTY OF SARPY, NEBRASKA

BY _____
CHAIRPERSON, COUNTY BOARD

Attest:

_____
COUNTY CLERK

INTERLOCAL COOPERATION ACT AGREEMENT
FOR CONTINUATION OF THE
PAPILLION CREEK WATERSHED PARTNERSHIP

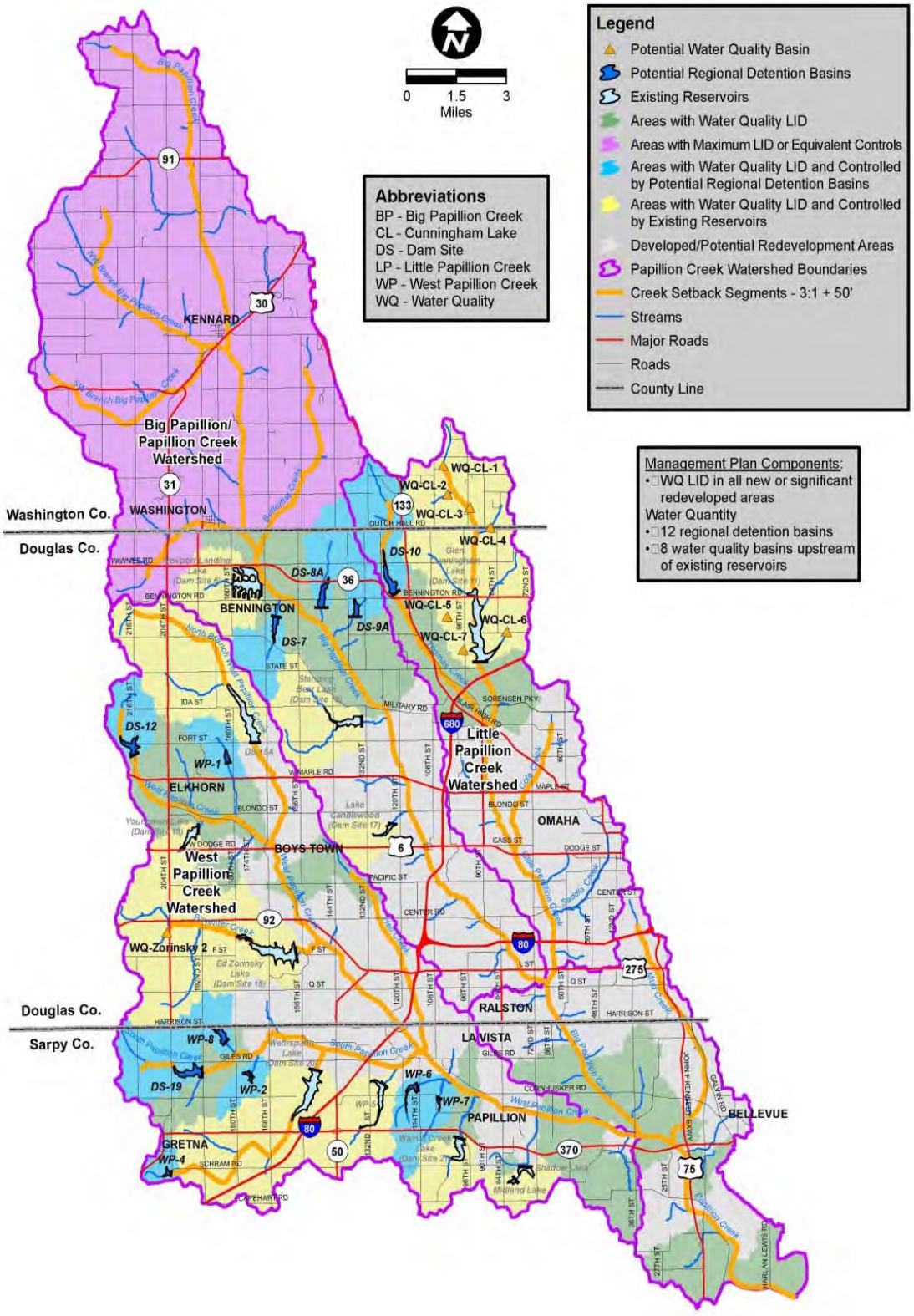
SIGNATURE PAGE

Executed by the Papio-Missouri River Natural Resources District on this ____ day of _____, 2014.

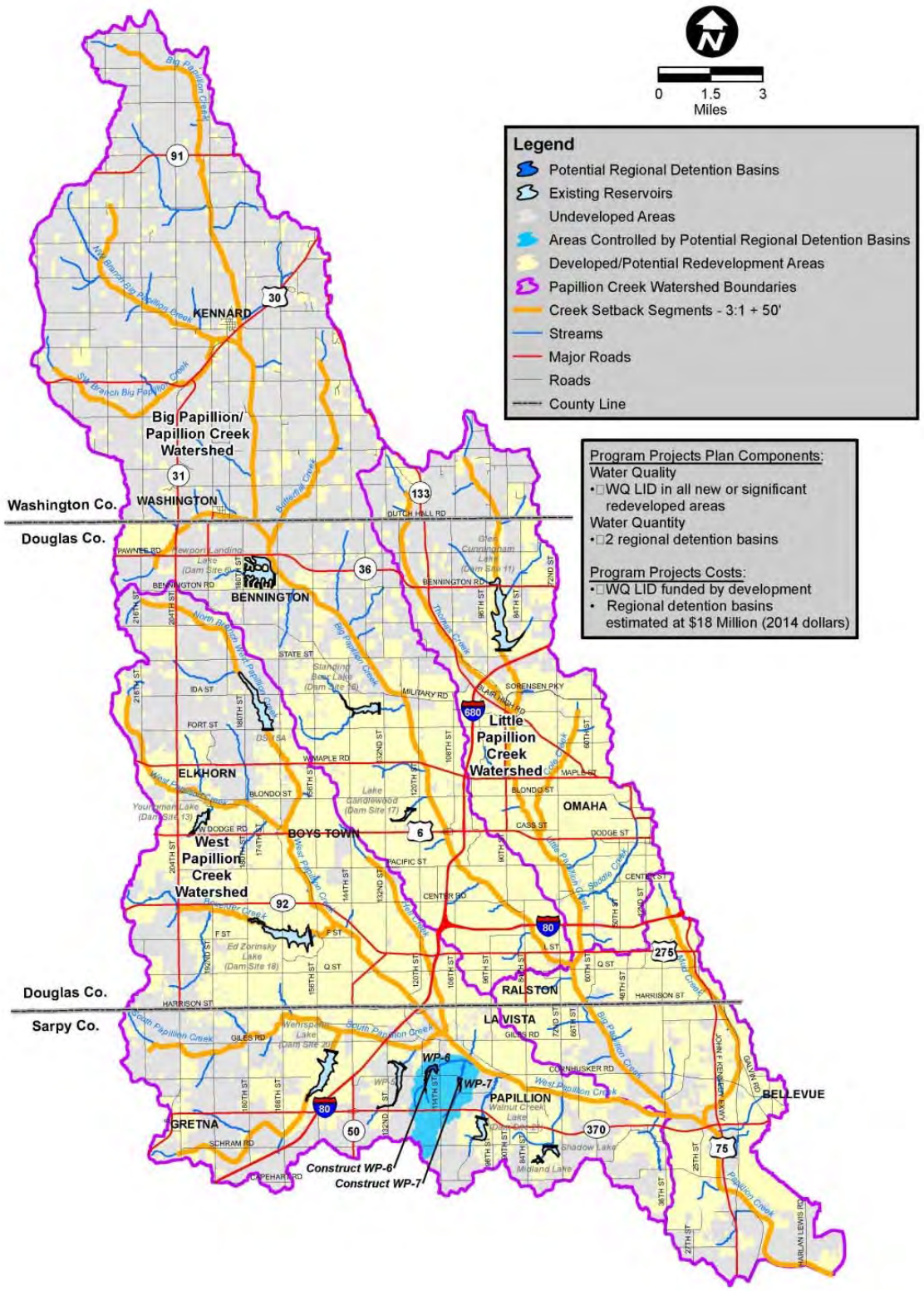
PAPIO-MISSOURI RIVER NATURAL
RESOURCES DISTRICT

BY _____
GENERAL MANAGER

2014 Watershed Management Plan Update for Full Build-Out Conditions



Papillion Creek Watershed Implementation Plan (Years 2014 to 2018)



PAPILLION CREEK WATERSHED
STORMWATER MANAGEMENT POLICIES

POLICY GROUP #1: WATER QUALITY IMPROVEMENT

ISSUE: Waters of the Papillion Creek Watershed are impaired.

"ROOT" POLICY: Improve water quality from all contributing sources, including but not limited to, agricultural activities, urban stormwater, and combined sewer overflows, such that waters of the Papillion Creek Watershed and other local watersheds can meet applicable water quality standards and community-based goals, where feasible.

SUB-POLICIES:

1) Water Quality LID shall be required on all new developments and significant redevelopments.
2) Protect surface and groundwater resources from soil erosion (sheet and rill, wind erosion, gully and stream bank erosion), sedimentation, nutrient and chemical contamination. Buffer strips and riparian corridors should be established along all stream segments.
3) Preserve and protect wetland areas to the fullest extent possible to maintain natural hydrology and improve water quality by minimizing the downstream transport of sediment, nutrients, bacteria, etc. borne by surface water runoff. Reestablishment of previously existing wetlands and the creation of new wetlands should be promoted. Any impacted wetlands shall be mitigated at a 3:1 ratio.
4) Support NDEQ in an accelerated TMDL development process that addresses potential pollutant sources in a fair and reasonable manner based on sound technical data and scientific approach.
5) Implement Best Management Practices (BMPs) that reduce both urban and rural pollution sources, maintain or restore designated beneficial uses of streams and surface water impoundments, minimize soil loss, and provide sustainable production levels. Water quality basins shall be located in general conformance with an adopted Papillion Creek Watershed Management Plan.

REFERENCE INFORMATION

DEFINITIONS:

1) Low-Impact Development (LID). A land development and management approach whereby stormwater runoff is managed using design techniques that promote infiltration, filtration, storage, evaporation, and temporary detention close to its source. Management of such stormwater runoff sources may include open space, rooftops, streetscapes, parking lots, sidewalks, medians, etc.
2) Water Quality LID. A level of LID using strategies designed to provide for water quality control of the first ½ inch of stormwater runoff generated from each new development or significant redevelopment and to maintain the peak discharge rates during the 2-year storm event to baseline land use conditions, measured at every drainage (stormwater discharge) outlet from the new development or significant redevelopment.
3) Best Management Practice (BMP). "A technique, measure or structural control that is used for a given set of conditions to manage the quantity and improve the quality of

stormwater runoff in the most cost-effective manner." *[Source: U.S. Environmental Protection Agency (EPA)]*

4) Total Maximum Daily Load (TMDL). A calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. Water quality standards are set by States, Territories, and Tribes. They identify the uses for each waterbody, for example, drinking water supply, contact recreation (swimming), and aquatic life support (fishing), and the scientific criteria to support that use. A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and non-point sources. The calculation must include a margin of safety to ensure that the waterbody can be used for the purposes the State has designated. The calculation must also account for seasonal variation in water quality. The Clean Water Act, Section 303, establishes the water quality standards and TMDL programs, and for Nebraska such standards and programs are administered by the Nebraska Department of Environmental Quality. *[Source: EPA and Nebraska Surface Water Quality Standards, Title 117].*

PAPILLION CREEK WATERSHED
STORMWATER MANAGEMENT POLICIES

POLICY GROUP #2: PEAK FLOW REDUCTION

ISSUE
Urbanization within the Papillion Creek Watershed has and will continue to increase runoff leading to more flooding problems and diminished water quality.

ROOT POLICY
Maintain or reduce stormwater peak discharge during development and after full build-out land use conditions from that which existed under baseline land use conditions.

SUB-POLICY

1) Regional stormwater detention facilities and other structural and non-structural BMPs shall be located in general conformance with an adopted Papillion Creek Watershed Management Plan and shall be coordinated with other related master planning efforts for parks, streets, water, sewer, etc.
2) Maximum LID shall be required to reduce peak discharge rates on all new developments and significant redevelopments as identified in the Papillion Creek Watershed Management Plan.
3) All significant redevelopment shall maintain peak discharge rates during the 2, 10, and 100-year storm event under baseline land use conditions.

REFERENCE INFORMATION

DEFINITIONS

1) Low-Impact Development (LID). A land development and management approach whereby stormwater runoff is managed using design techniques that promote infiltration, filtration, storage, evaporation, and temporary detention close to its source. Management of such stormwater runoff sources may include open space, rooftops, streetscapes, parking lots, sidewalks, medians, etc.
2) Water Quality LID. A level of LID using strategies designed to provide for water quality control of the first ½ inch of stormwater runoff generated from each new development or significant redevelopment and to maintain the peak discharge rates during the 2-year storm event to baseline land use condition, measured at every drainage (stormwater discharge) outlet from the new development or significant redevelopment.
3) Maximum LID. A level of LID using strategies, including water quality LID and on-site detention, designed not to exceed peak discharge rates of more than 0.2 cfs/acre during the 2-year storm event or 0.5 cfs/acre during the 100-year storm event based on the contributing drainage from each site, measured at every drainage (stormwater discharge) outlet from the new development or significant redevelopment.
4) Peak Discharge or Peak Flow. The maximum instantaneous surface water discharge rate resulting from a design storm frequency event for a particular hydrologic and hydraulic analysis, as defined in the Omaha Regional Stormwater Design Manual. The measurement of the peak discharge shall be at the lower-most drainage outlet(s) from a new development or significant redevelopment.

PAPILLION CREEK WATERSHED
STORMWATER MANAGEMENT POLICIES

5) Regional Stormwater Detention Facilities. Those facilities generally serving a drainage catchment area of 500 acres or more in size.
6) Baseline Land Use Conditions. That which existed for Year 2001 for Big and Little Papillion Creeks and its tributaries (excluding West Papillion Creek) and for Year 2004 for West Papillion Creek and its tributaries.
7) Full Build-Out Land Use Conditions. Fully platted developable land use conditions for the combined portions of the Papillion Creek Watershed that lie in Douglas and Sarpy Counties that are assumed to occur by the Year 2040, plus the projected 2040 land uses within the Watershed in Washington County; or as may be redefined through periodic updates to the respective County comprehensive plans.

PAPILLION CREEK WATERSHED
STORMWATER MANAGEMENT POLICIES

POLICY GROUP #3: LANDSCAPE PRESERVATION, RESTORATION, AND CONSERVATION

ISSUE: Natural areas are diminishing, and there is a need to be proactive and integrate efforts directed toward providing additional landscape and green space areas with enhanced stormwater management through restoration and conservation of stream corridors, wetlands, and other natural vegetation.

"ROOT" POLICY: Utilize landscape preservation, restoration, and conservation techniques to meet the multi-purpose objectives of enhanced aesthetics, quality of life, recreational and educational opportunities, pollutant reduction, and overall stormwater management.

SUB-POLICIES:

1) Incorporate stormwater management strategies as a part of landscape preservation, restoration, and conservation efforts where technically feasible.
2) Define natural resources for the purpose of preservation, restoration, mitigation, and/or enhancement.
3) For new development or significant redevelopment, provide a creek setback of 3:1 plus 50 feet along all streams as identified in the Papillion Creek Watershed Management Plan and a creek setback of 3:1 plus 20 feet for all other watercourses.
4) All landscape preservation features as required in this policy or other policies, including all stormwater and LID strategies, creek setbacks, existing or mitigated wetlands, etc., identified in new or significant redevelopment shall be placed into an out lot or within public right of way or otherwise approved easement.

REFERENCE INFORMATION

DEFINITIONS

1) Creek Setback. See Figure 1 below and related definitions in Policy Group #5. A setback area equal to three (3) times the channel depth plus fifty (50) feet (3:1 plus 50 feet) from the edge of low water on both sides of channel shall be required for any above or below ground structure exclusive of bank stabilization structures, poles or sign structures adjacent to any watercourse defined within the watershed drainage plan. Grading, stockpiling, and other construction activities are not allowed within the setback area and the setback area must be protected with adequate erosion controls or other Best Management Practices, (BMPs). The outer 30 feet adjacent to the creek setback limits may be credited toward meeting the landscaping buffer and pervious coverage requirements.

   A property can be exempt from the creek setback requirement upon a showing by a licensed professional engineer or licensed landscape architect that adequate bank stabilization structures or slope protection will be installed in the construction of said structure, having an estimated useful life equal to that of the structure, which will provide adequate erosion control conditions coupled with adequate lateral support so that no portion of said structure adjacent to the stream will be endangered by erosion

or lack of lateral support. In the event that the structure is adjacent to any stream which has been channelized or otherwise improved by any agency of government, then such certificate providing an exception to the creek setback requirement may take the form of a certification as to the adequacy and protection of the improvements installed by such governmental agency. If such exemption is granted, applicable rights-of-way must be provided and a minimum 20 foot corridor adjacent thereto.

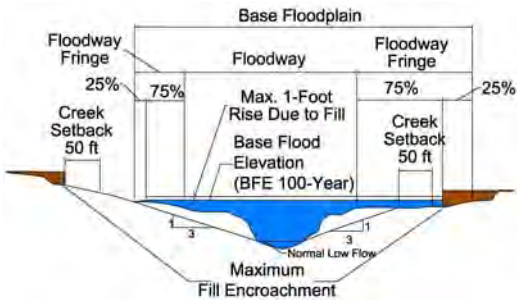


Figure 1 – Floodway Fringe Encroachment and Creek Setback Schematic

DEFINITIONS

1) Base Flood. The flood having a one percent chance of being equaled or exceeded in magnitude in any given year (commonly called a 100-year flood). *[Adapted from Chapter 31 of Nebraska Statutes]*
2) Floodway. The channel of a watercourse and the adjacent land areas that are necessary to be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot. *[Adapted from Chapter 31 of Nebraska Statutes].* The Federal Emergency Management Agency (FEMA) provides further clarification that a floodway is the central portion of a riverine floodplain needed to carry the deeper, faster moving water.
3) Floodway Fringe. That portion of the floodplain of the base flood, which is outside of the floodway. *[Adapted from Chapter 31 of Nebraska Statutes]*
4) Floodplain. The area adjoining a watercourse, which has been or may be covered by flood waters. *[Adapted from Chapter 31 of Nebraska Statutes]*
5) Watercourse. Any depression two feet or more below the surrounding land which serves to give direction to a current of water at least nine months of the year and which has a bed and well-defined banks. *[Adapted from Chapter 31 of Nebraska Statutes]*
6) Low Chord Elevation. The bottom-most face elevation of horizontal support girders or similar superstructure that supports a bridge deck.
7) Updated Flood Hazard Maps. The remapping of flooding sources within the Papillion Creek Watershed where Digital Flood Insurance Rate Maps (DFIRMs) are based on 2004 or more recent conditions hydrology and full-build out conditions hydrology. West Papillion Creek and its tributaries are currently under remapping and will become regulatory in 2009. Updating flood hazard maps for Big Papillion Creek and Little Papillion Creek are planned to be completed in the future.
8) New Development. New development shall be defined as that which is undertaken to any undeveloped parcel that existed at the time of implementation of this policy.

PAPILLION CREEK WATERSHED
STORMWATER MANAGEMENT POLICIES

POLICY GROUP #4: EROSION AND SEDIMENT CONTROL AND OTHER BMPs

ISSUE: Sound erosion and sediment control design and enforcement practices are needed in order to protect valuable land resources, stream and other drainage corridors, and surface water impoundments and for the parallel purpose of meeting applicable Nebraska Department of Environmental Quality regulatory requirements for construction activities that disturb greater than one acre.

"ROOT" POLICY: Promote uniform erosion and sediment control measures by implementing consistent rules for regulatory compliance pursuant to State and Federal requirements, including the adoption of the Omaha Regional Stormwater Design Manual.

SUB-POLICIES:

1) Construction site stormwater management controls shall include both erosion and sediment control measures.

2) The design and implementation of post-construction, permanent erosion and sediment controls shall be considered in conjunction with meeting the intent of other Stormwater Management Policies.

3) Sediment storage shall be incorporated with all regional detention facilities where technically feasible.

REFERENCE INFORMATION

DEFINITIONS

1) Erosion Control. Land and stormwater management practices that minimize soil loss caused by surface water movement.
2) Sediment Control. Land and stormwater management practices that minimize the transport and deposition of sediment onto adjacent properties and into receiving streams and surface water impoundments.

PAPILLION CREEK WATERSHED
STORMWATER MANAGEMENT POLICIES

POLICY GROUP #5: FLOODPLAIN MANAGEMENT

ISSUE: Continued and anticipated development within the Papillion Creek Watershed mandates that holistic floodplain management be implemented and maintained in order to protect its citizens, property, and natural resources.

"ROOT" POLICY: Participate in the FEMA National Flood Insurance Program, update FEMA floodplain mapping throughout the Papillion Creek Watershed, and enforce floodplain regulations to full build-out, base flood elevations.

SUB-POLICIES:

1) Floodplain management coordination among all jurisdictions within the Papillion Creek Watershed and the Papio-Missouri River Natural Resources District (P-MRNRD) is required.
2) Flood Insurance studies and mapping throughout the Papillion Creek Watershed shall be updated using current and full-build out conditions hydrology.
3) Encroachments for new developments or significant redevelopments within floodway fringes shall not cause any increase greater than one (1.00) foot in the height of the full build-out base flood elevation using best available data.
4) Filling of the floodway fringe associated with new development within the Papillion Creek System shall be limited to 25% of the floodway fringe in the floodplain development application project area, unless approved mitigation measures are implemented. The remaining 75% of floodway fringe within the project area shall be designated as a floodway overlay zone. For redevelopment, these provisions may be modified or waived in whole or in part by the local jurisdiction.
5) The low chord elevation for bridges crossing all watercourses within FEMA designated floodplains shall be a minimum of one (1) foot above the base flood elevation for full-build out conditions hydrology using best available data.
6) The lowest first floor elevation of buildings associated with new development or significant redevelopment that are upstream of and contiguous to regional dams within the Papillion Creek Watershed shall be a minimum of one (1) foot above the 500-year flood pool elevation.

REFERENCE INFORMATION

DEFINITIONS (See Figure 1 below and related definitions in Policy Group #3: Landscape Preservation, Restoration, and Conservation).

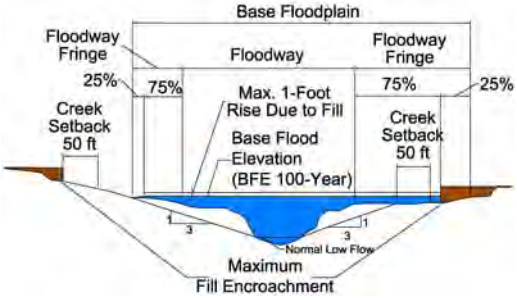


Figure 1 – Floodway Fringe Encroachment and Creek Setback Schematic

PAPILLION CREEK WATERSHED
STORMWATER MANAGEMENT POLICIES

1) Base Flood. The flood having a one percent chance of being equaled or exceeded in magnitude in any given year (commonly called a 100-year flood). *[Adapted from Chapter 31 of Nebraska Statutes]*
2) Floodway. The channel of a watercourse and the adjacent land areas that are necessary to be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot. *[Adapted from Chapter 31 of Nebraska Statutes].* The Federal Emergency Management Agency (FEMA) provides further clarification that a floodway is the central portion of a riverine floodplain needed to carry the deeper, faster moving water.
3) Floodway Fringe. That portion of the floodplain of the base flood, which is outside of the floodway. *[Adapted from Chapter 31 of Nebraska Statutes]*
4) Floodplain. The area adjoining a watercourse, which has been or may be covered by flood waters. *[Adapted from Chapter 31 of Nebraska Statutes]*
5) Watercourse. Any depression two feet or more below the surrounding land which serves to give direction to a current of water at least nine months of the year and which has a bed and well-defined banks. *[Adapted from Chapter 31 of Nebraska Statutes]*
6) Low Chord Elevation. The bottom-most face elevation of horizontal support girders or similar superstructure that supports a bridge deck.
7) Updated Flood Hazard Maps. The remapping of flooding sources within the Papillion Creek Watershed where Digital Flood Insurance Rate Maps (DFIRMs) are based on 2004 or more recent conditions hydrology and full-build out conditions hydrology. West Papillion Creek and its tributaries are currently under remapping and will become regulatory in 2009. Updating flood hazard maps for Big Papillion Creek and Little Papillion Creek are planned to be completed in the future.
8) New Development. New development shall be defined as that which is undertaken to any undeveloped parcel that existed at the time of implementation of this policy.

BASIC FEMA REQUIREMENTS

On March 1, 2003, FEMA became part of the U.S. Department of Homeland Security (DHS). In order for a community to participate in the FEMA National Flood Insurance Program, it must first define base flood elevations and adopt a floodway for all its major streams and tributaries. Once a community adopts its floodway, the requirements of *44 CFR 60.3(d)* must be fulfilled. The key concern is that each project in the floodway must receive an encroachment review; i.e., an analysis to determine if the project will increase flood heights or cause increased flooding downstream. Note that the FEMA regulations call for preventing any increase in flood heights. Projects, such as filling, grading or construction of a new building, must be reviewed to determine whether they will obstruct flood flows and cause an increase in flood heights upstream or adjacent to the project site. Further, projects, such as grading, large excavations, channel improvements, and bridge and culvert replacements should also be reviewed to determine whether they will remove an existing obstruction, resulting in increases in flood flows downstream. *[Adapted from Federal Emergency Management Agency guidance]*

PAPILLION CREEK WATERSHED
STORMWATER MANAGEMENT POLICIES

POLICY GROUP #6: STORMWATER MANAGEMENT FINANCING

ISSUE: Regulatory requirements for stormwater management and implementation of Stormwater Management Policies intended to accommodate new development and significant redevelopment will impose large financial demands for capital and operation and maintenance beyond existing funding resources.

"ROOT" POLICY: Dedicated, sustainable funding mechanisms shall be developed and implemented to meet capital and operation and maintenance obligations needed to implement NPDES Stormwater Management Plans, Stormwater Management Policies, and the Papillion Creek Watershed Management Plan.

SUB-POLICIES:

1) All new development and significant redevelopment will be required to fund the planning, implementation, and operation and maintenance of water quality LID.
2) A Watershed Management Fee system shall be established to equitably distribute the capital cost of implementing the Papillion Creek Watershed Management Plan among new development or significant redevelopment. Such Watershed Management Fee shall only apply to new development or significant redevelopment within the Papillion Creek Watershed and the initial framework shall consist of the following provisions:
    a. Collection of fees and public funding shall be earmarked specifically for the construction of projects called for in the Papillion Creek Watershed Management Plan, including Maximum LID costs such as on site detention, regional detention basins, and water quality basins.
    b. Multiple fee classifications shall be established which fairly and equitably distribute the cost of these projects among all undeveloped areas within the Papillion Creek Watershed.
    c. Watershed Management Fees (private) are intended to account for approximately one-third (1/3) of required capital funds and shall be paid to the applicable local zoning jurisdiction with building permit applications.
    d. Watershed Management Fee revenues shall be transferred from the applicable local zoning jurisdiction to a special P-MRNRD construction account via inter-local agreements.
    e. The P-MRNRD (public) costs are intended to account for approximately two-thirds (2/3) of required capital funds, including the cost of obtaining necessary land rights, except as further provided below; and the P-MRNRD shall be responsible for constructing regional detention structures and water quality basins using pooled accumulated funds.
    f. The P-MRNRD will seek general obligation bonding authority from the Nebraska Legislature to provide necessary construction scheduling flexibility.
    g. Financing for Papillion Creek Watershed Management Plan projects may require public-private partnership agreements between the P-MRNRD and developers/S&IDs on a case-by-case basis.
    h. On approximately three (3)-year intervals, the Papillion Creek Watershed Management Plan and Watershed Management Fee framework, rates, and construction priority schedule shall be reviewed with respect to availability of

needed funds and rate of development within the Papillion Creek Watershed by the parties involved (local zoning jurisdictions, P-MRNRD, and the development community). Subsequent changes thereto shall be formally approved by the respective local zoning jurisdictions and the P-MRNRD.

3) A Stormwater Utility Fee System shall be established to equitably distribute the costs for ongoing operation and maintenance of all stormwater BMPs and infrastructure among all existing property owners within NPDES Phase I or II municipal jurisdictions.
    a. NPDES Phase I and II cities and counties should actively seek legislation from the Nebraska Legislature to allow for the establishment of an equitable stormwater utility fee.
    b. The initial framework for the Stormwater Utility Fee System should consist of the following provisions provided Nebraska statutes allow for such a fee:
        i. A county or city shall establish by resolution user charges to be assessed against all real property within its zoning jurisdiction and may issue revenue bonds or refunding bonds payable from the proceeds of such charges, all upon terms as the county board or city council determines are reasonable.
        ii. Such charges shall be designed to be proportionate to the stormwater runoff contributed from such real property and based on sound engineering principles.
        iii. Such charges should provide credits or adjustments for stormwater quantity and quality BMPs utilized in order to encourage wise conservation and management of stormwater on each property.
        iv. Such charges shall be collected in a manner that the county or city determines as appropriate and shall not be determined to be special benefit assessments.
        v. A county or city shall establish a system for exemption from the charges for the property of the state and its governmental subdivisions to the extent that it is being used for a public purpose. The local elected body shall also provide an appeals process for aggrieved parties.
        vi. A county shall not impose these charges against real property that is being charges user charges by a city.
        vii. Any funds raised from a Stormwater Utility Fee shall be placed in a separate fund and shall not be used for any purpose other than those specified.

REFERENCE INFORMATION

DEFINITIONS

1) Stormwater Management Policies. Stormwater management policies developed by the Technical Workgroup and Policy Workgroup that were commissioned by the Papillion Creek Watershed Partnership (PCWP) subsequent to the “Green, Clean, and Safe” initiatives developed through the “Watershed by Design” public forums conducted in 2004 and 2005 and subsequently revised by the PCWP in 2009. The

following policy groups contain "root" policies and sub-policies for stormwater management that have been developed in addition to the Stormwater Management Financing Policy Group herein:

- Policy Group #1 – Water Quality Improvement
- Policy Group #2 – Peak Flow Reduction
- Policy Group #3 – Landscape Preservation, Restoration, and Conservation
- Policy Group #4 – Erosion and Sediment Control and Other BMPs
- Policy Group #5 – Floodplain Management

2) Stormwater Management Plan (SWMP). A SWMP is a required part of the NPDES Phase II Stormwater Permits issued to many of the Omaha metropolitan area Papillion Creek Watershed Partnership (PCWP) members. Development of Stormwater Management Policies is an integral part of the SWMP, and such policies are to be adopted by respective PCWP partners.
3) Comprehensive Development Plans. Existing plans developed by local jurisdictions that serve as the basis for zoning and other land use regulations and ordinances. The Stormwater Management Policies are to be incorporated into the respective Comprehensive Development Plans.
4) Policy Implementation. The implementation of the policies will be through the development of ordinances and regulations, in years 3 through 5 of the NPDES permit cycle; that is, by the year 2009. Ordinances and regulations are intended to be consistent for, and adopted by, the respective PCWP members. Such ordinances and regulations shall need to be consistent with the Comprehensive Development Plans of the respective PCWP members.
5) Low-Impact Development (LID). A land development and management approach whereby stormwater runoff is managed using design techniques that promote infiltration, filtration, storage, evaporation, and temporary detention close to its source. Management of such stormwater runoff sources may include open space, rooftops, streetscapes, parking lots, sidewalks, medians, etc.
6) Water Quality LID. A level of LID using strategies designed to provide for water quality control of the first ½ inch of stormwater runoff generated from each new development or significant redevelopment and to maintain the peak discharge rates during the 2-year storm event to baseline land use conditions, measured at every drainage (stormwater discharge) outlet from the new development or significant redevelopment.
7) Maximum LID. A level of LID using strategies, including water quality LID and on-site detention, designed not to exceed peak discharge rates of more than 0.2 cfs/acre during the 2-year storm event or 0.5 cfs/acre during the 100-year storm event based on the contributing drainage from each site, measured at every drainage (stormwater discharge) outlet from the new development or significant redevelopment.
8) Baseline Land Use Conditions. That which existed for Year 2001 for Big and Little Papillion Creeks and its tributaries (excluding West Papillion Creek) and for Year 2004 for West Papillion Creek and its tributaries. That which existed in 2007 for all areas not within the Papillion Creek Watershed.

PAPILLION CREEK WATERSHED
STORMWATER MANAGEMENT POLICIES

BASIS FOR STORMWATER MANAGEMENT FINANCING ISSUE

1) Time is of the essence for policy development and implementation:
   a) Under the existing Phase II Stormwater Permits issued by the Nebraska Department of Environmental Quality, permitees must develop strategies, which include a combination of structural and/or non-structural best management practices and incorporate them into existing Comprehensive Development Plans by the end of 2009.
   b) The S&ID platting process is typically several years ahead of full occupation of an S&ID. Therefore, careful pre-emptive planning and program implementation is necessary in order to construct regional stormwater detention and water quality basin improvements in a timely manner to meet the purposes intended and to avoid conflicts from land use encroachments from advancing development.
2) Financing to meet capital and O&M obligations for stormwater management projects requires a comprehensive, uniformly applied approach and not a project-by-project approach.

Attachment C

Omaha Stormwater Website		
2017 Month	**Users**	**Page Views**
January	437	1,343
February	553	2,044
March	547	2,038
April	562	1,903
May	555	2,099
June	457	1,559
July	450	1,251
August	475	1,494
September	489	1,565
October	450	1,710
November	353	1,363
December	349	1,524
Totals	**5,677**	**19,893**

Stormwater Facebook Page	
2017 Month	**Total Post Reach**
January	269
February	621
March	5,548
April	4,857
May	2,916
June	2,787
July	12,851
August	2,636
September	2,265
October	5,967
November	3,368
December	1,851
Totals	**45,936**
Total Posts	**69**

Attachment D

EVENT	DATE	ACTIVITY TYPE	TARGET AUDIENCE	# OF PEOPLE REACHED	DETAILS/COMMENTS
TD2 Bioretention Presentation	1/25/2017	Presentation/Demonstration	Construction/ Commercial	30	Lunch & learn with TD2 to discuss bioretention design, lesson learned, etc...
Indian Hill Science Night	1/26/2017	Education Booth	Residential/ Community	250	Watershed model during their Science Family Night
UNO/UNL Stormwater Class lecture	2/1/2017	Conference Presentation	Community	15	Presentation on green infrastructure at your home
Annual Sediment and Erosion Control Seminar	2/2/2017	Workshop	Construction/ Commercial/ Residential	271	Annual seminar to constrution industry
Rain barrel workshop - GS Troop 42695	2/5/2017	Workshop	Residential	10	Heather Bowman GS Troop leader - 402-960-3954
2017 Omaha Home Show & Garden Expo	2/9/2017	Education Booth	Residential	1,000	Booth in conjunction with Omaha Recycling, Keep Omaha Beautiful; handing out & discussing info
Master Gardener Theather - Home Show presentation	2/9/2017	Presentation/Demonstration	Residential	5	Presentation on green infrastructure at your home
UNL Urban Soils lecture	2/13/2017	Presentation/Demonstration	Community/ Construction/ Commercial	18	Lecture on stormwater & green infrastructure in Omaha
2017 Spring Stormwater Symposium	3/8/2017	Education Booth	Construction/ Commercial	120	Hosted by NeFSMA, UNL Extenstion, IECA
Pecha Kucha - GOC	3/20/2017	Education Booth	Community/ Residential	100	Green Omaha Coliation event; table with materials & discussions with attendees
Class Presentation	4/3/2017	Presentation/Demonstration	Community/ Residential	20	Presentation is Stormwater and GI to 8th grade class that are doing a project about their schoolyard and runoff
UNO/UNL Stormwater Class lecture	4/5/2017	Presentation/Demonstration	Community/ Construction/ Residential	15	Presentation on green infrastructure maintenance
2016 National Watershed & Stormwater Conference	4/4/2017	Presentation/Demonstration	Commercial/ Construction/ Residential	50	In conjunction with Douglas County Environmental Services
UNO/UNL GI Tour	4/8/2017	Tour	Community/ Commercial/ Residential	30	Toured UNO Welcome Center, Creighton Prep, 58th & Maple, Adams Park, Spring Lake Park, Elmwood Park
Wheeler Elementary School Presentation	4/10/2017	Presentation/Demonstration	Community/ Residential	95	Presentation to fourth grade students on stormwater runoff & how it relates to a job.
NWEA presentation	4/18/2017	Presentation/Demonstration	Commercial/ Construction/ Residential	100	Presentation on green infrastructure monitoring efforts
Humans & the Environment class presentation	4/20/2017	Presentation/Demonstration	Community/ Residential/ Commercial	40	Presentation on stormwater and green infrastructure in Omaha
Earth Day Omaha	4/22/2017	Education Booth	Community/ Residential	5,000	Handed out brochures and materials on all things stormwater (rain gardens, bioretention, GI, rain barrels, etc.). Estimated total attendance of event upwards of 10,000
Earth Day Omaha - Rain barrel & rain garden demos	4/22/2017	Presentation/Demonstration	Community/ Residential	30	Three demonstrations at the GOC Demonstration Tent
Dundee Elementary School 2nd Grade presentation	4/25/2017	Presentation/Demonstration	Community/ Residential	25	Watershed model and discuss demonstration project taking place at school
Nebraska Medical Center Sustainability Fair	4/27/2017	Education Booth	Residential/ Community	50	Staff a booth to discuss stormwater & GI practices. Hand out materials on those topics.

Together We Build a Better City - P&R	5/9/2017	Education Booth	Residential/ Community	300	Event focused on city provided services, goal is to have all EQCD programs there if possible. Tables with info & room for activities (frisbee)
Spring into Summer - Parks Dept	5/12/2017	Education Booth	Residential/ Community	675	Event focused on having fun for the citizens of Omaha. Set up frisbee game & handed out materials for stormwater & GI.
MCC Class Presentation	5/18/2017	Presentation/Demonstration	Community/ Residential/ Commercial	27	Present on stormwater, green infrastructure & tour bioretention gardens
WEF Collection Systems Presentation	5/24/2017	Conference Presentation	Construction/ Commercial/ Community	50	Invited Session Nebraska and Iowa - Tapping into Omaha Parks with Green Infrastructure
WEF CS 2017 GI Tour	5/24/2017	Tour	Construction/ Commercial/ Community	10	10 of each fact sheet: Adams Park, UNO, Fontenelle Park, Elmwood Park, Spring Lake Park
NUSA Presentation	5/26/2017	Conference Presentation	Community/ Residential	30	Present with Steve Rodie on Green Infrastructure in Omaha
SAFE 2017	6/3/2017	Education Booth	Residential/ Community	750	Will be doing the same setup as past years - frisbee toss game & handing out frisbees w/basic stormwater info
Green Infrastructure at Home - Big Garden Workshop	6/12/2017	Workshop	Residential/ Community	8	Hands-on workshop at the Big Garden campus, including classroom presentation & building a rain garden on NW corner of campus.
Sustainable Space Potluck	6/22/2017	Education Booth	Residential/ Community	15	Partner with KOB & Omaha Planning Department to convert a vacant lot into a community landscape including a rain garden, permeable pavers, & pollinator garden. Potluck is aimed at engaging the neigbhorhood into the project.
UNO Sustainability Academy	7/26/2017	Tour	Residential/ Construction	35	Steve Rodie lead a tour of students in summer program
Sustainable Panel Discussion	7/27/2017	Presentation/Demonstration	Community	65	Academy of Sustainability 2017
Terracon lunch-n-learn	8/10/2017	Presentation/Demonstration	Construction/ Commercial	15	Present to Terracon on construction & post-construction stormwater information. Also touch on basic usage of permix
Indian Hill Outreach	8/16/2017	Meeting	Community/ Residential	2	Discussed how to address eroding area along steps with sustainable plantings
World O! Water	9/9/2017	Event Sponsor	Community/ Residential	2,400	Half-day family event with over 50 organizations with act ivies and information all centered around water
MORE Nature Night - Oakdale Elementary	9/14/2017	Education Booth	Community/ Residential	150	Set up frisbee game, handed out storwmater & GI information geared to homeowners & kids
Green Infrastructure Tour	9/21/2017	Tour	Community/ Construction/ Commercial	95	Tour two full charter buses of various GI sites from across the metro.
Walk for the Animals	9/24/2017	Education Booth	Residential/ Community	750	Annual event to raise money for the Nebraska Humane Society. Shared information on proper pest waste disposal & handed out pet waste bag dispensers. 41 Tennis balls also handed out.
Fly into Fall	9/30/2017	Education Booth	Community/ Residential	300	Event hosted by the Parks & Recreation Department.
MORE Nature Night - Montclair Elementary	10/5/2017	Education Booth	Community/ Residential	350	Set up frisbee game, handed out storwmater & GI information geared to homeowners & kids
PCWP October Meeting	10/27/2017	Meeting	Construction/ Commercial/ Community	14	Discussed & handed out materials related to construction & post-construction stormwater
Environmental Planning & Poilcy Class - UNL	10/11/2017	Presentation/Demonstration	Community/ Commercial/ Residential	25	Presentation on stormwater and green infrastructure in Omaha

Kennedy Elementary - Adams Park Field Trip	10/13/2017	Tour	Community	65	Discuss stormwater & how the City utilized Adams Park to manage it in a more sustainable way. Part of their 5th grade project-based-learning project.
Kennedy Elementary - Project Based Learning Panel	11/3/2017	Presentation/Demonstration	Community	65	Sit on a panel of experts while 5th grade students presented on their project-based-learning project.
2017 Iowa Stormwater Summit	12/7/2017	Presentation/Demonstration	Commercial/ Construction/ Community	110	Presentation on stormwater and green infrastructure in Omaha
Zach Jilek - presentation to Lyman Richie for ISW	12/13/2017	Distribution	Construction	48	Industrial Stormwater topics & concrete washout.
				11,694	
				32	

EVENT	DATE	LOCATION	# OF PEOPLE REACHED	COMMENTS
TD2 Bioretention Presentation	1/25/2017	Omaha, NE	30	Lunch & learn with TD2 to discuss bioretention design, lesson learned, etc...
Annual Sediment and Erosion Control Seminar	2/2/2017	Ralston, NE	271	Annual seminar to constrution industry.
2017 Spring Stormwater Symposium	3/8/2017	Omaha, NE	120	Hosted by NeFSMA, UNL Extenstion, IECA.
2016 National Watershed & Stormwater Conference	4/4/2017	Omaha, NE	50	In conjunction with Douglas County Environmental Services.
NWEA presentation	4/18/2017	La Vista, NE	100	Presentation on green infrastructure monitoring efforts.
WEF Collection Systems Presentation	5/24/2017	Omaha, NE	50	Invited Session Nebraska and Iowa - Tapping into Omaha Parks with Green Infrastructure.
WEF CS 2017 GI Tour	5/24/2017	Omaha, NE	10	10 of each fact sheet: Adams Park, UNO, Fontenelle Park, Elmwood Park, Spring Lake Park
Terracon lunch-n-learn	8/10/2017	Omaha, NE	15	Present to Terracon on construction & post-construction stormwater information. Also touch on basic usage of permix.
Green Infrastructure Tour	9/21/2017	Omaha, NE	95	Tour-two full charter buses-various GI sites from across the metro.
PCWP October Meeting	10/27/2017	Omaha, NE	14	Discussed & handed out materials related to construction & post-construction stormwater.
2017 Iowa Stormwater Summit	12/7/2017	Ankeny, IA	110	Presentation on stormwater and green infrastructure in Omaha.
Zach Jilek - presentation to Lyman Richie for ISW	12/13/2017	Omaha, NE	48	ISW topics & concrete washout
			913	

Attachment E

Jurisdiction	Active Permits	Permits Issued	Phase 1 Permits Issued	Phase 2 Permits Issued	Site Inspections Submitted	Phase 1 Site Inspections Submitted	Phase 2 Site Inspections Submitted	City Inspections Submitted	Phase 1 City Inspections Submitted	Phase 2 City Inspections Submitted
Bellevue	49	11	6	5	1,020	680	340	170	89	81
Bennington	0	0	0	0	0	0	0	0	0	0
Boys Town	0	0	0	0	0	0	0	0	0	0
Gretna	27	6	5	1	569	491	78	90	75	15
Douglas County	7	0	0	0	35	35	0	0	0	0
La Vista	43	11	5	6	855	447	408	188	88	100
Omaha	455	103	36	67	8,841	5,017	3,824	1,213	614	599
Papillion	77	26	15	11	1,989	1,500	489	332	224	108
Ralston	2	1	0	1	24	0	24	4	0	4
Sarpy	56	15	8	7	1,190	889	301	201	157	44
TOTAL	716	173	75	98	14,523	9,059	5,464	2,198	1,247	951

Grading Permit Summary Report

Report generated 3/19/2018

Reporting Period: 2017 Calendar Year

Jurisdiction	Inspection RVC's	Recommended RVC	Recommended LOW	Recommended NOV	Recommended NOV w/Fine	Total Enforcement Actions	No Action	RVC	RFI	LOW	NOV	NOV w/Fine	SEP	Fines	SEP Value
Bellevue	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bennington	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boys Town	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gretna	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
La Vista	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Omaha	253	3	2	12	1	18	0	7	0	3	8	0	0	0	0
Papillion	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ralston	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sarpy	40	0	1	0	0	1	0	0	0	1	0	0	0	0	0
TOTAL	420	3	3	12	1	19	0	7	0	4	8	0	0	0	0

This summarizes City Inspection Reports that have noted that Request for Voluntary Compliance is recommended for the site, Column B

Also summarizes Enforcement Actions in the enforcement module of a given project. Columns C & on

Total Complaint type inspections	43
Complaint inspections w/RVC	37

Attachment F

UNIVERSITY OF NEBRASKA AT OMAHA

Evaluating Regional Rain Garden Environmental Conditions, Functional Attributes, and Plant Health: A Three-Year Study

Rachael Burns-Omaha Northwest High School, Brianna Greco-Norris Middle School, Steve Rodie-UNO Biology Department,
John O'Donnell-City of Omaha Stormwater Program, Andy Szatko-City of Omaha Stormwater Program
Teacher-Researcher Partnership Program, University of Nebraska at Omaha, Omaha, NE 68182

Abstract

Six city-installed rain gardens in the Saddle Hills neighborhood in Omaha, NE were assessed over a three-year period (summers of 2015-2017) to identify and compare infiltration rates, soil characteristics, and plant health. This study addressed the following hypotheses: 1) the soil adjacent to the rain garden forebays will have a slower infiltration rate due to sediment buildup which lessens soil porosity; 2) established sedges with expansive root systems will increase the rate of infiltration in areas immediately within plant groupings; 3) infiltration rates will be faster on average when comparing current infiltration rates (2017) with rates in previous years; and 4) rain gardens located in watersheds containing more street and parking lot runoff will accumulate more pollutants (heavy metals, hydrocarbons, etc.) in the forebays. Additionally, we compared three different infiltrometers on the ease of use, data reliability, consistency of measurements (is it the tool or the variability of the soil?), and whether the results between infiltrometers had similar trends. Hypotheses results indicated that sediment loading does slow infiltration, which emphasizes the need for effective forebay design to capture sediment; sedge rooting does not necessarily increase immediately adjacent infiltration rates (but may enhance area infiltration); infiltration rates increased over time as gardens matured; and pollutant runoff increases in watersheds that include more parking lot and street surfaces. In equipment comparisons, each infiltrometer has its own unique characteristics and challenges for reliable usage; rate comparisons between equipment types do not appear to be feasible due to the wide variation in the units of measure for each type. Nevertheless, the comparisons illustrate the importance of fully understanding the output data for each type relative to specific garden performance criteria.

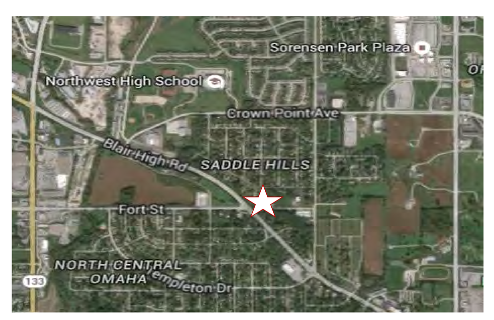
Introduction

Rain gardens are shallow depressions planted with deep-rooted, native and adapted shrubs, perennial flowers, grasses, and sedges. Selected plants are able to tolerate relatively short periods of rain-soaked soil as well as extended drought and extremes in Great Plains regional growing conditions. Rain gardens allow stormwater runoff from homes, businesses, and streets to infiltrate into the soil, which reduces the runoff to storm drains. This protects streams and lakes from pollutants that are washed from roofs and paved areas and from channel and bank erosion. An important element of the City of Omaha's Long Term Control Plan for stormwater management will be the continued operation of green infrastructure practices such as rain gardens. These practices assist Omaha in addressing water quality and water quantity management issues and reducing the amounts of pollutants as well as runoff volumes entering the sewer system or receiving streams.

Materials/Methods

Six gardens (two park, four residential) were tested in the Saddle Hills Neighborhood in northwest Omaha. Infiltration tests were completed in June 2015, 2016, and 2017; soil tests were also completed in June 2015 and June 2017.

1. Soil testing
   - •Scrape forebay sediments (forebay traps sediment entering garden)
   - •Obtain soil via soil-core probe
   - •Collect mulch samples
   - •Send to Midwest Labs for chemical analysis of salts, phosphates, nitrates, heavy metals, hydrocarbons, etc.
2. Assess infiltration rates using Turf-Tec Mini Double-Ring Infiltrometers, Modified Philip-Dunne (MPD) Infiltrometers, and Mini Disk Portable Tension Infiltrometers
   - •Set up each infiltrometer
   - •Compare between gardens
   - •Compare differences of locations within individual gardens
   - •Compare differences of infiltration between sedges versus no plants
3. Overall plant assessment – tie to original planting designs
   - •What conditions does each plant species prefer in the garden (sun/shade/water preferences)?
   - •On average, how has each plant species grown and thrived over the three years (plants measured for height, canopy cover, pest/disease issues, etc.)



Project Area

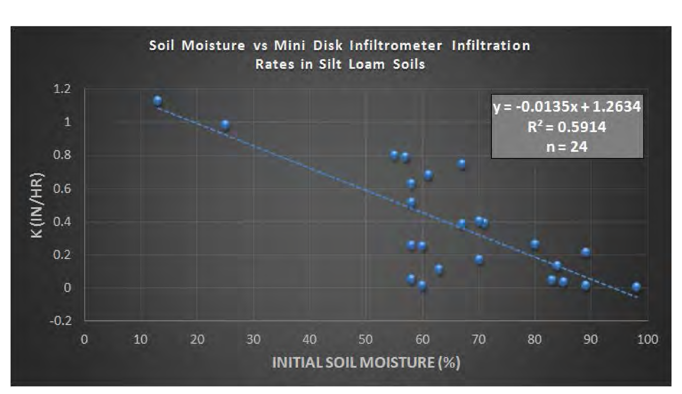
Infiltration test equipment (left to right): Turf-Tec Mini Double-Ring Infiltrometer (2015, 2016, 2017), Modified Philip-Dunne Infiltrometer (2016, 2017), and Mini Disk Portable Tension Infiltrometer (2017).

Infiltrometer Comparisons

Turf-Tec Mini Double-Ring Infiltrometer
- measures the vertical infiltration of the soil
- measures the percolation of water through the soil

Modified Philip-Dunne Infiltrometer
- falling head test that captures the movement of water in the soil
- measures the saturated hydraulic conductivity (Ksat)
- can run multiple tests simultaneously, and WiFi connected for data collection

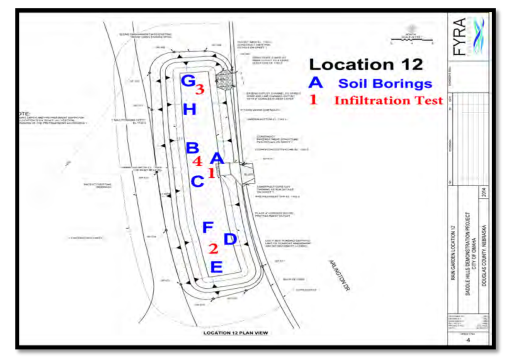
Mini Disk Portable Tension Infiltrometer
- measures the unsaturated hydraulic conductivity (K) and infiltration rates at the surface of the soil



Soil moisture (%) vs surface infiltration rates (in/hr) using the Mini Disk Portable Tension Infiltrometers across the six Saddle Hills rain garden sites.

The University of Nebraska does not discriminate based on race, color, ethnicity, national origin, sex, pregnancy, sexual orientation, gender identity, religion, disability, age, genetic information, veteran status, marital status, and/or political affiliation in its programs, activities, or employment.

Typical Rain Garden Assessment (Site 12)



Grading and layout engineering plan. Blue letters indicate locations of soil samples and red numbers indicate infiltration test locations.

Locations of rain gardens within the neighborhood.

Metered water fill from hydrant to assess designed capacity; forebay at garden entrance

Black Chokeberry (*Aronia melanocarpa*) plants received a rating of 5 on the BMP Plant Evaluation Form

Typical Soil Borings and Locations

12A

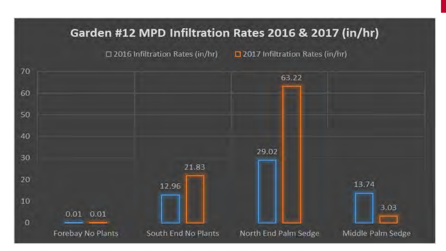
Soil probe test at approx. 9.25 inches (23.5 cm) depth for each location

12B

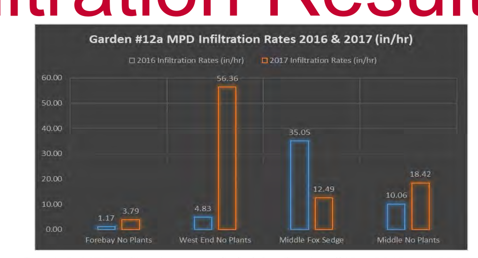
12C

12D

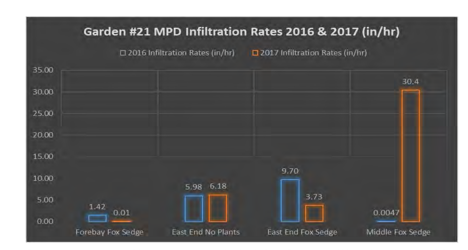
Infiltration Results



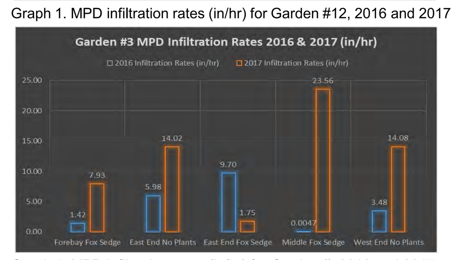
Graph 1. MPD infiltration rates (in/hr) for Garden #12, 2016 and 2017.



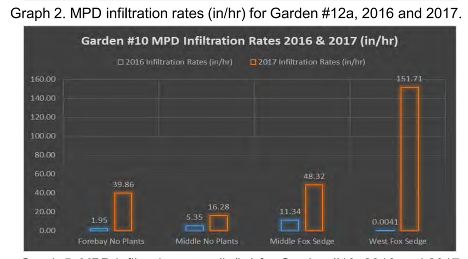
Graph 2. MPD infiltration rates (in/hr) for Garden #12a, 2016 and 2017.



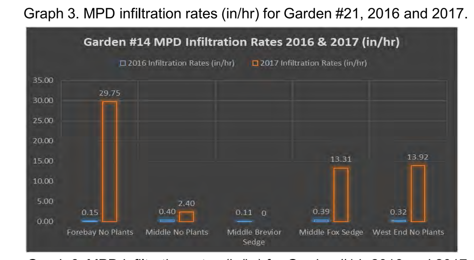
Graph 3. MPD infiltration rates (in/hr) for Garden #21, 2016 and 2017.



Graph 4. MPD infiltration rates (in/hr) for Garden #, 2016 and 2017.



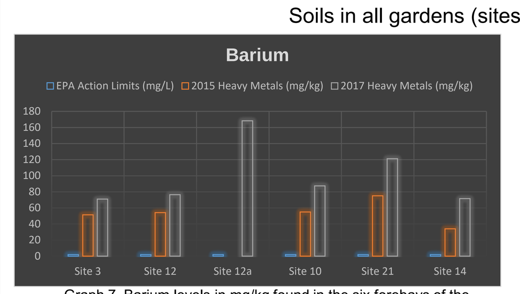
Graph 5. MPD infiltration rates (in/hr) for Garden #10, 2016 and 2017.



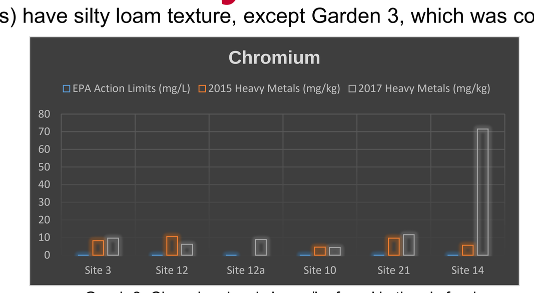
Graph 6. MPD infiltration rates (in/hr) for Garden #14, 2016 and 2017.

Soil Analysis Results*

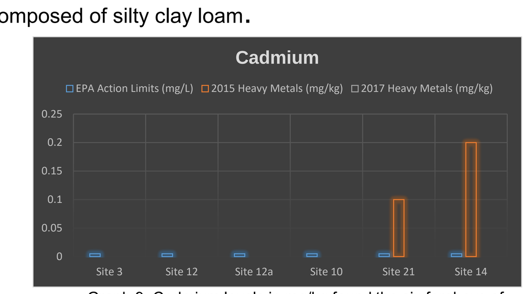
Soils in all gardens (sites) have silty loam texture, except Garden 3, which was composed of silty clay loam.



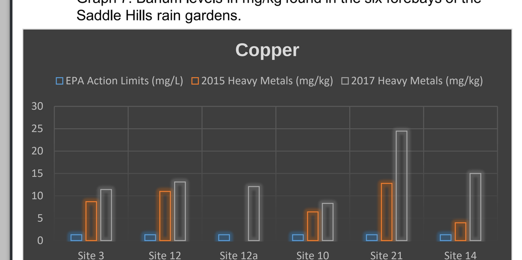
Graph 7. Barium levels in mg/kg found in the six forebays of the Saddle Hills rain gardens.



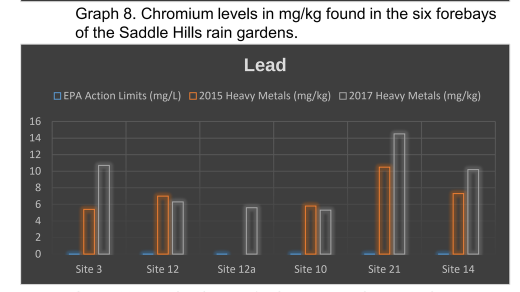
Graph 8. Chromium levels in mg/kg found in the six forebays of the Saddle Hills rain gardens.



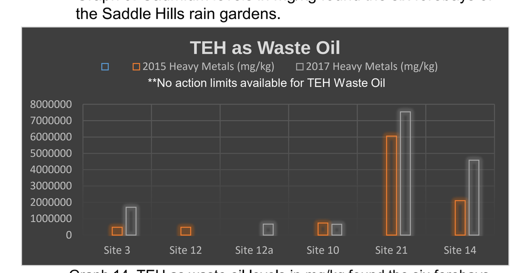
Graph 9. Cadmium levels in mg/kg found the six forebays of the Saddle Hills rain gardens.



Graph 10. Copper levels in mg/kg found the six forebays of the Saddle Hills rain gardens.



Graph 11. Lead levels in mg/kg found the six forebays of the Saddle Hills rain gardens.



Graph 14. TEH as waste oil levels in mg/kg found the six forebays of the Saddle Hills rain gardens.

*EPA action limits given are for drinking water. Other chemicals tested include: aluminum, arsenic, boron, calcium, cobalt, iron, magnesium, manganese, mercury, molybdenum, nickel, phosphorus, potassium, selenium, silver, sodium, sulfur, zinc, TEH as gasoline, mineral spirits, kerosene, and diesel.

Acknowledgements

Thanks to the following people working on other 2017 TRPP projects and City stormwater projects for their field work and poster assistance:
- Dr. Andy Miller and Rachel Benzoni; UNO Chemistry and Omaha Northwest High School
- Dr. Ashley Dere and LeeAnn Stover; UNO Geography/Geology and Omaha Burke High School
- Dr. Timothy Dickson and Maggie Duffy; UNO Biology and Dundee Elementary School
- John O'Donnell and Andy Szatko: City of Omaha Stormwater Program

Project Limitations

- Limited time
- Infiltration tests were not always accurate with respect to the spatial and temporal variation of the soils within the gardens
- Limited background research available on Modified Philip-Dunne (MPD) Infiltrometers
- No statistical evidence yet developed; only trends
- Some plants in gardens did not match engineering design (in placement or species)
- Weather

Results

- On average, the infiltration rates were slowest near the forebays where significant amounts of sediment had not been captured due to lack of forebay capacity or maintenance.
- The fastest infiltration rates are found between fox sedges; however, there is not a strong trend showing that infiltration rates are faster between sedges versus areas with no sedges.
- On average, infiltration rates continued to increase in 2017; the results from all testing equipment and methods are showing similar trends.
- On average, the infiltration rates in 2017 are faster than in 2016 and 2015; a direct precise numerical correlation is not possible given the double ring mini infiltrometer measures infiltration in inches/hour, the MPD infiltrometer measures in saturated hydraulic conductivity, and the mini disk tension infiltrometer measures in unsaturated hydraulic conductivity (K). This difference was not apparent until after 2016 testing began and protocols were established. The MPD equipment is in a beta-testing stage; irregular results when they occurred were explained through equipment issues that we worked to remedy with the company.
- The rain gardens connected to the larger watersheds (in particular garden site 14 and 21) accumulated more lead, copper, cadmium, waste oil, etc.; the forebays continued to accumulate in persistent heavy metals from 2015 to 2017.
- Plants such as *Carex stipata* (fox sedge) and *Diervilla lonicera* (honeysuckle) scored best in each garden during plant evaluation. They grow well in all areas of the garden and showed no signs of disease/pests.

Chemical and plant assessments can be accessed upon request

Conclusions and Future Directions

The Saddle Hills rain gardens were constructed at the end of 2014, so plants are well established and have developed deep root systems. The soil between sedges exhibits the fastest infiltration rates, supporting the importance of root growth in enhanced infiltration. The slow rates in forebay areas with no plants indicate a need for additional forebay clean-out and greater sediment capacity. On average, the infiltration rates have increased over time – a sign of healthy gardens. In addition, the rain gardens are collecting multiple persistent heavy metals. This data serves as a starting point for an on-going analysis over the functionality and maintenance of the Saddle Hills rain gardens. Future plant assessments are proposed that will determine which plants are best used for future rain gardens relative to best locations for each plant species, and relative costs for long-term maintenance. Additionally, tests are proposed to determine patterns in pollutant accumulation and mitigation among plants.

Translation into the Classroom

- Brought awareness of green infrastructure in Omaha, Omaha Northwest neighborhoods, and Omaha Public Schools buildings to students.
- Taught students how to identify native Nebraska plants.
- Trained students how to take soil and infiltration tests.
- Guided students on proper plant assessments.
- Gave Northwest students the opportunity to design and build a rain garden for the Northwest campus that won the state contest and competed nationally in the Samsung Solve for Tomorrow Contest. This project was also recognized in National Geographic's Next Generation Environmental Leaders webpage.
- Allowed students to conduct their own inquiry-based projects in gardens.
- Enhanced STEM (Science, Technology, Engineering and Math) education and curriculum – Northwest and Norris rain garden design requires calculations for runoff and garden sizing, soil infiltration testing, slope calculations, selection of proper plants, garden access for people, and aesthetic beauty and maintainability.
- Engaged cross-curricular and cross-teaming learning (chemistry, art, biology, computer science, math, language arts, etc.)
- Connected students to the environment through the use of Digital Observation Technology Skills and inquiry-based learning.

Future plans include students at Norris planning, designing, and building a rain garden for the Norris campus.

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Omaha Stormwater

University of Nebraska Omaha

Saddlebrook Green Infrastructure Assessment

2017 Monitoring Summary

The Saddlebrook Joint Use Facility is located at 149th Street and Laurel Avenue in northwest Omaha, Nebraska (Figure 1). This city-owned, multi-use facility sits on roughly 20 acres of land, slightly upstream of Standing Bear Lake. The Saddlebrook Joint Use Facility acts as a stormwater demonstration project with several stormwater best management practices (BMPs), including a green roof, a bioretention system, and a dry retention pond. In 2009, a sedum-type green roof was installed on the library portion of the building, which can be viewed from the community center's second floor walking/running track. On the North side of the multi-use building, a bioretention system was installed to collect stormwater runoff from the west parking lot. A traditional dry retention pond was installed on the northeast portion of the building to collect stormwater runoff from the east parking lot. The Saddlebrook demonstration project was designed to compare traditional "gray" infrastructure practices against green infrastructure practices.

Flow monitoring equipment has been installed on site to measure discharge (outflow) rates from the gray roof, the green roof, the bioretention system, and the dry retention pond. This data is collected with 2150 Area Velocity Flow Module and Sensors which provide quantity and velocity measurements of stormwater runoff. This data will be used to compare volume, peak flow rate, and overall efficiency between traditional and green infrastructure practices. A rain gauge has been installed on site to measure precipitation at the site. For this annual report, the 2017 assessment of the green and gray roofs is provided. The bioretention system and parking lot systems were monitored in 2017; however the full analysis of data could not be completed prior to this annual report. Outflow (discharge) data was collected from the gray and green roofs. Inflow and outflow data was collected from the bioretention system and outflow (runoff) data was collected from the East parking lot.

Monitoring equipment collected data from June through early November 2017. During the 2017 sampling period, 35 precipitation events were recorded at the Saddlebrook site, totaling 15.71 in of precipitation (Table 1). The total accumulation recorded at Saddlebrook is slightly lower than recorded values (during the same sampling period) at the National Weather Service Valley weather station (Valley, NE; station ID USC00258795) and Waterford weather station (Bennington, NE; station ID KNEBENNI11) with 20.26 in and 18.83 in, respectively. The lowest recorded precipitation event at Saddlebrook was 0.02 in with the highest recorded precipitation event at 1.90 in. The average precipitation across all events was 0.45 in with the average duration for a precipitation event of 2 hours and 20 minutes.

All 35 precipitation events recorded discharge values from the gray roof with an observed total volume of 12,241.9 cubic feet (91,575.77 gallons) for the 2017 sampling period. Only 22 out of the 35 precipitation events recorded discharge values from the green roof with an observed total volume of 4,451.58 cubic feet (33,000.13 gallons). In 2017, the green roof had 7,790.32 cubic feet (58,275.64 gallons) less stormwater runoff than the gray roof, a 64% reduction in volume. Accounting for the variation in footprint or area of both the monitored gray and green roof, we can calculate that on average one square foot of gray roof will displace 1.56 cubic feet (11.6 gallons) of stormwater runoff while the one square foot of green roof will displace 0.49 cubic feet (3.66 gallons) of stormwater runoff.

Green infrastructure practices are known for their reduction of stormwater runoff volumes but have also been documented to delay and reduce peak flows when compared to traditional gray infrastructure practices. During the 2017 sampling period, the delay in peak flows from the gray roof to the green roof ranged from a 14-minute delay to 2 hours and 45-minutes, with an average delay time of 38 minutes. Precipitation intensity and duration heavily influenced this range. On average, a 75% reduction in peak flow occurred across all events (Table 1).

Flow monitoring data remains consistent with previous years in showing reduced peak discharge rates and total volume from the green roof when compared to the traditional gray roof. The same is true for the bioretention system in 2017. Monitoring will continue for this site in 2018 with no change in what data is being collected. As data is collected, the City will continue to compare the performance of the traditional versus the green infrastructure features in terms of volume and peak flow reduction.

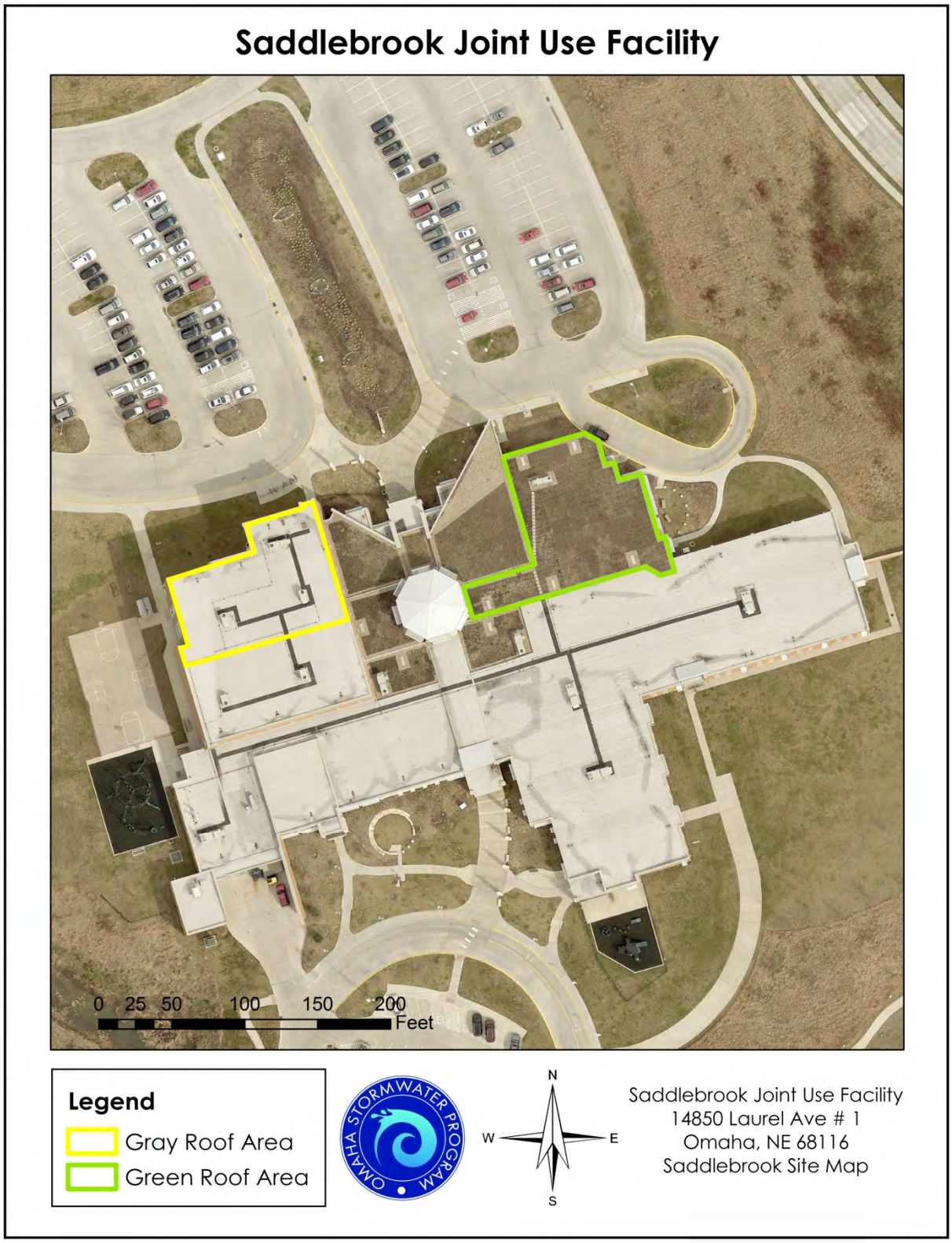

Figure 1. Site map of the Saddlebrook Joint Use Facility highlighting the drainage area for both the Gray and Green Roofs.

Table 1. Summary of 2017 rain/discharge events for the Gray and Green Roofs at Saddlebrook.

Year	Month	Date	Total Precip	Observed Volume Gray Roof	Observed Volume Green Roof	Peak Rate Gray Roof	Peak Rate Green Roof	% Reduction Peak Flow
yyyy	*mmm*	*dd-mmm*	*in*	*cf*	*cf*	*cfs*	*cfs*	*%*
2017	JUN	12-Jun	0.13	114.84	0.00	0.024	0.0	100%
2017	JUN	13&14-Jun	0.48	37.68	5.10	0.043	0.004	91%
2017	JUN	15&16-Jun	0.11	141.36	1.08	0.099	0.001	99%
2017	JUN	16&17-Jun	1.5	392.58	499.56	1.791	0.462	74%
2017	JUN	26-Jun	0.24	253.02	0.84	0.105	0.001	99%
2017	JUN	28-Jun	0.18	244.5	0.72	0.085	0.001	99%
2017	JUN	29&30-Jun	0.20	167.52	0.00	0.085	0.0	100%
2017	JUN	30-Jun	0.08	136.86	0.00	0.050	0.0	100%
2017	JUL	2-Jul	0.13	193.32	0.00	0.051	0.0	100%
2017	JUL	3-Jul	0.55	142.62	73.20	0.106	0.056	47%
2017	JUL	11&12-Jul	0.13	77.04	0.00	0.033	0.0	100%
2017	JUL	13-Jul	0.14	145.2	0.00	0.043	0.0	100%
2017	JUL	18-Jul	0.05	34.92	0.00	0.037	0.0	100%
2017	JUL	26&27-Jul	1.44	472.68	332.76	0.107	0.17	-59%
2017	AUG	5-Aug	0.06	183.24	0.00	0.028	0.0	100%
2017	AUG	10-Aug	0.35	79.14	4.14	0.075	0.002	97%
2017	AUG	13-Aug	0.02	60.12	0.00	0.013	0.0	100%
2017	AUG	15&16-Aug	1.56	275.58	584.04	0.074	0.164	-122%
2017	AUG	20-Aug	0.35	213.54	17.70	0.054	0.003	94%
2017	AUG	21&22-Aug	0.45	75.18	68.58	0.052	0.029	44%
2017	AUG	25-Aug	0.33	351.9	19.44	0.082	0.002	98%
2017	SEP	10-Sep	0.03	147.24	0.00	0.037	0.0	100%
2017	SEP	16&17-Sep	0.65	381.54	76.02	0.090	0.017	81%
2017	SEP	18&19-Sep	0.5	489.66	306.18	0.131	0.041	69%
2017	SEP	24-26-Sep	1.71	1478.8	649.62	0.119	0.072	39%
2017	OCT	1-Oct	0.20	410.52	72.78	0.094	0.009	90%
2017	OCT	2-Oct	0.48	686.52	230.58	0.132	0.032	76%
2017	OCT	3-Oct	0.25	202.38	169.86	0.087	0.017	80%
2017	OCT	5&6-Oct	0.65	1102.32	315.24	0.111	0.086	23%
2017	OCT	6&7-Oct	1.9	2010.54	908.64	0.076	0.054	29%
2017	OCT	9-Oct	0.02	21.06	0.00	0.016	0.0	100%
2017	OCT	10-Oct	0.59	787.8	115.14	0.129	0.012	91%
2017	OCT	14-Oct	0.10	245.76	0.36	0.056	0.001	98%
2017	OCT	21-Oct	0.08	234.3	0.00	0.157	0.0	100%
2017	NOV	12-Nov	0.07	250.62	0.00	0.172	0.0	100%
		Total	15.71	12,241.90	4,451,58		**Average**	75%

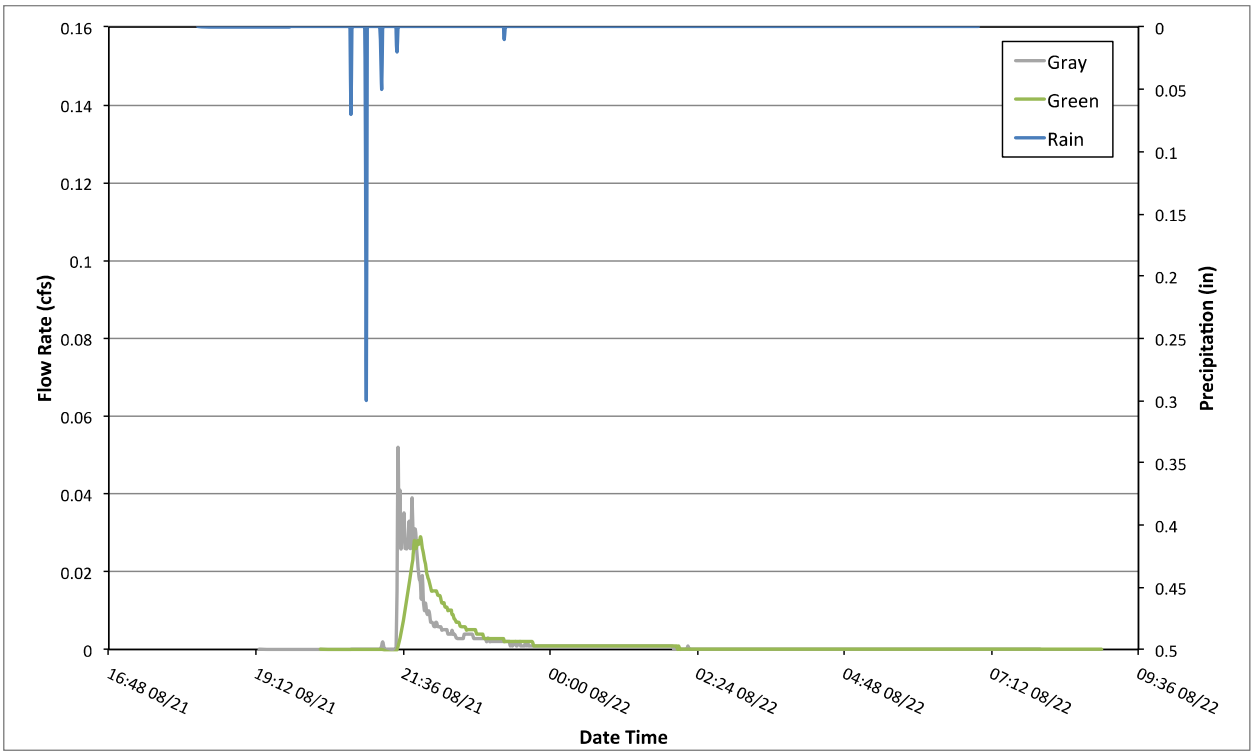

Figure 2. Discharge event for 08/22/2017 through 08/22/2017. Total precipitation for the event was recorded at 0.45 inches.

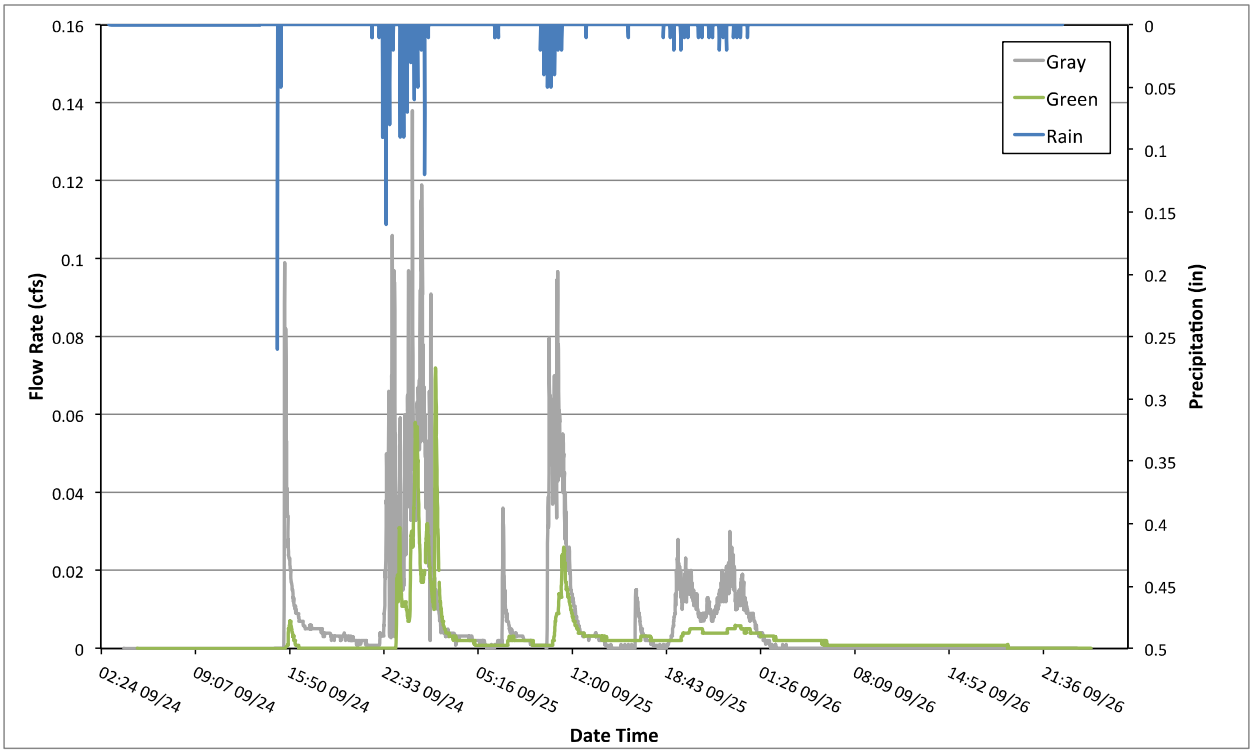

Figure 3. Discharge event for 09/24/2017 through 09/26/2017. Total precipitation for the event was recorded at 1.71 inches.

Saturated Hydraulic Conductivity (Infiltration) Assessment

2017 Monitoring Executive Summary

The purpose of this study was to estimate infiltration rates via saturated hydraulic conductivity (K_{sat}) measurements within bioretention systems, rain gardens, and adjacent traditional turf areas. K_{sat} is a quantitative measure of the maximum water transmission rate of a saturated soil. Data generated from this study will be added to annual assessments for each project, provide comparison estimates to baseline measurements collected in 2016, and examine seasonal variation of K_{sat} within individual bioretention systems and rain gardens. An additional objective of this study was to examine the spatial distribution of K_{sat} values. Understanding how these living systems function over time will help improve overall stormwater management.

Similar to 2016, we sampled nine sites throughout Omaha, Nebraska: Saddle Hills Park (SHP), University of Nebraska at Omaha (UNO) Welcome Center, Orchard Park (OP), Florence Streetscape (FL), The Benson East Gateway (BEN), Under the Sink Facility (UTS), Creighton Prep (CRP), South Omaha Industrial Area (SOIA) Lift Station, and Omaha Sewer Maintenance Facility (SMF) (Figure 1). A quick summary of site details can be found in Table 1.

Measurements were collected at all sites using Modified Philip-Dunne (MPD) Infiltrometers. The MPD infiltrometer is a falling head device used to measure the saturated hydraulic conductivity (K_{sat}) at the soil surface. K_{sat} is important for modeling infiltration rates within BMPs. Sampling at each site was conducted using a grid method technique. Grid sampling allows for a better approximation of the spatial variability for a given parameter within site, is easier to set up for routine monitoring, and provides better estimates for site characteristics as a whole. Grid sampling for each site was set up to account for 2016 sampling locations, while still trying to capture the spatial variability of K_{sat} within each site accurately.

Samples were collected during three periods throughout 2017; spring (mid-April to Mid-May), summer (late-June to early August), and fall (late October to early December). Sampling in fall occurred prior to the ground freezing. All nine sites were sampled in both the spring and fall of 2017. Only four sites (UNO, SMF, CRP, & Saddle Hills Park) were sampled during the summer of 2017 as a result of logistical constraints. A total of 560 MPD Infiltrometer samples were acquired in 2017, with a combined total of 672 samples across both the 2016 and 2017 sampling seasons.

Data generated were compared within site and against non-BMPs (nearby turf and landscape areas) adjacent to each site. Data were compared across sites for evaluation of pretreatment effect on K_{sat} within the bioretention systems, distribution of K_{sat} across the entire system, and plant influence.

Increased sampling periods throughout 2017 identified seasonal trends within and across our nine study sites. Across all sites, mean site values of K_{sat} were one and a half to five times larger in the fall than the spring (Table 2). Mean site values of K_{sat} recorded in the spring ranged from 4.56 to 17.19 in/hr and 15.57 in/hr to 37.62 in/hr in the fall. The Benson and Sewer Maintenance Facility bioretention gardens saw the largest increase in site average K_{sat} values from spring to fall. Two of the four sites that were sampled over spring, summer, and fall saw a steady increase in site average K_{sat} values during each sampling period. The University of Nebraska bioretention systems exhibited a low mean site K_{sat} value in the spring, a seven fold increase in the summer, and then decrease in the fall. Lower site average K_{sat} values in the spring could be indicative of higher ground water tables and/or dormant plant root systems, while higher site average K_{sat} values in the summer and fall could result from active root systems and greater evapotranspiration rates.

Comparative analysis between fall 2016 and fall 2017 sampling data saw slight increases in site average K_{sat} values (Table 2). Site average K_{sat} values ranged from 4.01 to 55.35 in/hr and 15.57 to 37.62 in/hr for fall 2016 and fall 2017, respectively. Saddle Hills Park and the University of Nebraska sites saw a significant decrease in site average K_{sat} from fall 2016 to fall 2017, which could correspond to variation in sample size. Increases in site average K_{sat} from year to year could be associated with vegetative growth, which has been shown to increase infiltration rates by increasing pore spaces within soil via root growth.

Spatial analysis of K_{sat} values within each study site identified “troubled spots” or areas of low permeability. These low permeability areas most often corresponded to locations within proximity or adjacent to inflow points. Despite various pretreatment options at each site, sedimentation, silt deposits, and erosion reduce permeability resulting in lower K_{sat} values.

The mean K_{sat} values across all sampling periods and for both rain gardens and bioretention systems sampled ranged from 14.37 to 31.20 in/hr (Table 2). Across all survey sites and all sampling periods, average measurements of saturated hydraulic conductivity in rain gardens (31.20 in/hr) and bioretention systems (19.55 in/hr) were significantly higher than those acquired over adjacent turf grasses (6.30 in/hr) (Table 4).

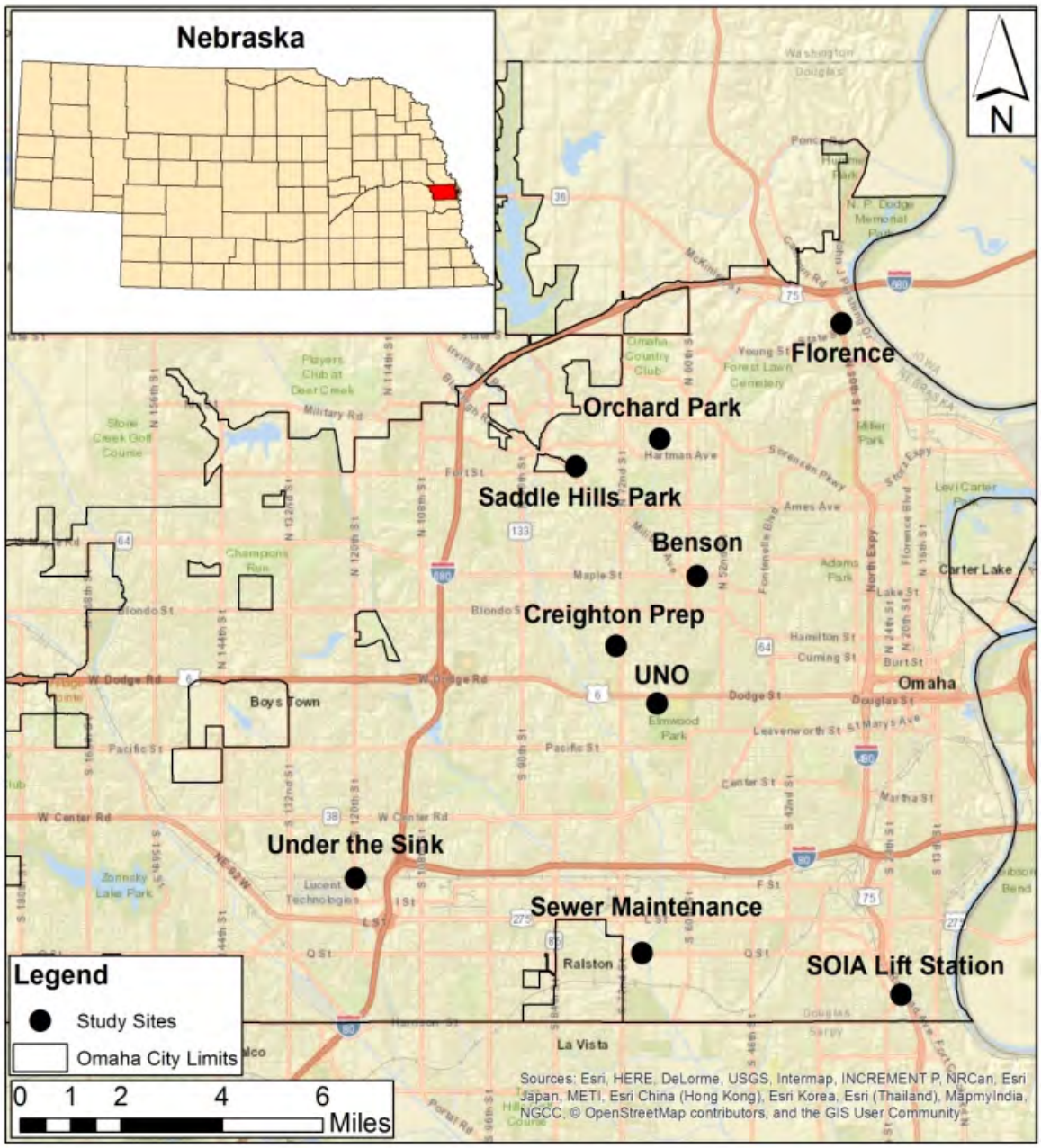

Figure 1. Map of the City of Omaha, Douglas County, highlighting the nine study sites in our study.

Table 1. Summary of project details for each of the nine study sites examined in this study.

Site	Install	Type*	Footprint (ft^2)	Contributing Area (acres)	% Footprint to Contributing Area	Design Volume (gal)	Pretreatment	Under-drain Outlet Control	Under-drain	Overflow	Bioretention Soil Mix
Saddle Hills Park	2014	RG	2,310	2.5	2.2	N/A	Utility box curb-wells	None	None	Soft weir in berm	Compost amended in-situ soils
University of Nebraska-Omaha	2012	B	1,345	0.6	5.5	2,469	None	4" Polyball valve	4" perforated HDPE	Soft weir in berm	50/50 sand/compost
Orchard Park	2009	B	3,180	0.8	9.2	14,270	Vegetated Forebay	2" Brass Curb-Stop Valve	4" perforated PVC	Offline system	50/50 sand/compost
Florence	2012	B	440	0.7	1.5	2,825	Stainless steel sediment trap w/ Permeable Base	2" Brass Curb-Stop Valve	4"perforated HDPE	Offline system	50/50 sand/compost
Benson	2013	B	1,225	1.0	2.8	5,535	2 Forebays & Dry Creek Bed	2" Brass Curb-Stop Valve	4" perforated PVC	High flow structure & soft weir	50/50 sand/compost
Under the Sink Facility	2008	B	1,540	2.5	1.4	9,620	Bioswale	4" Polyball valve	4" perforated HDPE	Soft weir in berm	50/50 sand/compost
Creighton Prep	2014	B	5,720	2.7	4.9	40,395	Permeable patio (East) & manhole sump w/Envirohood (West)	4" Slide Gate Valve	4" perforated PVC	Soft weir in berm	80/20 sand/compost
South Omaha Industrial Area	2014	B	3,400	0.7	11.5	25,430	Turf swale	4" Polyball valve	4" perforated PVC	High flow structure & soft weir	100% 1" washed limestone
Sewer Maintenance Facility	2014	B	2,200	0.95	5.3	39,085	Permeable paver parking lot (East) & Forebay (West)	4" Slide Gate Valve	4" perforated PVC	High flow structure	100% pea gravel

*RG = Rain Garden; B= Bioretention System

Table2. Summary of mean K_{sat} values (in/hr) and number of samples acquired (N) for each of the nine study sites during each sampling period.

Site	Fall 2016	*N*	Spring 2017	*N*	Summer 2017	*N*	Fall 2017	*N*	Cumulative	*N*
SHP	55.31	*16*	13.92	*25*	25.59	*7*	34.15	*29*	31.20	*77*
OP	11.77	*4*	13.68	*13*	-	*-*	15.99	*12*	14.37	*29*
BEN	27.55	*6*	4.56	*18*	-	*-*	25.66	*18*	16.89	*42*
UNO	55.35	*6*	5.37	*20*	40.69	*17*	15.63	*18*	23.16	*61*
FL	18.28	*6*	8.84	*17*	-	*-*	24.61	*17*	16.96	*40*
CRP	4.01	*8*	10.12	*25*	16.47	*25*	15.57	*26*	14.95	*84*
UTS	12.57	*7*	-	*-*	-	*-*	16.48	*9*	20.90	*16*
SOIA	29.14	*15*	17.19	*34*	-	*-*	33.31	*33*	25.86	*82*
SMF	20.83	*7*	7.73	*11*	21.36	*13*	37.62	*13*	22.59	*44*

Table 3. Summary of mean K_{sat} values (in/hr) and number of samples acquired (N) for individual bioretention systems and/or rain gardens at each of the nine study sites during each sampling period.

Site	Fall 2016	*N*	Spring 2017	*N*	Summer 2017	*N*	Fall 2017	*N*	Cumulative	*N*
SHP	55.31	*16*	13.92	*25*	25.59	*7*	34.15	*29*	31.20	*77*
SHP-E	65.41	*10*	17.28	*11*	29.36	*3*	35.66	*12*	37.78	*36*
SHP-W	38.48	*6*	11.27	*14*	22.76	*4*	33.08	*17*	25.96	*41*
UNO	55.35	*6*	5.37	*20*	40.69	*17*	15.63	*18*	23.16	*61*
UNO-N	76.46	*3*	2.43	*9*	50.36	*8*	4.89	*8*	24.76	*28*
UNO-S	34.25	*3*	7.78	*11*	32.09	*9*	24.23	*10*	21.80	*33*
FL	18.28	*6*	8.84	*17*	-	*-*	24.61	*17*	16.96	*40*
FL-E	30.56	*3*	8.20	*12*	-	*-*	18.72	*12*	15.36	*27*
FL-W	6.00	*3*	10.39	*5*	-	*-*	38.73	*5*	20.28	*13*
CRP	4.01	*8*	10.12	*25*	16.47	*25*	15.57	*26*	14.95	*84*
CRP-W	3.09	*4*	9.37	*13*	12.25	*14*	13.84	*14*	11.10	*45*
CRP-E	4.93	*4*	10.94	*12*	21.85	*11*	17.59	*12*	19.69	*39*
UTS BG	12.57	*7*	-	*-*	-	*-*	16.48	*9*	20.90	*16*
UTS BG3	10.88	*3*	-	*-*	-	*-*	7.05	*4*	8.69	*7*
UTS BG4	18.12	*3*	34.93	*7*	-	*-*	24.02	*5*	27.93	*15*

Table 4. Summary of mean K_{sat} values (in/hr) and number of samples acquired (N) from all nine study sites throughout each sampling period.

Averages (in/hr)	**2016 Fall**	**N**	**2017 Spring**	**N**	**2017 Summer**	**N**	**2017 Fall**	**N**	**Collectively**	**N**
Turf with BG	5.57	*16*	3.23	*15*	-	*-*	8.39	*16*	5.78	*47*
Turf	6.30	*14*	3.23	*13*	-	*-*	7.45	*14*	5.72	*41*
BG	0.431	*2*	3.22	*2*	-	*-*	14.93	*2*	6.19	*6*
Tree Planters	33.30	*6*	14.20	*8*	-	*-*	46.89	*8*	31.30	*22*
Bioretention	23.00	*59*	11.62	*145*	25.11	*55*	23.94	*146*	19.55	*405*
Bioretention Infiltration Cell	19.42	*13*	14.38	*37*	22.66	*15*	20.99	*39*	18.68	*104*
Bioretention Basin	24.01	*46*	10.68	*108*	26.03	*40*	25.01	*107*	19.85	*301*
Rain Garden	55.31	*16*	13.92	*25*	25.59	*7*	34.15	*29*	31.20	*77*

Final Report

City of Omaha, Nebraska

2017 Stormwater BMP Monitoring
Project No. 84726

Revision A
3/15/2018

Final Report

prepared for

City of Omaha, Nebraska
2017 Stormwater BMP Monitoring
Omaha, Nebraska

Project No. 84726

Revision A
3/15/2018

prepared by

Burns & McDonnell Engineering Company, Inc.
Kansas City, Missouri

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LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
Burns & McDonnell	Burns & McDonnell Engineering Company, Inc.
BMP	Stormwater Best Management Practice
Creighton Prep	Creighton Preparatory School
EC	Electrical Conductivity
MCC	Metropolitan Community College
NVR	Network Video Recording
PVC	Polyvinyl Chloride
SMS	Soil Moisture Sensor
STB	Stilling Basin
STW	Stilling Well
UNO	University of Nebraska Omaha
USGS	United States Geological Survey
VMC	Volumetric Moisture Content

1.0 INTRODUCTION

The City of Omaha, Nebraska (City) has implemented a Stormwater Best Management Practice (BMP) monitoring program to evaluate the performance at several BMP sites across the City. This report summarizes the sites evaluated during the 2017 monitoring period and the data collected, organized by site.

1.1 Background

In 2015 Burns & McDonnell partnered with the City of Omaha to develop a detailed implementation plan for the Draft BMP Monitoring Plan, dated November 5, 2014. The sites chosen for the monitoring plan include: Creighton Preparatory School (Creighton Prep) Bioretention; Florence Bioretention; Fort Omaha Metropolitan Community College (MCC) Bioretention Garden; Orchard Park Bioretention and Rain Gardens; and University of Nebraska Omaha (UNO) Welcome Center Bioretention Garden.

In 2016, the first round of monitoring equipment was selected and installed at the Creighton Prep Bioretention and Orchard Park Bioretention sties. Additionally, in 2016, the University of Nebraska was supported in installing equipment at the Orchard Park site. The 2017 monitoring activities continued to build on the findings from 2016 with additional BMP monitoring at the UNO Welcome Center site, and monitoring plans were developed for Dundee Elementary and Adams Park sites.

1.2 Data Collection

Data was collected at each site based on the monitoring plans developed in conjunction with the City. Specific data collected for each site is described in Section 4.0 of this report and generally as follows:

- Video Data
- Equipment Data
  - Water Level Data from Pressure Transducer Data
  - Soil Moisture Sensor Data
  - Flow Meter Data
  - Rain Gauge Data

Additionally, a ‘Water Quality Sampling Protocol’ was developed in during the 2017 monitoring period, based on the water quality work completed in 2016. The ‘Water Quality Sampling Protocol’ is included in Appendix B for reference.

2.0 MONITORING SITES

2.1 Orchard Park

2.1.1 Site Description

The Orchard Park site is located on the western edge of Orchard Park near the intersection of N 66th Street and Kansas Avenue. The bioretention garden was constructed in 2009 and receives runoff from two street side curb-cuts which serve an approximate 1.0-acre drainage area. t For rain events that produce runoff greater than the designed bioretention garden capacity, the bioretention garden is bypassed and flow enters the adjacent storm inlets.

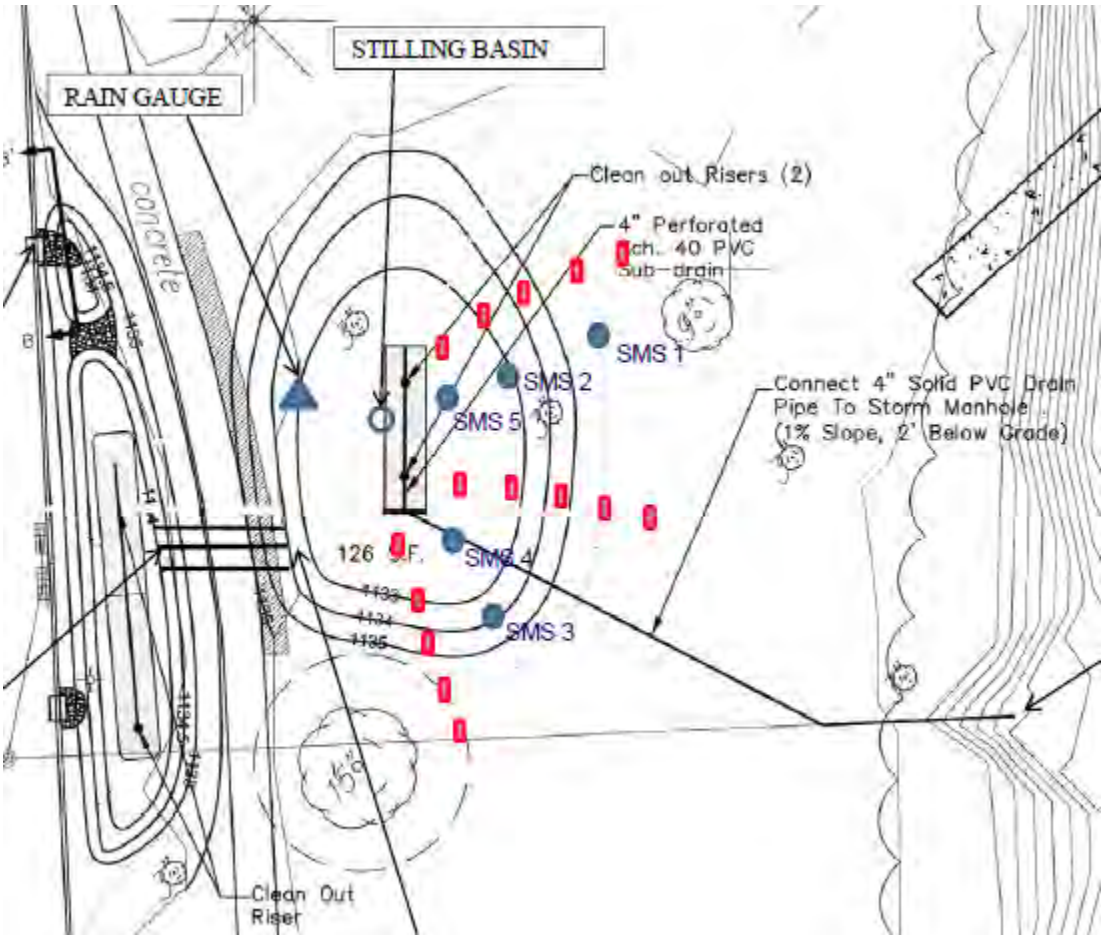

Figure 2-1: Orchard Park Site Plan

2.1.2 Monitoring

The following equipment was used to collect data at the Orchard Park site:

- ECH20 GS3 Soil Moisture Sensors by Decagon Devices, Inc.
- Em50 Data Loggers by Decagon Devices, Inc.
- ECRN-100 High Res Rain Gauge by Decagon Devices, Inc.
- WL16 Pressure Transducer and Data Logger Combination by Global Water

The three data loggers controlled the collection of data from the rain gauge and the soil moisture sensors (SMS). Soil moisture sensors were installed at depths of 6 inches and 36 inches below grade at five locations. The ponding depth within the bioretention basin was monitored using a stilling basin with a pressure transducer. The stilling basin was made of 4-inch polyvinyl chloride (PVC) pipe with 3/8-inch perforation holes on 1.5-inch centers. The pressure transducer was mounted on the inside of the stilling basin pipe at ground level and recorded the ponding depth every 5 minutes.

2.1.3 Period of Record

During the 2017 monitoring period, the rain gauge and pressure transducer were installed from April to November. Soil moisture sensors remained in place year-round. Soil Moisture Sensor Data

ECH20 GS3 Soil Moisture Sensor data was collected on site from January to October at five sites with some data gaps as discussed in Section 2.1.4. Soil moisture sensor data is provided electronically.

2.1.3.1 Stilling Basin Data

A Global Water WL 16 pressure transducer within a single stilling basin recorded ponding depth on site from April to May. Data gaps and suspect data due to equipment malfunctions are discussed in Section 2.1.4.

2.1.3.2 Water Quality Data

No water quality data was collected during the 2017 monitoring period.

2.1.4 Monitoring Issues and Equipment

During the monitoring period, several equipment issues resulted in gaps in the data. Four soil moisture sensors had data gaps due to damaged cables, port connection issues, and data logger battery life at various times throughout the year. Additionally, the batteries died in one data logger resulting in a 2-month gap between data collection site visits.

The rain gauge was installed in April and connected to one of the data loggers. During the first data collection in June, it was observed that the gauge showed only two instances of measured precipitation, when in reality, there were several precipitation events during that same timeframe. The rain gauge was

found to have a buildup of dirt in the gauge's collection area and was thoroughly washed and tested to make sure it was registering data. The gauge appeared to be operational, but data collected during the rest of the monitoring period continued to show inconsistencies and inaccuracies compared to other sources. After analyzing all data, it was concluded that none of the rain data from this equipment is usable. Local weather station in the vicinity will be used in lieu of the Orchard Park rain gauge.

During the monitoring period, the pressure transducer required unexpected manufacturer maintenance resulting in large gaps in the data. The pressure transducer was installed in April. Data was collected without an issue through June. In September the pressure transducer was inoperable and needed to be sent back to the manufacturer for repairs. The pressure transducer at Orchard Park was replaced with one of the pressure transducers from the Creighton Prep site. This sensor was found to be inoperable as well during the next site visit to collect data. After also sending this pressure transducer back to the manufacturer for repair, some data was recovered and included in our findings.

It appeared that the WL16 Global Water pressure transducers had internal moisture issues due to a breakdown of water resistant features over the course of being exposed to the elements. Although these pressure transducers are designed to be completely submerged, only pressure transducers directly in the stilling basin within ponding depth had performance issues while none of the pressure transducers in the sealed wells did.

Table 2-1: Orchard Park Available Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Transducers:												
STB				x[1]	x[1]					x	x	-
Soil Moisture Sensors												
SMS-1	x	x	x	x	x	x	x	x				-
SMS-2	x	x	x	x	x[2]	x[2]	x[2]	x[2]				-
SMS-3	x[3]	x[3]	x[3]	x[3]	x[3]	x[3]	x[3]	x[3]	x[3]	x[3]		-
SMS-4	x	x	x	x	x	x	x	x	x	x		-
SMS-5	x	x	x	x	x	x	x	x	x	x		-

[1] STB data in April and May was suspect and not used during the analysis.

[2] SMS-2A_6" of Data Logger 2 didn't work from 5/16/17 to 6/15/17 and recorded suspect data from 6/15/17 forward

[3] SMS-3B_36" of Data Logger 3 didn't work from 1/16/17 forward

2.2 Creighton Prep

2.2.1 Site Description

The Creighton Prep site is located on the southern edge of the Creighton Preparatory High School near the intersection of N 72nd Street and Western Avenue. Drainage to the bioretention garden at the Creighton Prep site generally comes from parking lot runoff to the west through a 24-inch storm sewer with a contributing area of 2.1 acres (80% impervious) and receives overland flow runoff from a 7.7-acre irrigated grass turf sports field to the north. The bioretention garden was constructed in spring 2014. A 4-inch PVC pipe underdrain runs the length of the bioretention garden which regulates the amount of surface flow through the soils and subsurface drainage. For storm events producing runoff greater than 0.5-inches the primary cobble berm is overtopped and the area inlet collects and conveys stormwater to the 36-inch storm sewer downstream in Western Avenue.

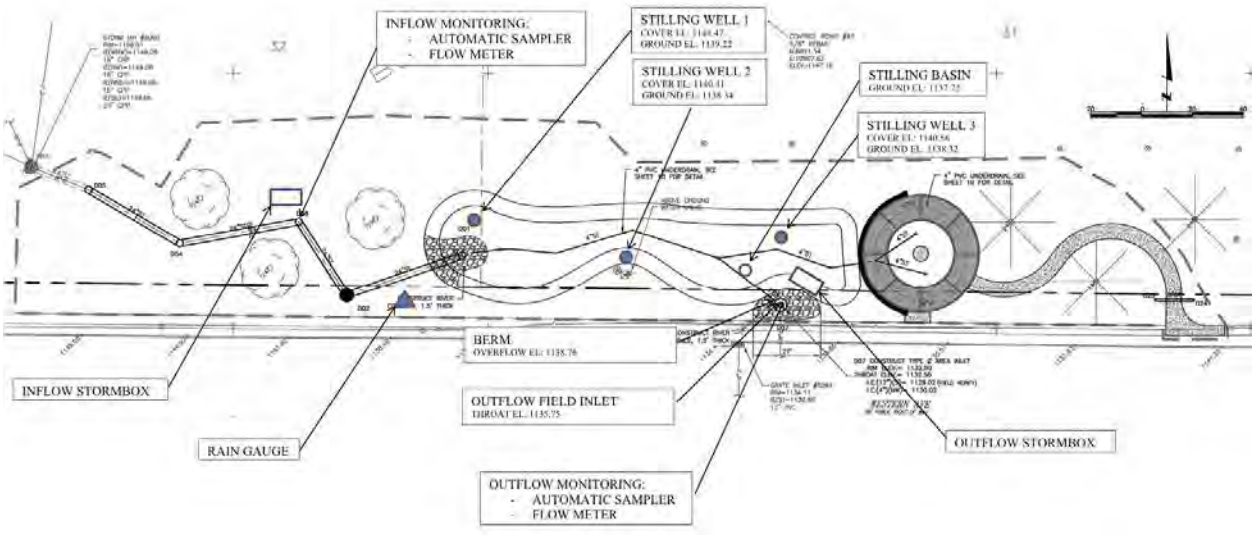

Figure 2-2: Creighton Prep Site Plan

2.2.2 Monitoring

The following equipment was used to collect data at the Creighton Prep site:

- ISCO 674 Rain Gauge
- ISCO 2150 Area Velocity Module
- WL16 Pressure Transducer and Data Logger Combination by Global Water

The area velocity meters were installed in the 24-inch inflow pipe and the 12-inch area inlet outflow pipe. The inflow and outflow rates were measured every 5 minutes once flow was detected. The inflow rates were summed for each event to determine a total inflow volume from the primary drainage area. The outflow discharge rates were similarly summed to estimate outflow volumes by event.

The local water table beneath the bioretention basin was monitored using three stilling wells. Each 2.5-inch diameter stilling well was installed to a depth of approximately 10 feet with 5 feet of well screen. A pressure transducer was installed to record depth of water every 15 minutes.

The ponding depth within the bioretention basin was monitored using a stilling basin and a pressure transducer. The stilling basin was made of 4-inch PVC pipe with 3/8-inch perforation holes on 1.5-inch centers. A pressure transducer was mounted on the inside of the stilling basin pipe at ground level and recorded the ponding depth every 5 minutes.

The rain gauge was installed for local precipitation data at the site. Rain gauge data was collected and stored along with area velocity meters in the ISCO controller.

2.2.3 Period of Record

During the 2017 monitoring period, the rain gauge, stilling basin pressure transducer, and area velocity meters were installed from April to November. Stilling well pressure transducers remained in place year-round and data was collected throughout the year.

2.2.3.1 Flow Meter Data

ISCO 2150 Area velocity flow meters recorded flow on site from April to September with some data gaps as discussed in Section 2.2.4. During this period of record, 37 inflow flow events and 48 outflow events were recorded. The largest inflow measured was approximately 27 cubic feet/second on 6/16/17 and the largest outflow recorded during the same event. Flow data is provided electronically.

2.2.3.2 Stilling Basin Data

A Global Water WL 16 pressure transducer within a stilling basin recorded ponding depth on site from April to May. During this monitoring period several ponding events were recorded. The maximum ponding event elevation was 0.3 feet on 5/16/17. However, this maximum does not correspond with the anticipated ponding for the inflow rate measured by the flow meters and indicates that the stilling basin was not operating accurately during the period of record. Data gaps due to equipment malfunctions are further discussed in Section 2.2.4. Complete ponding data is provided electronically.

2.2.3.3 Stilling Well Data

Global Water WL 16 pressure transducers within shallow monitoring wells recorded local water table levels on site from January to August with some data gaps as discussed in Section 2.2.4. Stilling Wells are located in the northeast corner, the south center, and the northwest corner of the bioretention cell. During the monitoring period, the well data varied greatly between wells for the same events. Stilling well data is provided electronically.

2.2.4 Water Quality Data

No water quality data was collected during the 2017 monitoring period.

2.2.5 Monitoring Issues and Equipment

During the monitoring period, several pressure transducers became inoperable and required manufacturer maintenance. Working pressure transducers were moved around the sites to replace those that became inoperable at locations where to minimize total site data gaps. The ponding depth data, collected by stilling basins, took priority over the stilling well data, so working pressure transducers were transferred from stilling wells to replace the inoperable pressure transducers in stilling basins. This transferring of pressure transducers resulted in data gaps for two of the three stilling wells at Creighton Prep for a majority of the year.

During the August site visit for data collection, the inflow area velocity meter was not responsive. After further investigation it was discovered that the batteries died, resulting in a data gap for the inflow and rain gauge data.

Table 2-2: Creighton Prep Available Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Transducers:												
STW-1	x	x	x	x	x	x	x	x				
STW-2	x	x	x	x	x	x						
STW-3	x	x	x	x								
STB				x	x							
Flow Meters:												
Inflow				x	x	x	x	x	x	x		
Outflow				x	x	x	x	x	x	x		
Precipitation:												
Rain Gauge				x	x							

2.3 UNO Welcome Center

2.3.1 Site Description

The UNO Welcome Center site is located on the west side of the University of Nebraska – Omaha, Nebraska campus at 6001 Dodge Street near the Welcome Center. Drainage to the bioretention garden at the UNO Welcome Center site generally comes from Welcome Center building runoff through two 8-inch drain pipes east of the bioretention garden. The bioretention garden was constructed in 2012. Two infiltration trenches, Type A and Type B, tie into a 4-inch PVC pipe underdrain which regulates the subsurface drainage. For the Type B infiltration trench, ponding depths greater than 1 foot overtop the segmental retaining wall into the Type A infiltration trench. For the Type A infiltration trench, ponding depths greater than 1 foot overtop the precast wall cap unit onto the river rock apron, where the trench drain inlet collects and conveys stormwater to the existing 4-inch PVC pipe.

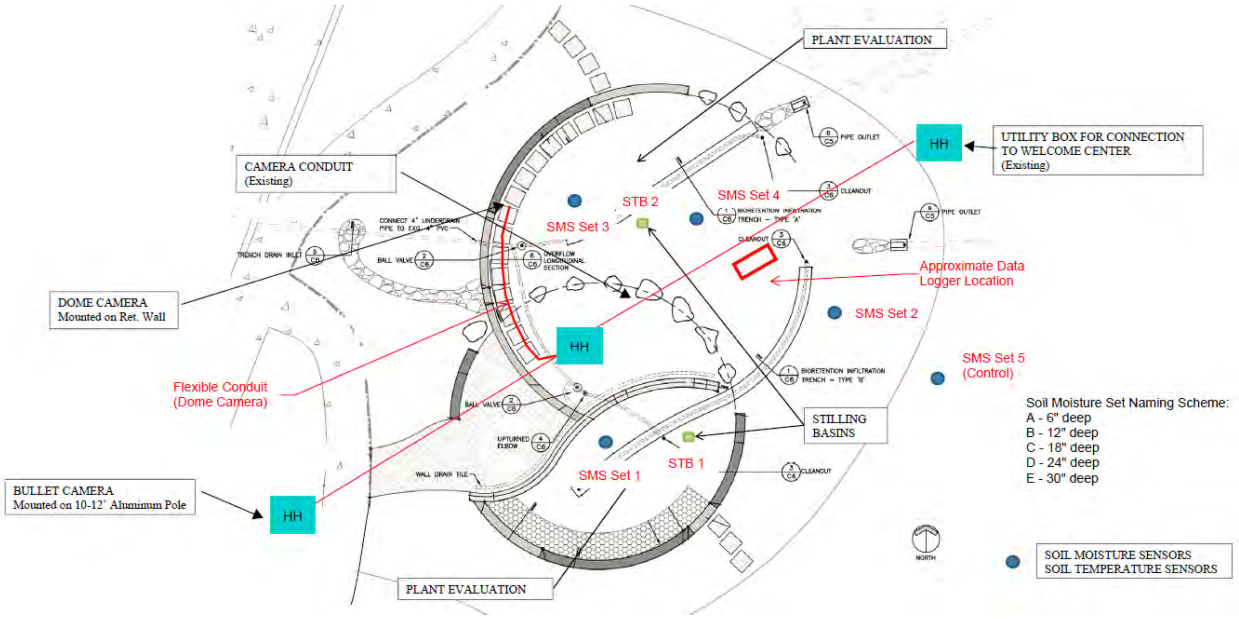

Figure 2-3: UNO Site Plan

2.3.2 Monitoring

The following equipment was used to collect data at the UNO Welcome Center site:

- 25 Campbell Scientific (Models: CS655-U-L40-PT-DS, CS655-U-L30-PT-DS, and CS655-U-L25-PT-DS) Soil Moisture Sensors
- 2 Campbell Scientific CS451-75-SA-7-SN Pressure Transducers

- Campbell Scientific CR6-NA-ST-SW Data Logger
- Two Cameras with Network Video Recording (NVR)

The soil moisture sensors were installed at five locations in and around the bioretention garden. At each of the five locations, a sensor was buried at 6 inches, 12 inches, 18 inches, 24 inches, and 30 inches below ground surface. The sensors recorded volumetric moisture content, temperature, and electric conductivity every 15 minutes.

The ponding depth within the bioretention garden was monitored using a stilling basin and a pressure transducer and at two locations. The stilling basins were made of 4-inch PVC pipe with 3/8-inch perforation holes on 1.5-inch centers. A pressure transducer was mounted on the inside of each stilling basin pipe at ground level and recorded the ponding depth every 5 minutes.

2.3.3 Period of Record

During the 2017 monitoring period, the two stilling basins with pressure transducers were installed in April to begin the sampling period for the wet season and 25 soil moisture/temperature sensors remained in place year-round.

2.3.3.1 Soil Moisture Sensor Data

Campbell Scientific Soil Moisture Sensor data was collected on site at 5 locations from January to December with some data gaps as discussed in Section 2.3.4. Soil moisture sensor data is provided electronically.

2.3.3.2 Stilling Basin Data

Campbell Scientific CS451-75-SA-7-SN pressure transducers within stilling basins recorded ponding depth on site at two locations from April to December. Data gaps due to equipment malfunctions are discussed in Section 2.3.4. Stilling basin data is provided electronically.

2.3.3.3 Water Quality Data

No water quality data was collected during the 2017 monitoring period.

2.3.4 Monitoring Issues and Equipment

During the monitoring period precipitation data from the UNO weather station was not downloaded with enough frequency to provide granularity of date for intensity. Precipitation data from the UNO weather station was only available as daily summaries. Working pressure transducers were moved around the sites to replace those that became inoperable at locations where data was more desired. The ponding depth

data, although appearing as "operational" did not show response to precipitation events during April and May.

Table 2-3: UNO Available Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Transducers:												
STB-1				x[1]	x[1]	x	x	x	x	x	x	x
STB-2				x	x	x	x	x	x	x	x	x
Soil Moisture Sensors:												
SMS-1	x	x	x	x	x	x	x	x	x	x	x	x
SMS-2	x	x	x	x	x	x	x	x	x	x	x	x
SMS-3	x	x	x	x	x	x	x	x	x	x	x	x
SMS-4	x	x	x	x	x	x	x	x	x	x	x	x
SMS-5	x	x	x	x	x	x	x	x	x	x	x	x

[1] In April and May, the pressure transducer in STB-1 was operable but was not recording a response to precipitation events that should have resulted in ponding.

2.4 Dundee Elementary

2.4.1 Site Description

A site visit was completed 6/27/17 at the Dundee Elementary Stormwater Demonstration Classroom to evaluate the site and discuss the proposed monitoring implementation plan. Overall, the plan includes the following elements:

- Rain gauge mounted to the Dundee Elementary School roof for precipitation data
- Pressure transducer within the 500-gallon rain silo to track harvested rainwater depths
- Monitoring camera on the building to monitor plant growth

At the time of this report, the monitoring equipment had been procured but not installed. The monitoring camera is in the possession of the school principal. A goal in the setup of this site is the inclusion of school students and staff to participate in the monitoring of the outdoor classroom area. The proposed monitoring activities could be included in science classes or clubs sponsored by the school to engage and educate the local school children on stormwater management.

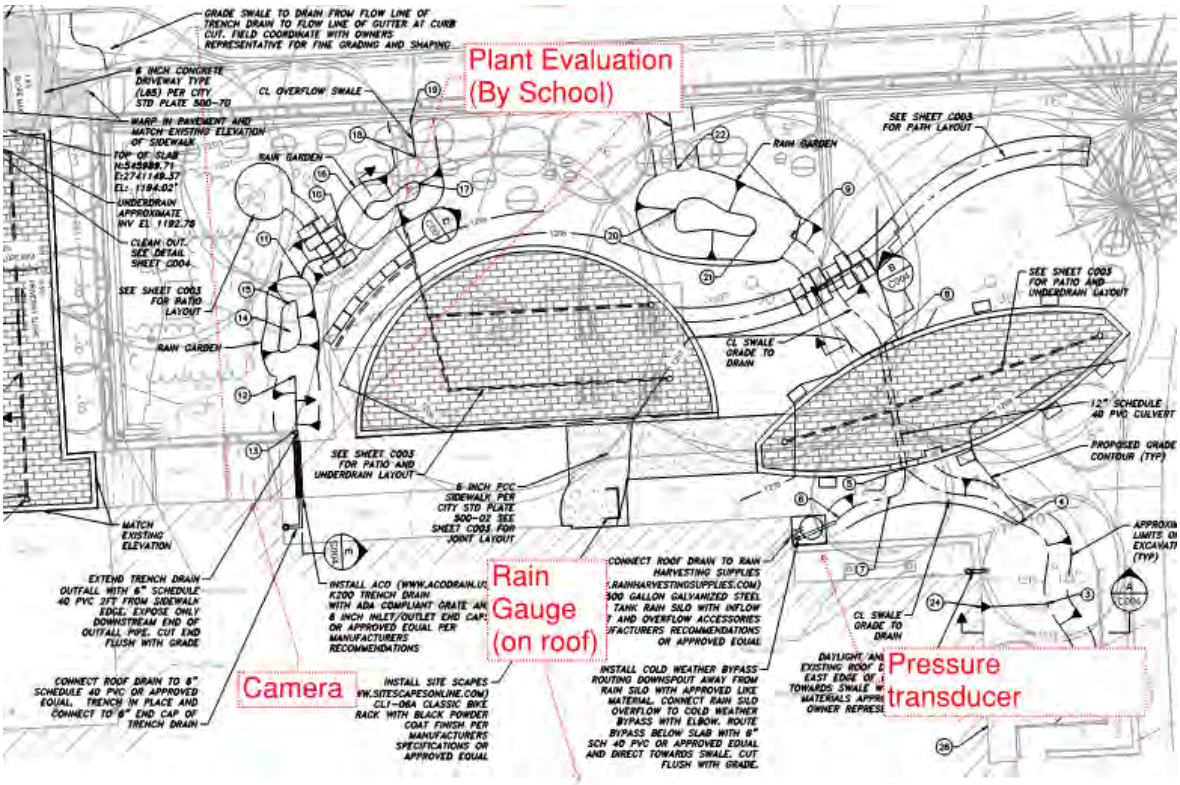

Figure 2-4: Dundee Elementary Site Plan

No data was collected during the 2017 monitoring period.

2.5 Adams Park

2.5.1 Site Description

A site visit was completed on 6/27/17 at the Adams Park wetland and detention facility to evaluate the site and discuss the proposed monitoring implementation plan. Overall, the plan includes the following elements:

- Rain gauge on the Adams Park Community Center roof for precipitation data
- Pressure Transducers on the future park road bridge near the box culvert and one additional site within the wetland to monitor water depth
- Either a pressure transducer or ultrasonic flow meter on outlet structure for flow monitoring

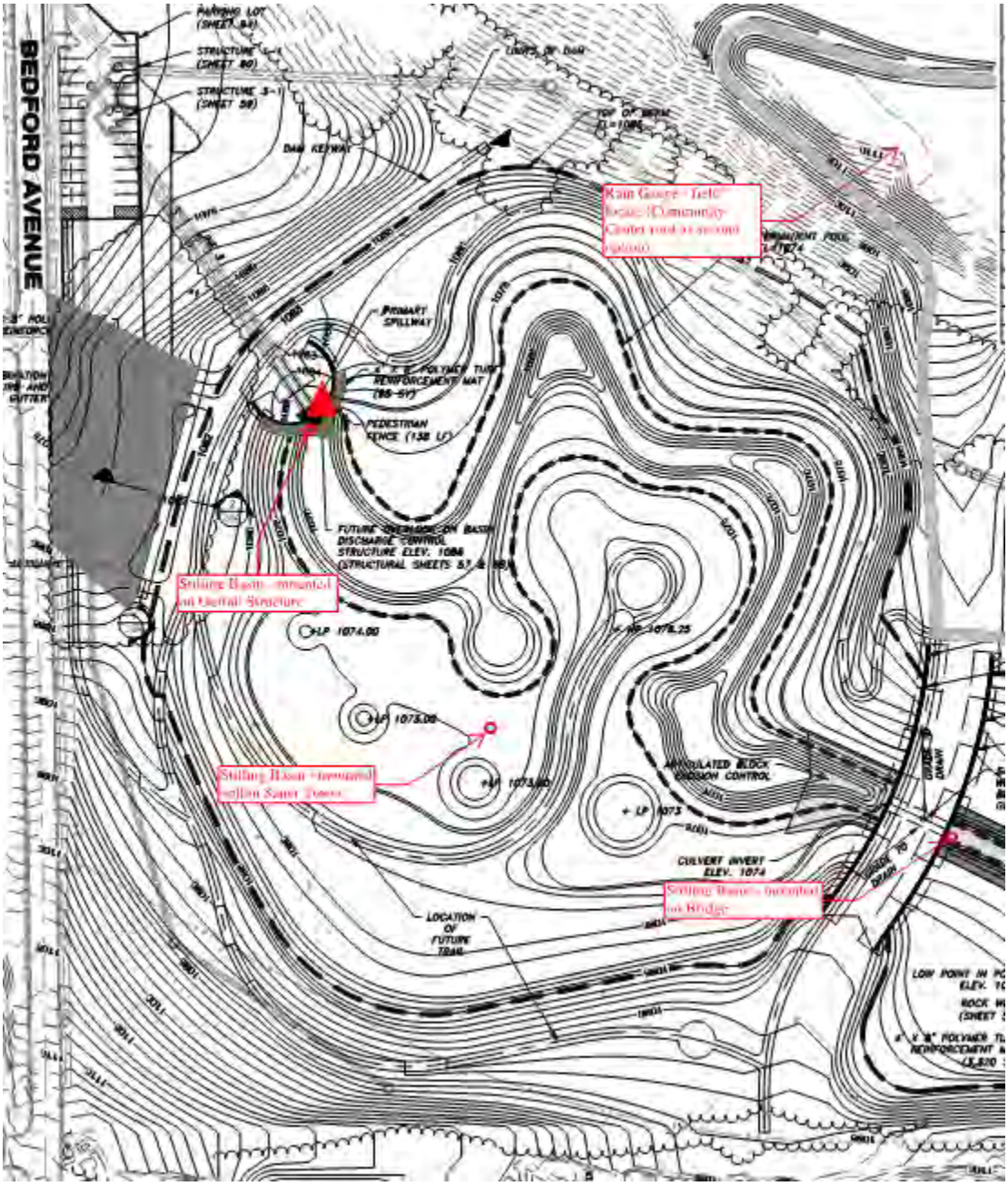

Figure 2-5: Adams Park Site Plan

No data was collected during the 2017 monitoring period.

3.0 SITE WEATHER CONDITIONS

3.1 Data

Daily weather history and observations from the Eppley Airfield Weather Station were downloaded from https://www.wunderground.com/history/airport/KOMA/. Appendix A contains monthly weather history and observation tables for the monitoring period.

Provisional rain data from the United States Geological Survey (USGS) 06610765 site at Little Papillon Creek at Ak-Sar-Ben in Omaha, Nebraska was used to supplement collected data since the on-site rain gauges had many data gaps or were inoperable throughout the 2017 monitoring period. USGS 06610765 provisional rain data was recorded at 5-minute intervals from March 1, 2017 through October 31, 2017.

3.2 Observations

During the monitoring period, the overall weather conditions were warmer and drier than normal, with below-average snowfall. The National Weather Service, in an article published in the Omaha World Herald on January 6, 2018, stated that "official data from Eppley Airfield showed Omaha had the sixth-warmest year on record, with an average temperature of 54 degrees. That average was 3 degrees above normal."

Based on the Eppley Airfield Weather Station data, the total precipitation is 2017 was 26.38 inches which is a departure from 30.63 inches annually. Further, there were 22 precipitation events that exceeded 0.5 inches and seven precipitation events that exceeded 1 inch. A summary of the 0.5-inch and 1-inch events are included in Table 3-1.

Table 3-1: 2017 Event Summary for 0.5-inch and 1.0-inch Events

Date	24-hour Rainfall Total
2/23/17	0.50
3/24/17	0.60
3/29/17	1.21
4/30/17	0.95
5/10/17	0.64
5/16/17	1.35
5/18/17	0.53
5/19/17	0.94
5/20/17	0.55
6/16/17	1.13
6/29/17	0.74
7/26/17	0.57
8/15/17	0.59
8/20/17	0.50
8/21/17	1.07
8/25/17	0.64
9/17/17	1.05
9/25/17	1.05
10/2/17	0.73
10/5/17	0.68
10/6/17	1.15
10/10/17	0.54

4.0 RESULTS

4.1 Orchard Park

Three events were evaluated at the Orchard Park site. Events were selected based on periods of available data and to reflect a range of rainfall events from 0.5-inches to 1-inch, singular events, and back-to-back events. Although five soil moisture sensor sets were installed, only SMS-1, SMS-2, SMS-4, and SMS-5 were used to analyze the following events for migration of the wetting front. SMS-3 was not used due to data gaps and vertical elevation correlation between soil moisture sensor depths. SMS-4, 6 inches below ground surface, SMS-5, 6 inches below ground surface, SMS-2, 6 inches below ground surface, and SMS-1, 36 inches below ground surface are located at approximately the same elevation. SMS-4, 36 inches below ground surface, SMS-5, 36 inches below ground surface, and SMS-2, 36 inches below ground surface are located at approximately the same elevation. SMS-4, SMS-5, SMS-2 are located within the bioretention garden extents. SMS-1 is the control and is located outside of the bioretention garden extents. The movement of the wetting front can be observed by comparing SMS-4, SMS-5, SMS-2, and SMS-1 volumetric moisture content (VMC) responses to rainfall.

4.1.1 Event 1: 5/10/2017 (0.60 inches)

This event was selected to most closely evaluate the water quality runoff event of 0.5 inches of runoff over a 24-hour period. The tributary area to Orchard park is highly impervious, indicating that this 0.60 inches of rainfall would result in approximately 0.5 inches of runoff. A plot of the VMC and rainfall data from the USGS rain gauge 06610765 demonstrates the bioretention garden's subsurface response to rainfall that approximately results in a water quality runoff event. Figure 5-1 depicts the findings of the Event 1 analysis.

The wetting front for this water quality runoff event infiltrates vertically into the engineered soil media but does not reach a depth 36 inches below ground surface. The wetting front does not extend laterally to the in-situ soils outside of the bioretention garden extents as seen by the lack of response in VMC for SMS-1 at 36 inches below ground surface. Additional observations for Event 1 are described in Table 5-1.

Figure 5-1: Event 1 Analysis

Table 5-1: Event 1 Observations

Callout ID	Sensor Set	SMS Description (depth below ground surface)	Observation
1	SMS-4	6 inches	• Moderate increase in VMC within 36 hours after rain event
2	SMS-4	36 inches	• Minimal to no increase in VMC within 24 hours after rain event
3	SMS-5	6 inches	• Sharp increase in VMC at tail end of rain event
4	SMS-5	36 inches	• No change to VMC following rain event
5	SMS-2	6 inches	• Moderate increase in VMC within 36 hours of rain event, followed by immediate drying
6	SMS-2	36 inches	• Minimal to no increase in VMC within 24-36 hours of rain event
7	SMS-1	6 inches	• Minimal to no increase in VMC during rain event
8	SMS-1	36 inches	• Minimal increase in VMC during rain event

4.1.2 Event 2: 6/16/2017 (1.32 inches)

This event was selected to most closely evaluate an event larger than the water quality runoff event of 0.5 inches over a 24-hour period. On 6/16/17 over 1 inch of rainfall fell over less than 3 hours. Event 2 is a larger, more intense event than Event 1, previously analyzed. A plot of the VMC and rainfall data from the USGS rain gauge 06610765 demonstrates the bioretention garden's subsurface response to intense rainfall that is more than two times the water quality runoff event. Figure 5-2 depicts the findings of the Event 2 analysis.

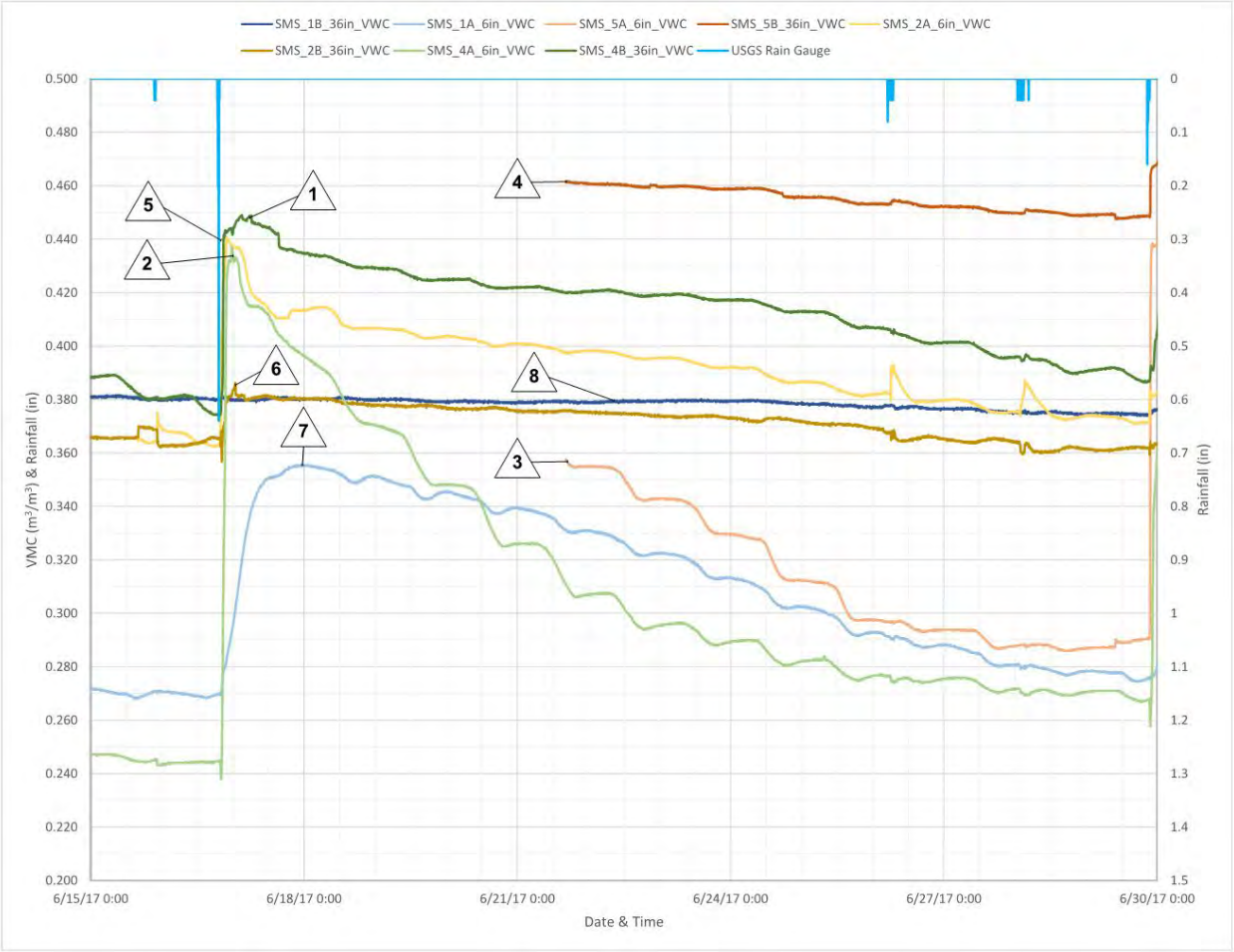

Figure 5-2: Event 2 Analysis

The wetting front for an event of this intensity and magnitude infiltrates into the top 6 inches of the soil profile adjacent to the bioretention garden extents. Water in the bioretention garden infiltrates vertically through the engineered soil profile to depths of 36 inches below ground surface, but does not extend laterally, indicated by the lack of VMC response for SMS-1 at 36 inches below ground surface. Additional observations for Event 1 are described in Table 5-2.

Table 5-2: Event 2 Observations

Callout ID	Sensor Set	SMS Description (depth below ground surface)	Observation
1	SMS-4	6 inches	• Sharp increase in VMC within 3 hours after event • Quicker drying of soil than SMS-4, 36-inch drying • Despite quickened drying, soil profile remains wetted for longer than 1 week following event
2	SMS-4	36 inches	• Sharp increase in VMC within 3 hours after event • Gradual drying of soil, where soil profile is wetted for longer than 1 week following event
3	SMS-5	6 inches	• Data gap for SMS-5 during the rain event • Drying mimicking SMS-4, 6-inch drying curve
4	SMS-5	36 inches	• Data gap for SMS-5 during the event • Drying more gradual than SMS-5, 6-inch drying curve
5	SMS-2	6 inches	• Moderate increase in VMC within 3 hours after event • Quicker drying of soil than SMS-2, 36-inch drying • Despite quickened drying, soil profile remains wetted for longer than 1 week following event
6	SMS-2	36 inches	• Sharp increase in VMC within 3 hours after event • Gradual drying of soil, where oil profile is wetted for longer than 1 week following event
7	SMS-1	6 inches	• Relatively sharp increase in VMC with peak VMC occurring at 24 hours after event • Relatively gradual drying of soil, where soil profile remains wetted for longer than 1 week following event
8	SMS-1	36 inches	• No increase in VMC during event

4.1.3 Event 3: 4/28/2017 to 5/1/2017 (1.44 inches)

This event was selected to most closely evaluate the site's response to back-to-back events. On 4/28/17 a rainfall event producing approximately the water quality runoff occurred, followed by an event on 4/30/17 that produced approximately two times the water quality runoff. The event on 4/28/17 was a morning rain of 0.44 inches of rainfall over a 12-hour period. On 4/29/17 0.08 inches of rainfall occurred, followed by 0.92 inches of rainfall over a 24-hour period on 4/30/17. A plot of the VMC and rainfall data from the USGS rain gauge 06610765 demonstrates the bioretention garden's subsurface response to prolonged rainfall that occurs in back-to-back events. Figure 5-3 depicts the findings of the Event 1 analysis.

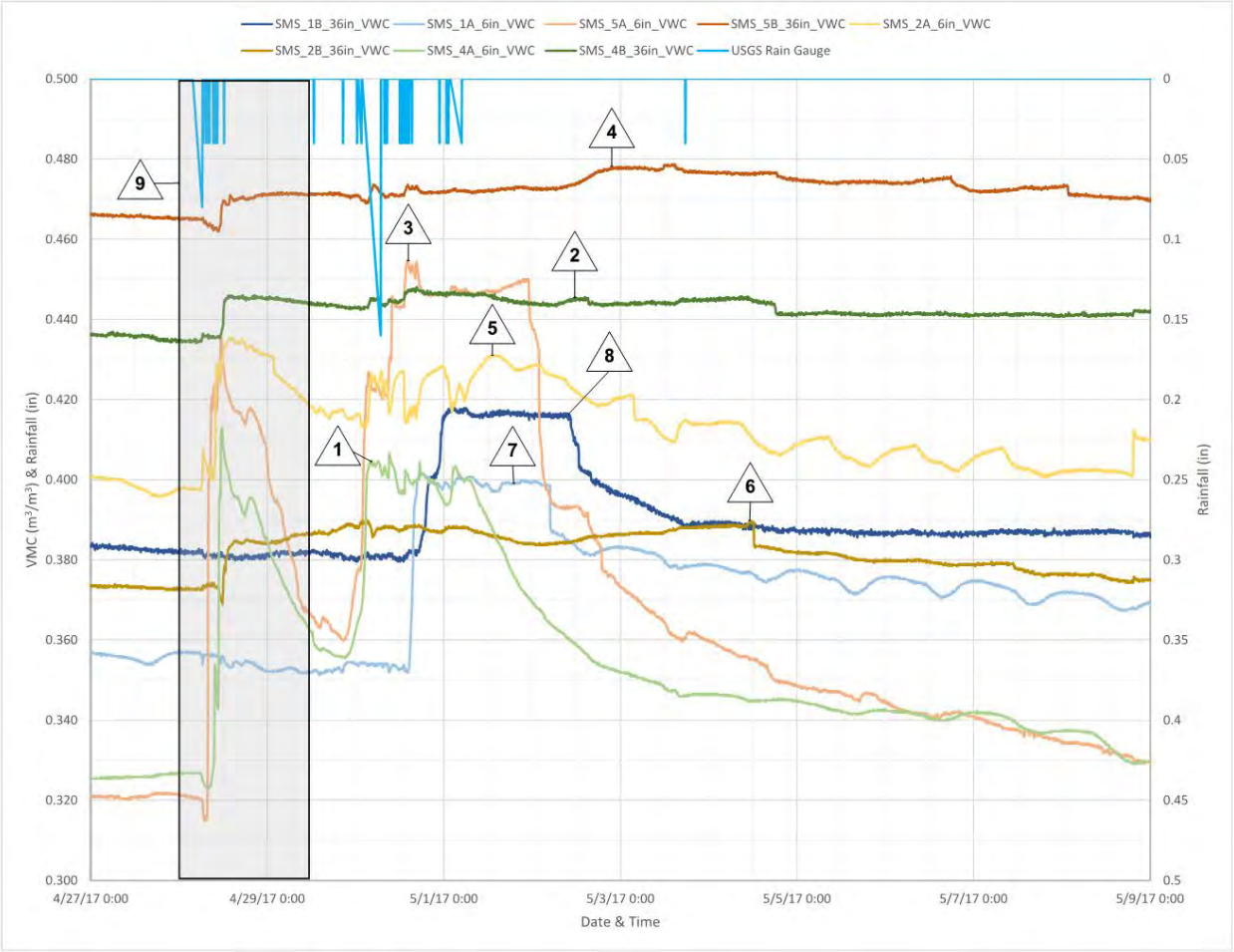

Figure 5-3: Event 3 Analysis

The wetting front for an event of this intensity and magnitude infiltrates into the top 6 inches of the soil profile adjacent to the bioretention garden extents. Water in the bioretention garden infiltrates vertically through the engineered soil profile to depths of 36 inches below ground surface, but does not extend laterally, indicated by the lack of VMC response for SMS-1 at 36 inches below ground surface. Additional observations for Event 1 are described in Table 5-3.

Table 5-3: Event 3 Observations

Callout ID	Sensor Set	SMS Description (depth below ground surface)	Observation
1	SMS-4	6 inches	• Responded similarly to Event 2, but had a period of prolonged wetting before subsequent drying of soil
2	SMS-4	36 inches	• Minimal additional increase in VMC after 4/30/17 event • Soil may be approaching saturated condition
3	SMS-5	6 inches	• Responded similarly to Event 2, but had a period of prolonged wetting before subsequent drying of soil
4	SMS-5	36 inches	• Minimal additional increase in VMC after 4/30/17 event • Soil may be approaching saturated condition
5	SMS-2	6 inches	• Responded similarly to Event 2, but had a period of prolonged wetting before subsequent drying of soil • SMS-2 had a slower drying rate than SMS-4 or SMS-5 possibly due to its proximity of adjacent in-situ soils. The clayey in-situ soils may be holding additional water after the event and contributing to the moisture content of the adjacent engineered soils.
6	SMS-2	36 inches	• Minimal additional increase in VMC after 4/30/17 event • Soil may be approaching saturated condition
7	SMS-1	6 inches	• Increase in VMC after prolonged wetting of soils 36 inches below the bottom elevation of the bioretention garden suggests vertical movement of wetting front before lateral movement.
8	SMS-1	36 inches	• Responded similarly to Event 2, but had a period of prolonged wetting before subsequent drying of soil
9	SMS-1,2,4,5	6 & 36 inches	• The VMC for all SMS sets (1, 2, 4, and 5) respond similarly to Event 1, an event of similar size

The following conclusions can be made on the performance of the Orchard Park Bioretention Garden:

1. Water quality runoff event does not invoke deep infiltration in bioretention garden.
2. An event twice the water quality runoff event encourages vertical infiltration into the subgrade of the facility but does not allow for lateral infiltration.
3. Prolonged rainfall exceeding 1-inch results in lateral infiltration.
4. The wetting front moves vertically through the engineered soil media and into the subgrade below before it extends outward into the adjacent in-situ soil profile.

4.2 Creighton Prep

Three storm events were evaluated at the Creighton Prep bioretention site. Events were selected based on periods of available data and to cover a range of events from the water quality event to the largest event of the season.

4.2.1 Event 1: 5/10/2017 (0.66-in)

This event was selected to most closely evaluate the water quality runoff event of 0.5 inches over a 24-hour period. Due to the equipment issues previously mentioned, this was one of a few where multiple stilling wells, the stilling basin, the rain gauge and inflow and outflow meters all were operational. This event was drawn out over several hours with a majority of the depth falling between 5:00 AM and 9:40 AM as shown in Figure 5-4. As expected, the basin bean to fill within an hour of the start of precipitation and quickly drained down to a dry state-an indication of the high porosity of the amended soils below. As expected, the stilling well response was delayed by several hours as the runoff infiltrated in the basin and quickly infiltrated into the deep subsurface or moved laterally out of the system.

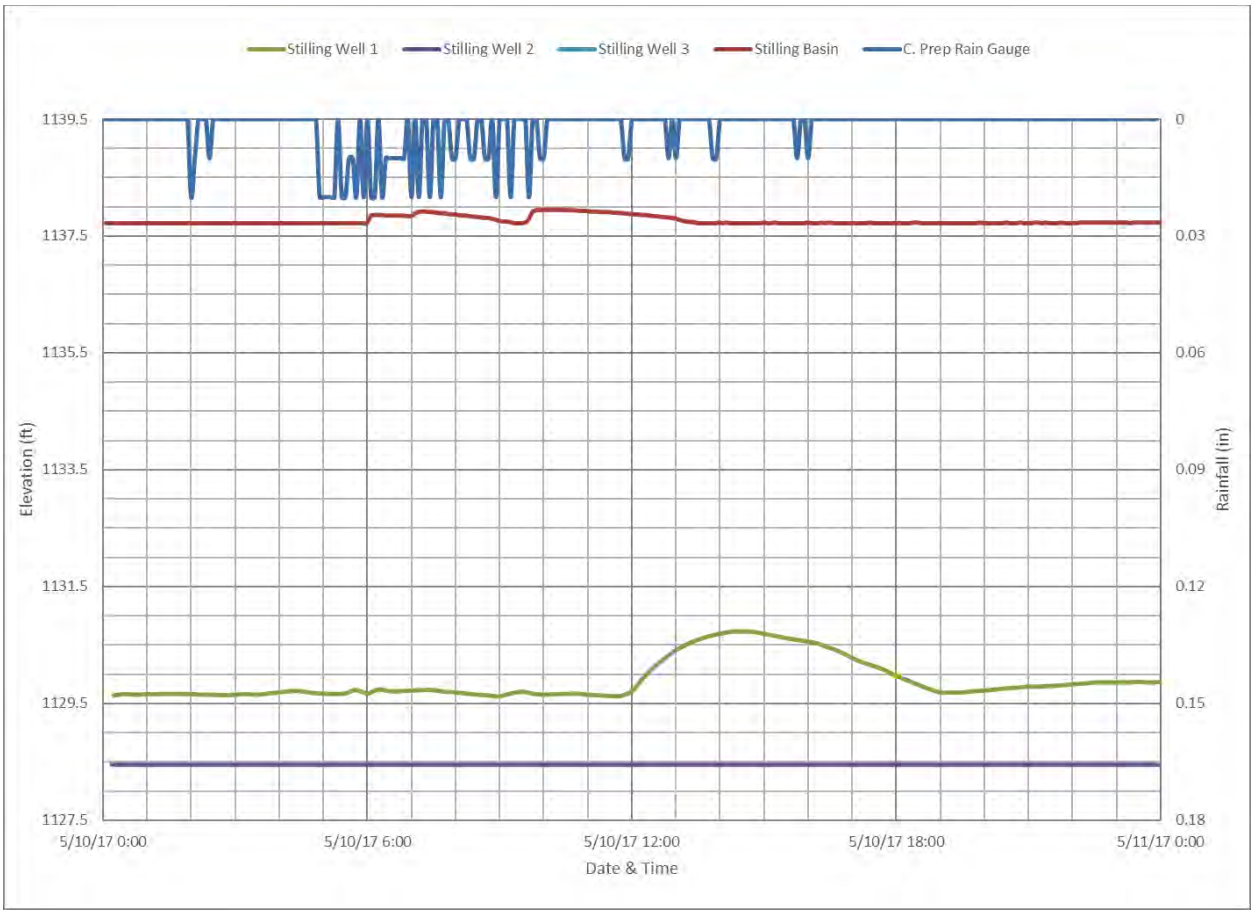

Figure 5-4: 5/10/17 Stilling Well & Stilling Basin

Measured inflow generally matched the precipitation pattern witnessed for the event. However, exceeded inflow for the duration indicating a high amount of runoff from the adjacent field or overspray by the irrigation system as shown in Figure 5-5.

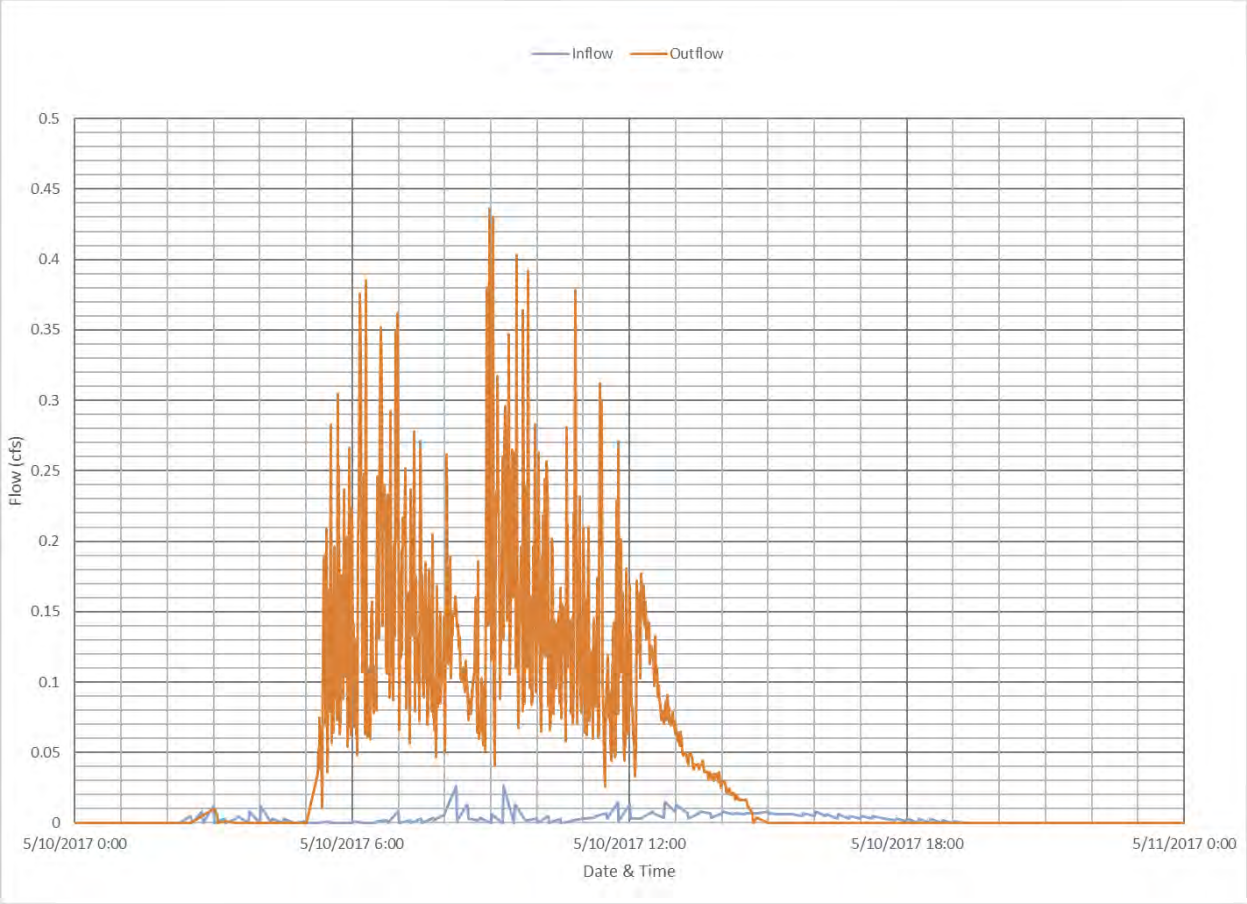

Figure 5-5: 5/10/17 Inflow & Outflow

4.2.2 Event 2: 6/12/17 to 6/18/17 (1.98-in)

This event was analyzed for several reasons. First, it provided insight on how the bioretention basin responds over several days of small rainfall. Ultimately, this period included a severe storm with high winds and intense rainfall demonstrating performance during a more extreme runoff event as shown in Figure 5-6. As noted in the Event 1 analysis, the groundwater level quickly returns to the baseline within hours of the rain event. As noted previously, the stilling basin and rain gage were not operational, so a detailed analysis of the hydrograph or ponding was not completed. However, a comparison of the inflow to the spike in the groundwater depth showed a lag of approximately 8 hours. This was not completely unexpected as periods of intense rainfall are more prone to running of directly not allowing the soil to absorb much of the water.

Figure 5-6: 6/12/17 to 6/18/17 Stilling Well & Stilling Basin

Figure 5-7 shows the inflow and outflow hydrograph for the Event 2 analysis from 6/12/17 to 6/18/17. Figure 5-8 isolates the 6/16/17 rainfall, demonstrating the peak inflow at 7 PM and the peak outflow at approximately the same time. It is hypothesized that the basin overtopped during this event since the peak outflow never exceeded 5 cubic feet/second. The outflow hydrograph is drawn out for several hours after the termination of the inflow hydrograph.

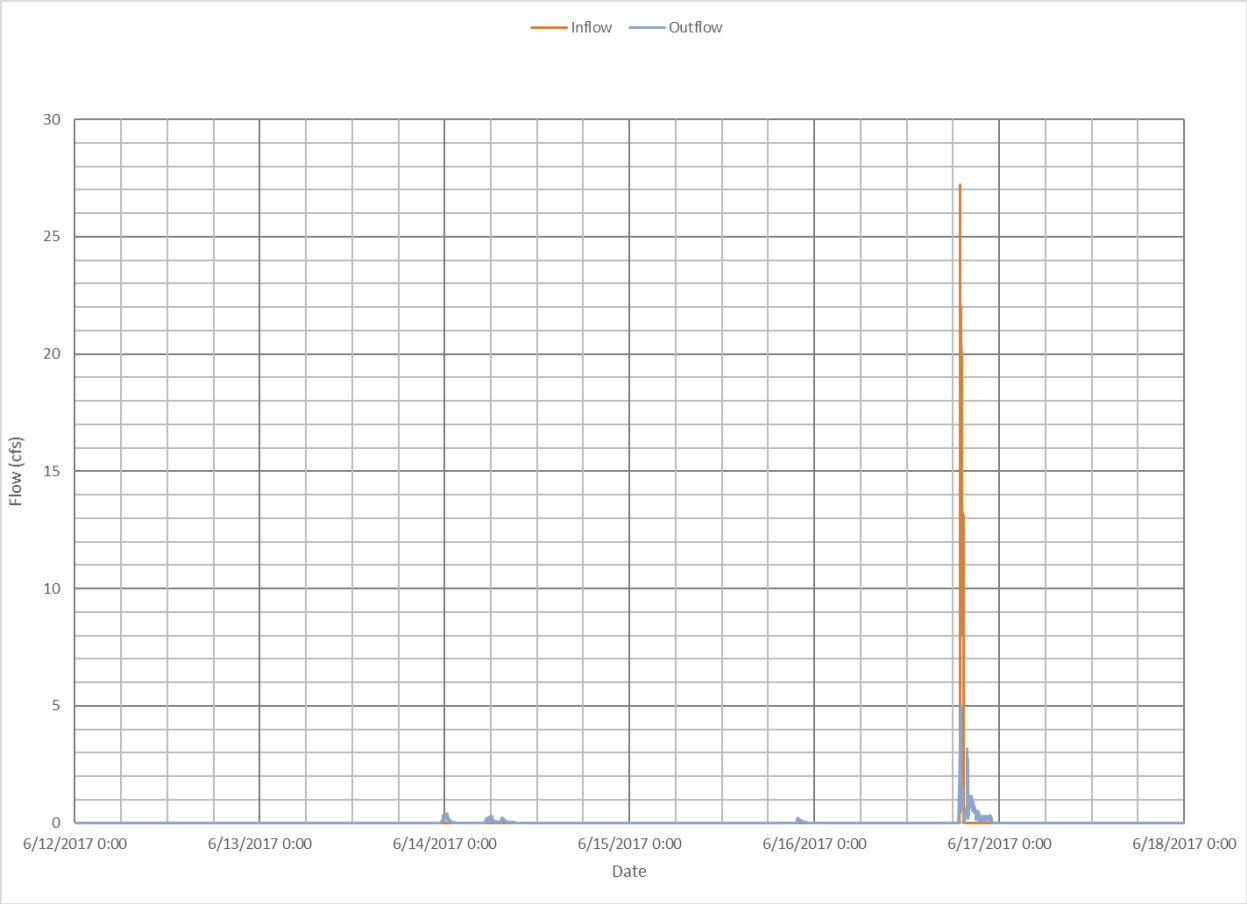

Figure 5-7: 6/12/17 to 6/18/17 Inflow & Outflow

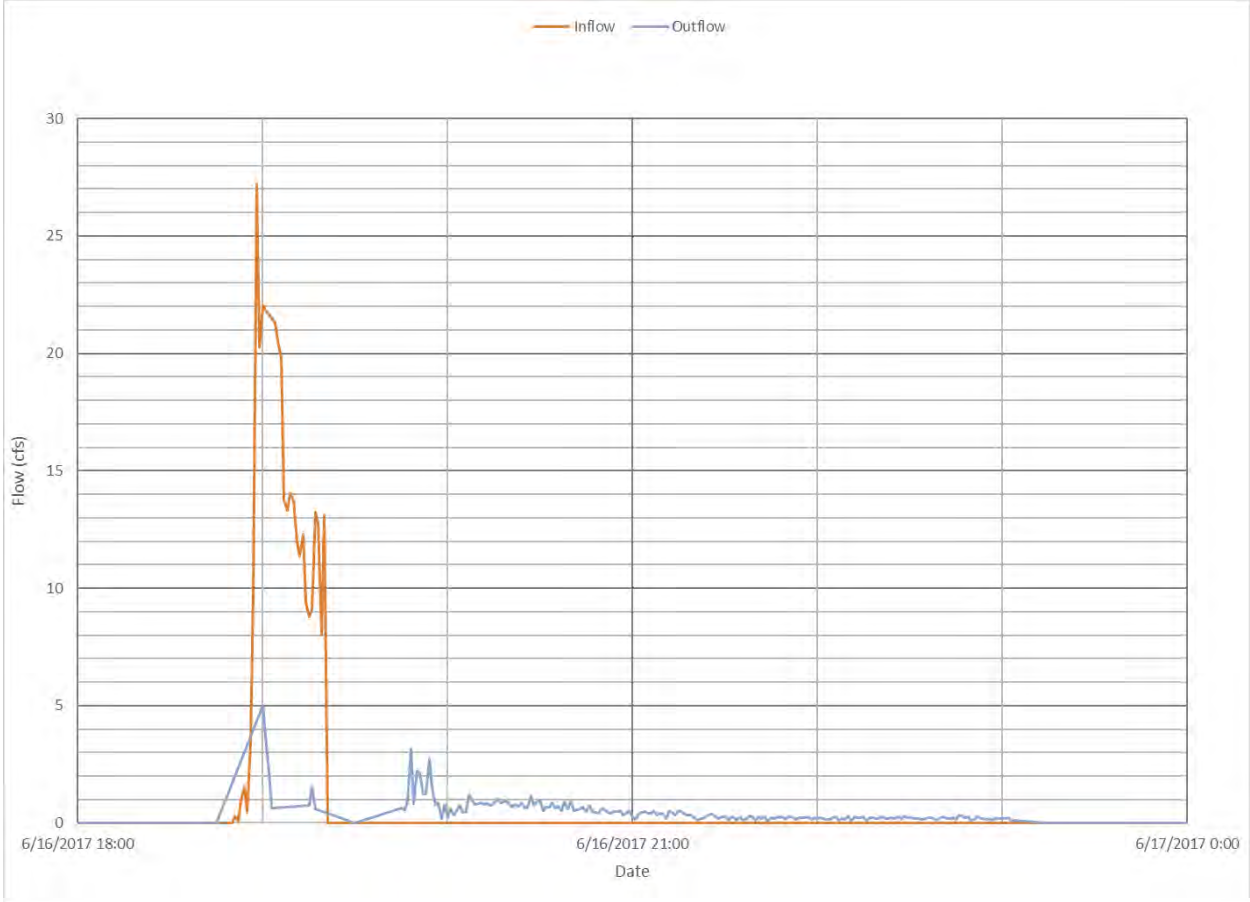

Figure 5-8: 6/16/17 to 6/17/17 Inflow & Outflow

4.2.3 Event 3: 5/16/17 to 5/20/17 (3.47-in)

Similar to Event 2, Event 3 was selected as a series of back to back events including two water quality events and approximately 1-inch plus events. The stilling basin was operational during the first few days of this event, but the results did not respond to the daily rainfall or groundwater elevation changes as anticipated. An evaluation of Figure 5-9 showed three similar peaks for groundwater. For each peak, the rising limb should be related to the absorption rate and the falling limb similar to the deep infiltration rate. For the peak following the 5/16/17 rainfall and 5/20/17 rainfall, the infiltration rate was calculated at 2.6 inches/hour. For the 5/19/17 rainfall, the infiltration rate was estimated at 5 inches/hour.

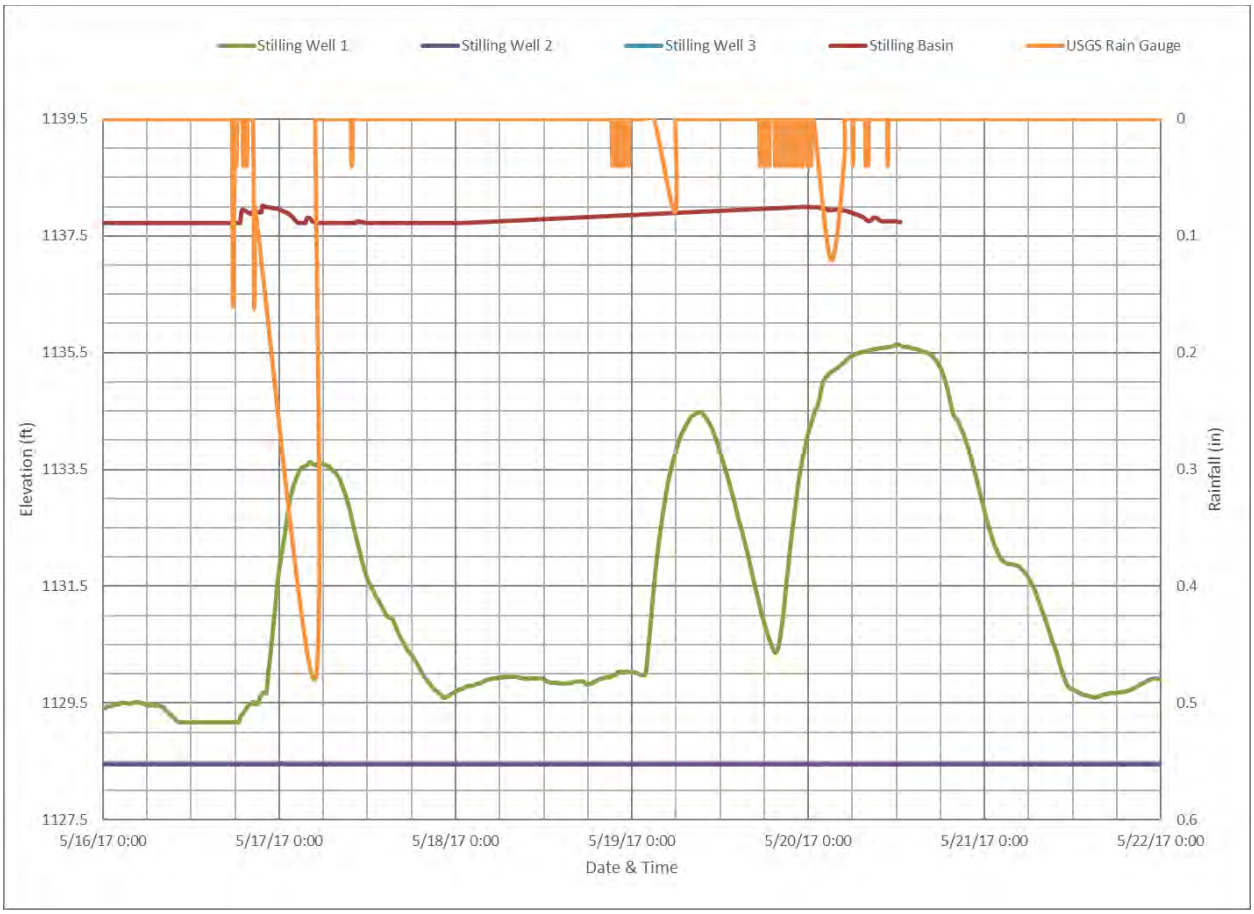

Figure 5-9: 5/16/17 to 5/22/17 Stilling Well & Stilling Basin

The response to the 5/19/17 rainfall also demonstrated the bioretention basin's ability to delay and shave peak outflow rates as shown in Figure 5-10. For the most intense rainfalls, the peak flowrate was shaved by up to 42% (5/19/17) while during the 0.53-inch event, shaved by 70%.

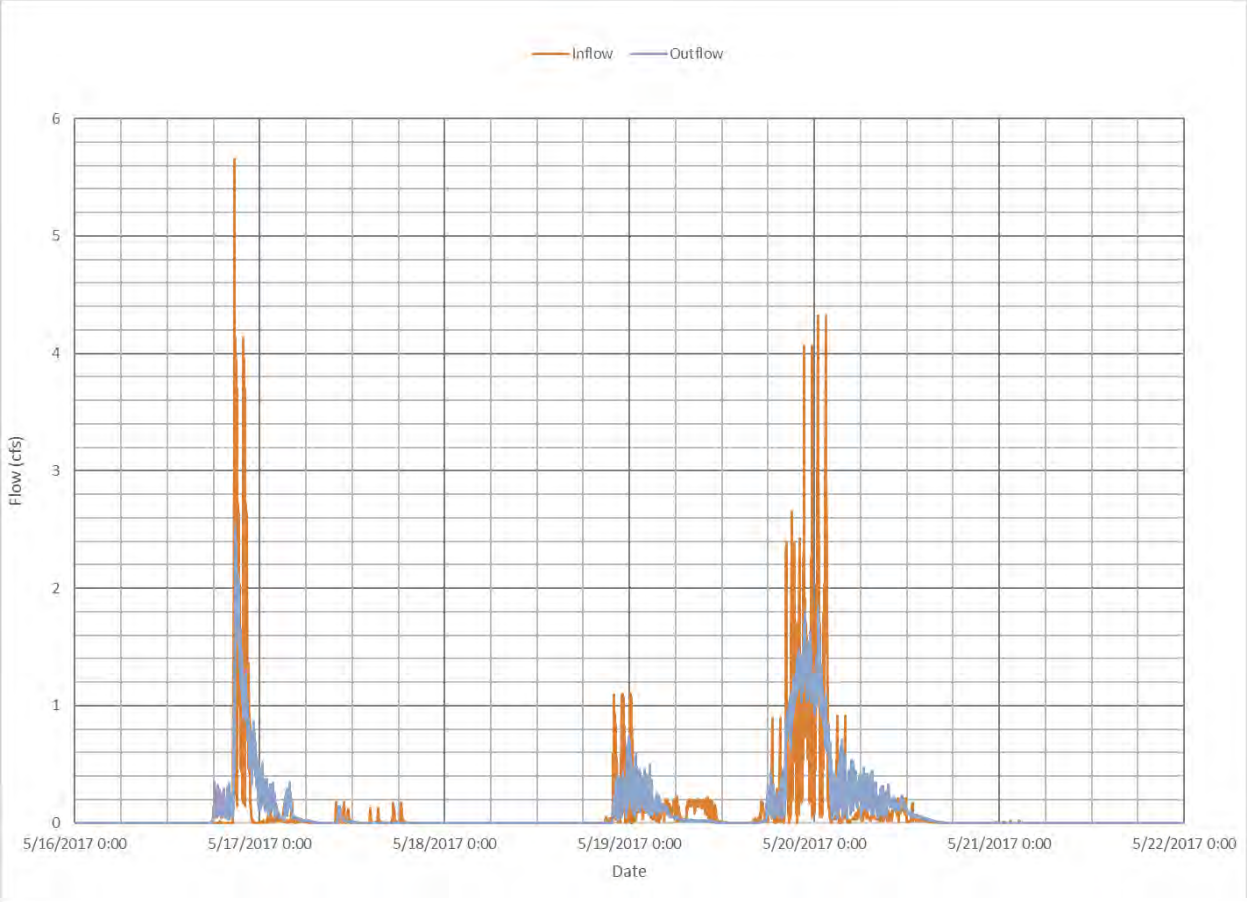

Figure 5-10: 5/16/17 to 5/22/17 Inflow & Outflow

The inflow and outflow data were plotted against the stilling basin and stilling well data as shown in Figure 5-11. As stated previously, the lag between the peak inflow and the spike in groundwater level is in excess of 8 hours. However, groundwater level returns to baseline within 12 to 24 hours. This indicates the importance of providing adequate surface storage volume is necessary to promote deep infiltration.

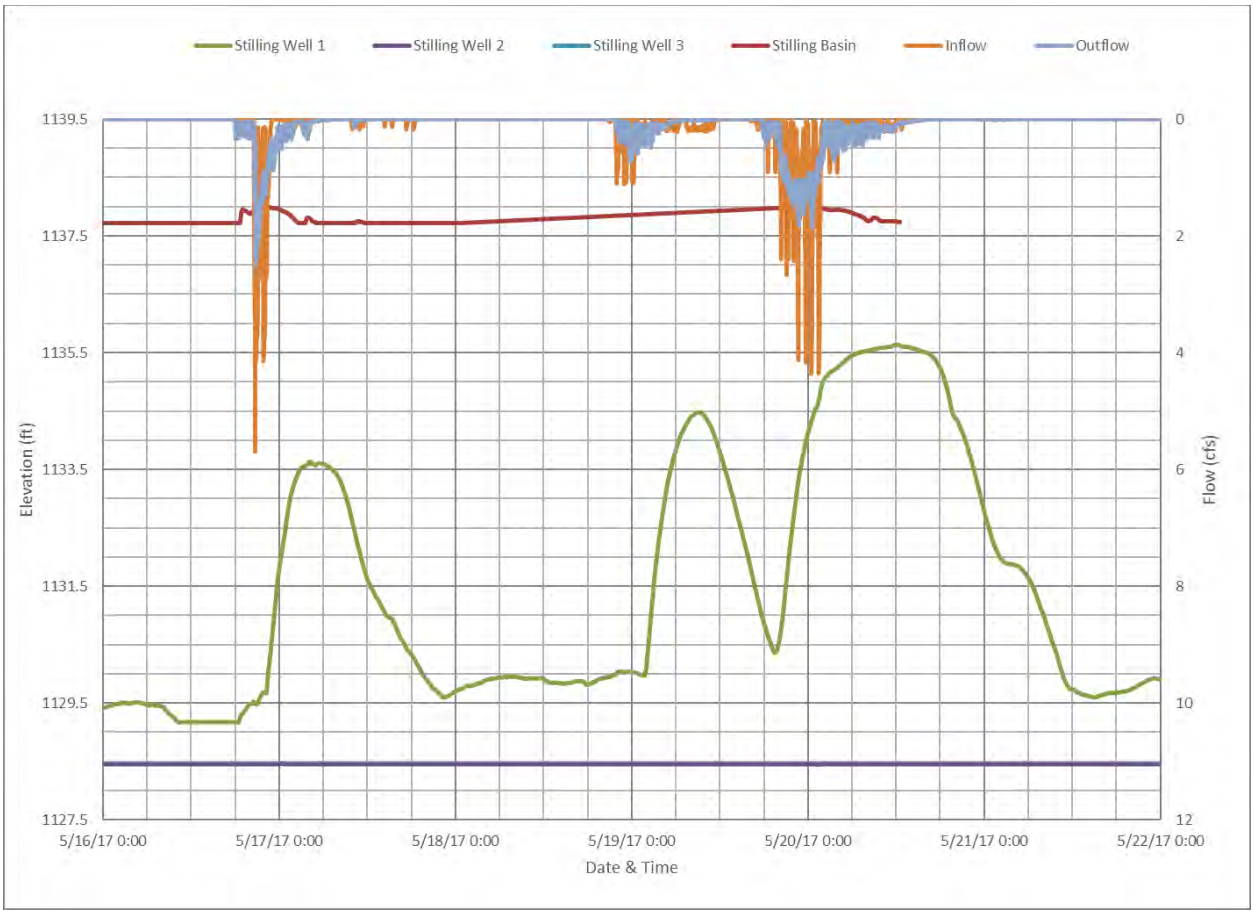

Figure 5-11: 5/16/17 to 5/22/17 Inflow, Outflow, Stilling Well, and Stilling Basin

The following conclusions can be made on the performance of the Creighton Prep Bioretention:

1. The site adequately shaves the peaks of the most frequent events (between 0.5 inches and 1 inch), reducing runoff into the storm system.
2. The system effectively infiltrates at depths in excess of 10 feet, at a rate quite high for the Hydrologic Soil Group C soils.
3. External factors, such as runoff from the adjacent field may skew inflow/outflow results.
4. While detailed precipitation data can be used to evaluate an event, the inflow and outflow data exhibit similar peakiness and intensity components to rainfall and can be used to evaluate overall system performance.

4.3 UNO Welcome Center

Two of the three storm events evaluated at Creighton Prep were also evaluated at the UNO Welcome Center bioretention garden site. For the UNO Welcome Center, Event 1 is defined as the rainfall on 5/10/17 and Event 2 is the rainfall occurring from 5/16/17 to 5/20/17. In addition to rainfall event analyses, subsurface temperature data was analyzed in relation to freeze-thaw from January to April.

4.3.1 Event 1: 5/10/2017 (0.59-in)

This event was selected to most closely evaluate the water quality runoff event of 0.5 inches of runoff due to the extremely high impervious tributary area to the bioretention garden. During this event, the stilling basin STB-2 adjacent to the Type A infiltration trench and soil moisture and temperature sensors were operational. (Stilling basin STB-1 adjacent to the Type B infiltration trench should have been operational but did not produce a response to this event.)

The bioretention garden began to fill as indicated by the response in STB-2 and infiltrate into the below substrate, as reflected in the soil moisture sensor data shown in Figure 5-12. For a rainfall event approximately equal (in volume) to the water quality runoff event (0.59 inches of actual rainfall is nearly equal to the 0.50-inch water quality runoff event), the bioretention garden only reaches half of the maximum designed ponding depth of 1 foot.

Figure 5-12 also demonstrates the implications of engineered soil systems. The VMC of saturated soils is typically around 0.48 to 0.49 m^3/m^3. The VMC of the engineered soils at a depth of 6 inches is in excess of 0.50 m^3/m^3, indicating a supersaturated state, which doesn't normally occur under natural soil conditions.

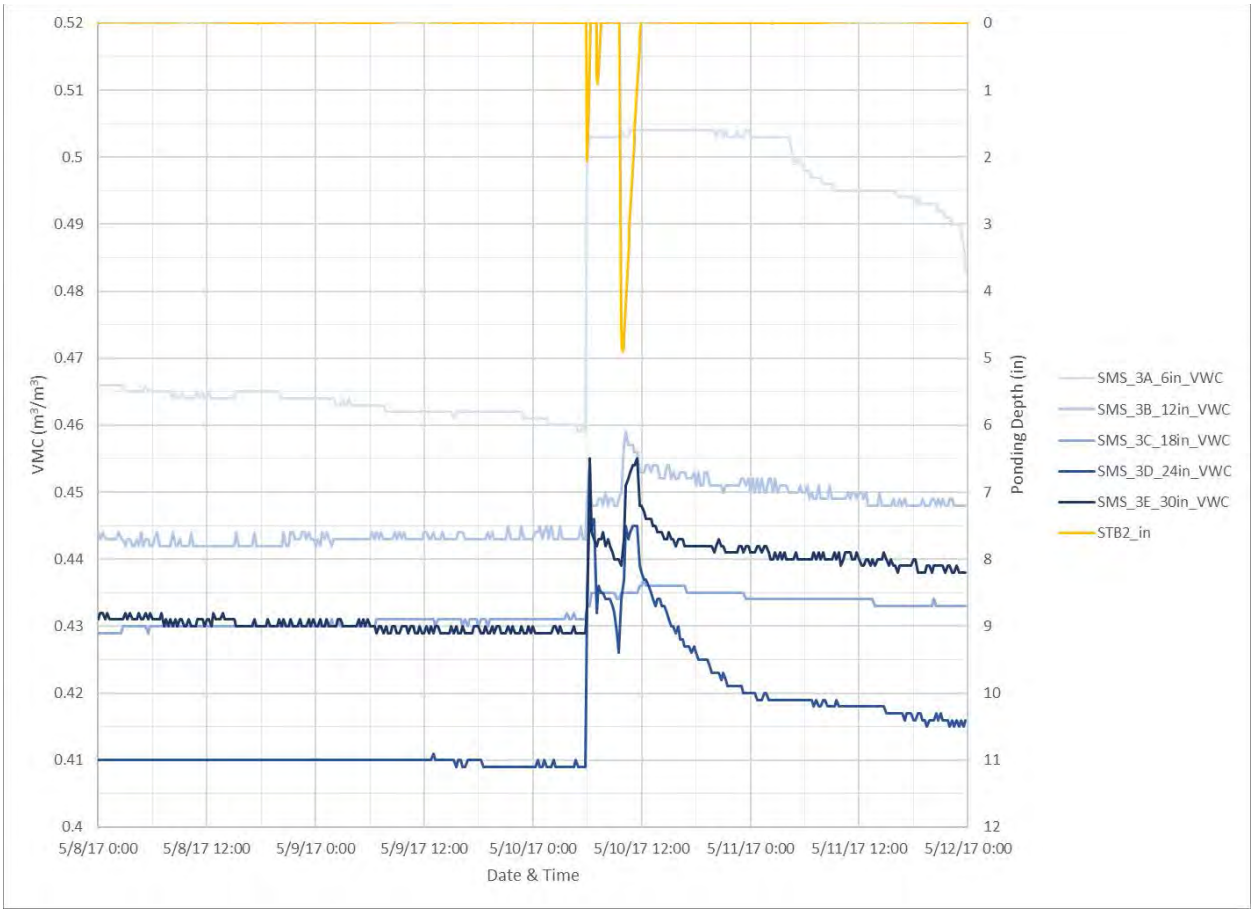

Figure 5-12: 5/10/17 Volumetric Moisture Content (VMC) and Stilling Basin

Soil moisture responds to infiltration sequentially with depth, demonstrated by the order in which the soil moisture sensors recorded an increase in moisture content, as shown in Figure 5-13. This order of response is as expected; as the wetting front moves vertically downward through the soil profile from the ground surface, the moisture content of the underlying soil increases. Likewise, after the ponded volume has dewatered, the soil dries from ground surface downward, with the sandy engineered soils drying out quicker than the underlying clayey soils, which hold more moisture than sandy soils. Table 5-4 shows the peak VMC and VMC 24 hours after rainfall has ceased at varying sensor depths.

Table 5-4: VMC Response at Varying Sensor Depths

Sensor Depth Below Ground Surface (in)	Peak VMC (m^3/m^3)	VMC (m^3/m^3) 24 hrs after Rainfall
6	0.458	0.400
12	0.426	0.414
18	0.432	0.427
24	0.445	0.444
30	0.433	0.432

The valve on the underdrain at the bottom of the 27-inch engineered subsurface profile maintains moisture in the native subgrade when the valve is closed and is likely creating a perched aquifer condition that results in a higher VMC in the soils at the 24-inch sensor depth than the in the soils at the 36-inch sensor depth.

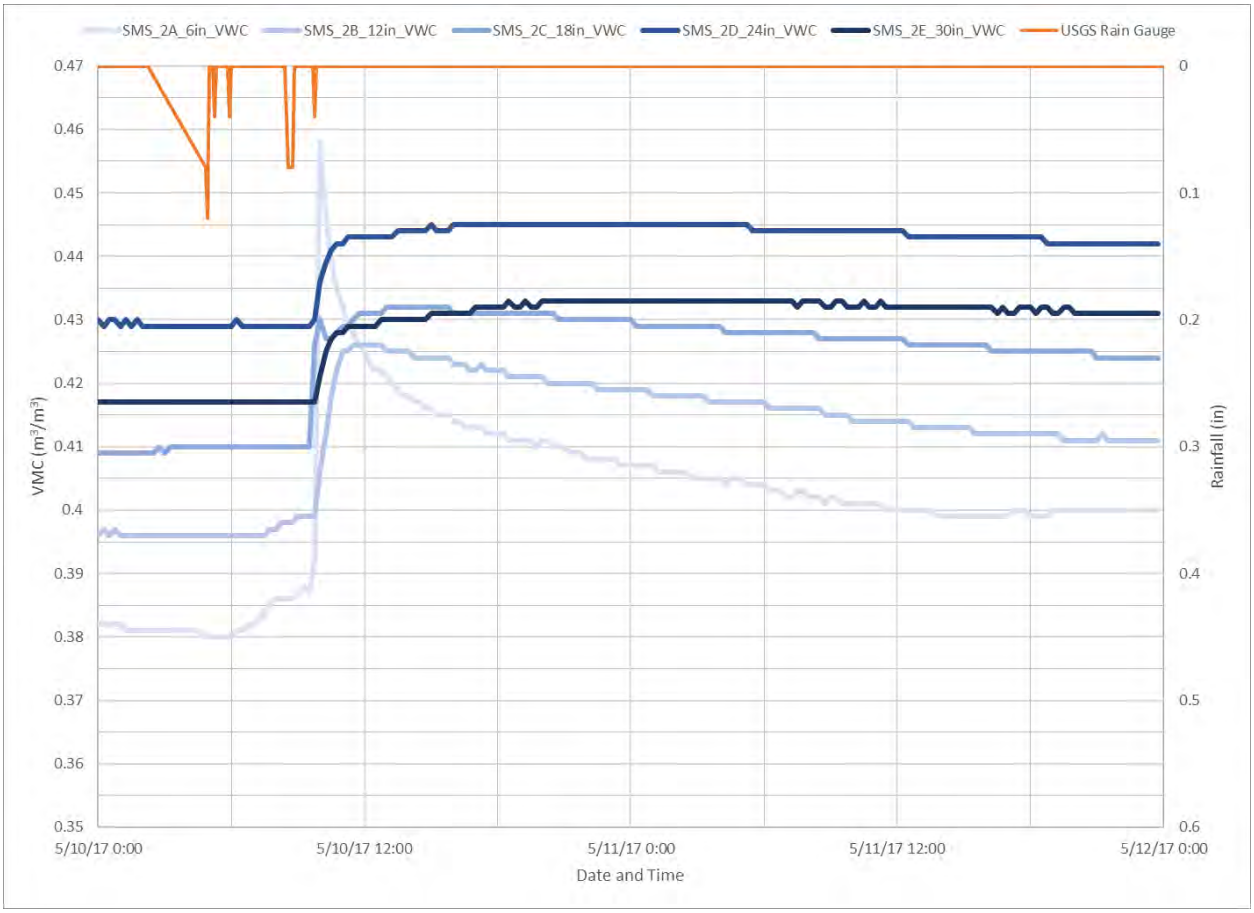

Figure 5-13: 5/10/17 Volumetric Moisture Content

Figure 5-14 shows that the response between volumetric moisture content and electrical conductivity (EC) are similar. As VMC increases, EC generally increases; as VMC decreases, EC generally decreases, both with similarly shaped response curves.

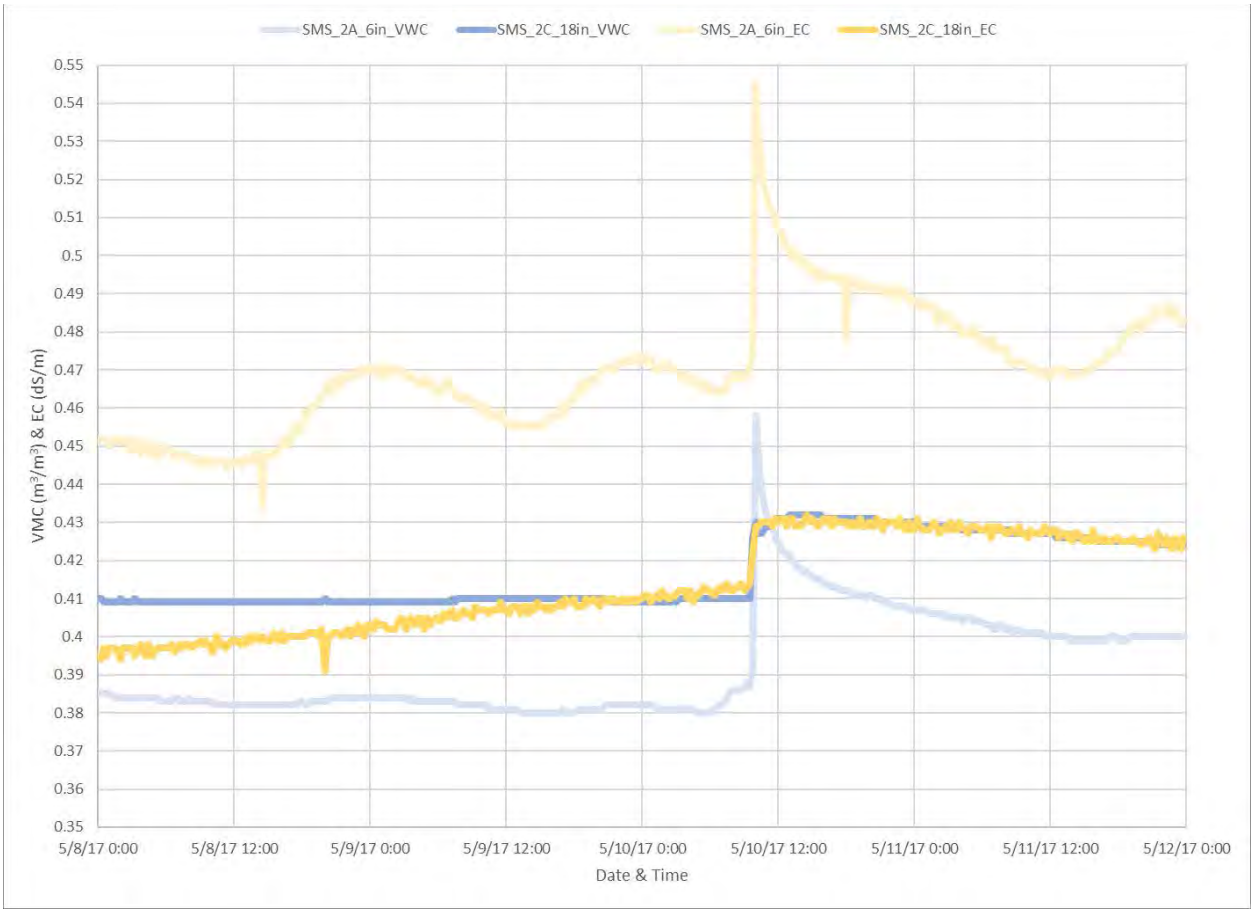

Figure 5-14: 5/10/17 SMS & VMC

4.3.2 Event 2: 5/16/17 to 5/20/17 (3.16-in)

The event on June 16th was greater than 1-inch, which for this site would generate approximately two times the runoff of the water quality runoff event due to the imperviousness of the tributary area. Additional rainfall was observed the following three days, with total precipitation exceeding 3 inches over the five-day period. Throughout the multi-day rainfall, the ponding height in the stilling basin did not exceed 8 inches (two-thirds of the maximum ponding height of 1 foot) as seen in Figure 5-15. As previously mentioned, engineered soils in the UNO Welcome Center bioretention garden approach supersaturated conditions following a rainfall event. For this event, the subgrade beneath the 17-inch engineered soil profile adjacent to SMS-4 also achieves supersaturated conditions.

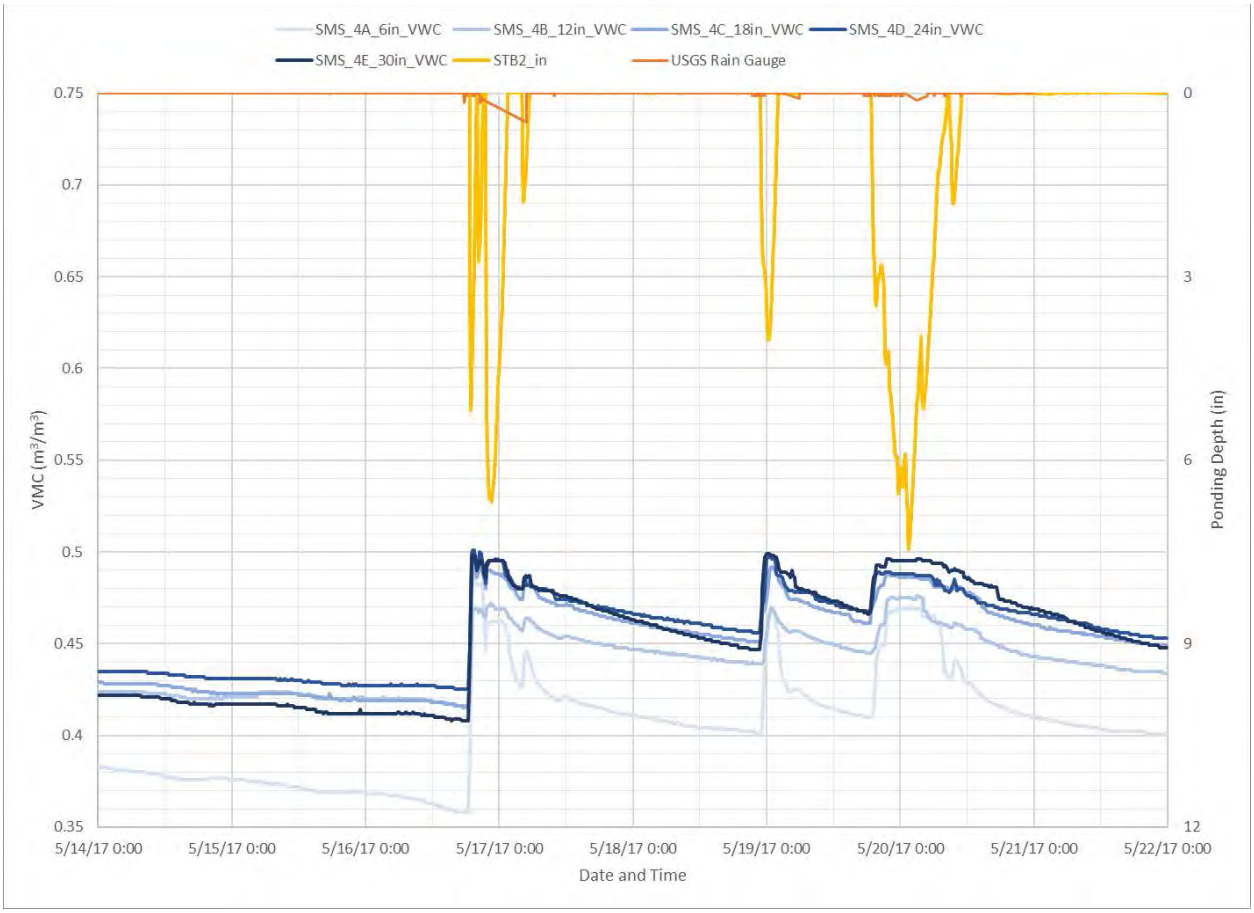

Figure 5-15: 5/16/17 to 5/20/17 VMC & Stilling Basin

4.3.3 Freeze-Thaw Analysis

Subsurface temperature data collected by the soil moisture sensors from January to April were analyzed to evaluate the effects of freeze-thaw on engineered soil profiles compared to in-situ soils. SMS-1 adjacent to Type B infiltration trench, SMS-3 adjacent to Type A infiltration trench, and SMS-5 the control in in-situ soils, were analyzed. Soil temperatures dropped below 32 degrees Fahrenheit (freezing) only during January (see Figure 5-16) and early February (see Figure 5-17) for the 2017 monitoring period. Of SMS-1, SMS-3, and SMS-5, only soil temperatures at 6 inches below ground surface for SMS-1, adjacent to the Type B infiltration trench, and SMS-5, the control, ever reached freezing temperatures. Soil temperatures at 6 inches below ground surface reached freezing temperatures after multiple sequential days of average ambient air temperatures less than 32 degrees Fahrenheit, and or following days when maximum ambient air temperatures did not exceed freezing.

The engineered soil at comparable soil depths was warmer than the in-situ soil. The engineered soil had a more moderate change in temperature than the in-situ soil at the 6-inch depth during cold weather conditions, taking longer to reach freezing temperatures, and thawing sooner than in-situ soils. This moderate response to cold conditions in engineered soil profiles is most likely due to their composition. Engineered soils have a sand content greater and have less water retaining capabilities than the clayey in-situ soils. During warm weather conditions the engineered soils heat up more quickly than the in-situ soils as seen in Figure 5-18.

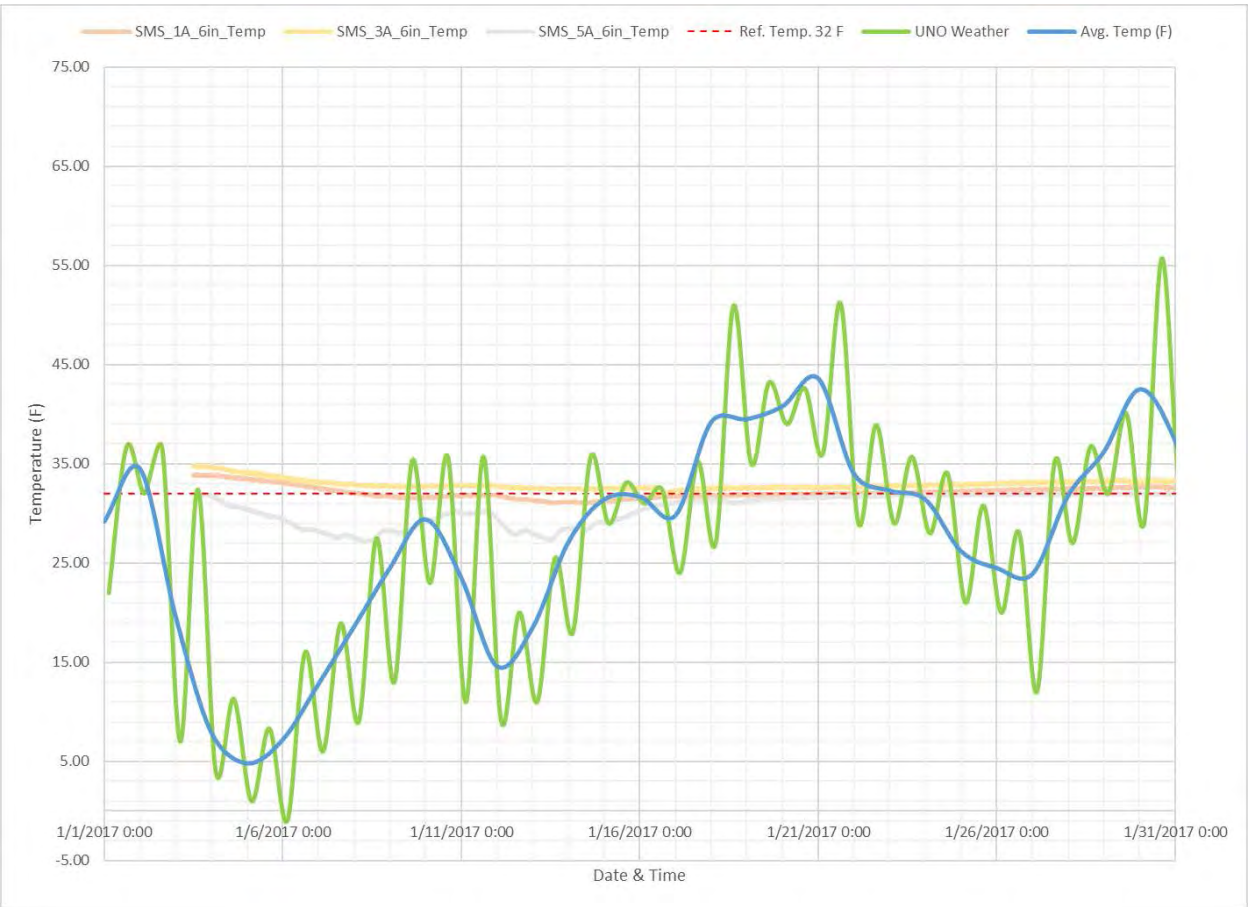

Figure 5-16: January 2017 Subsurface Temperatures

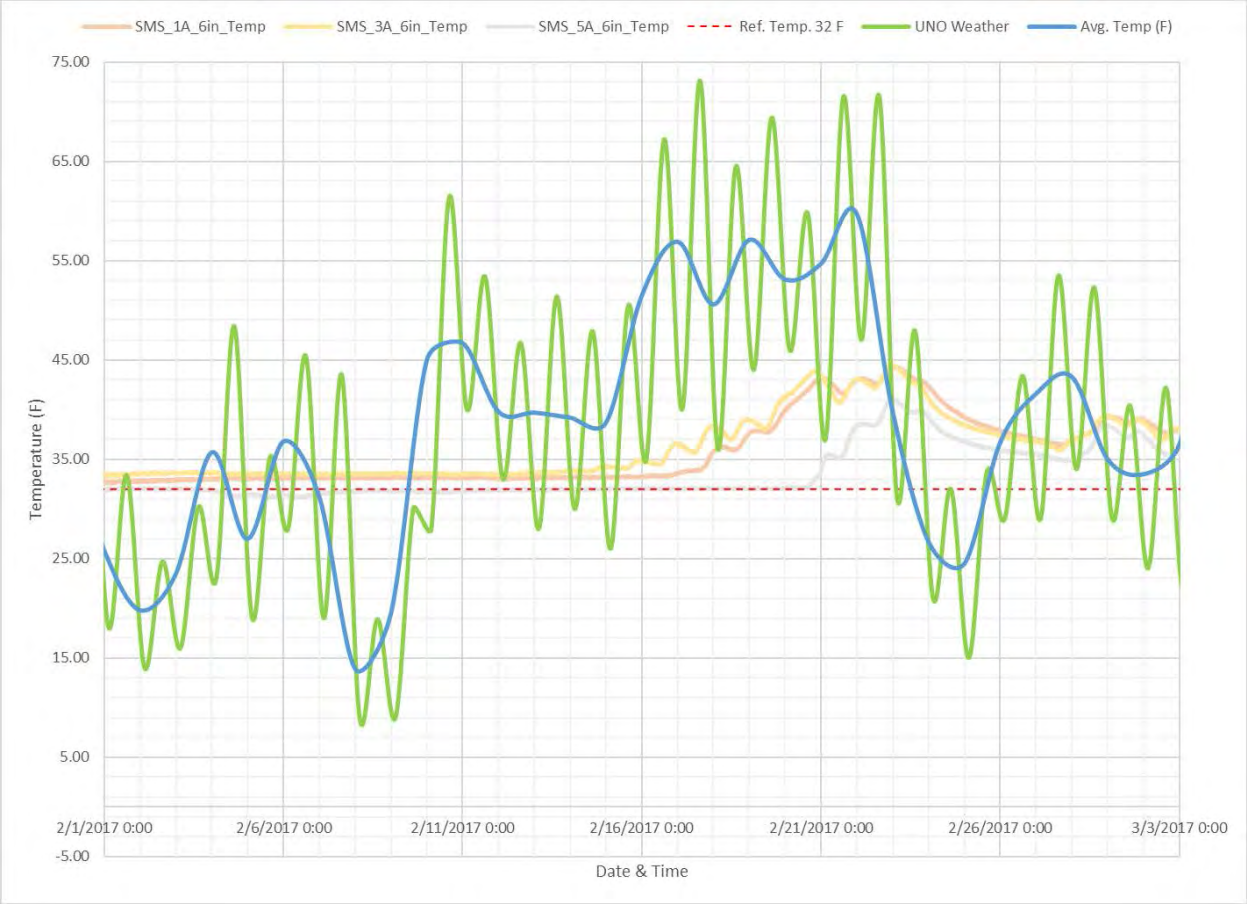

Figure 5-17: February 2017 Subsurface Temperatures

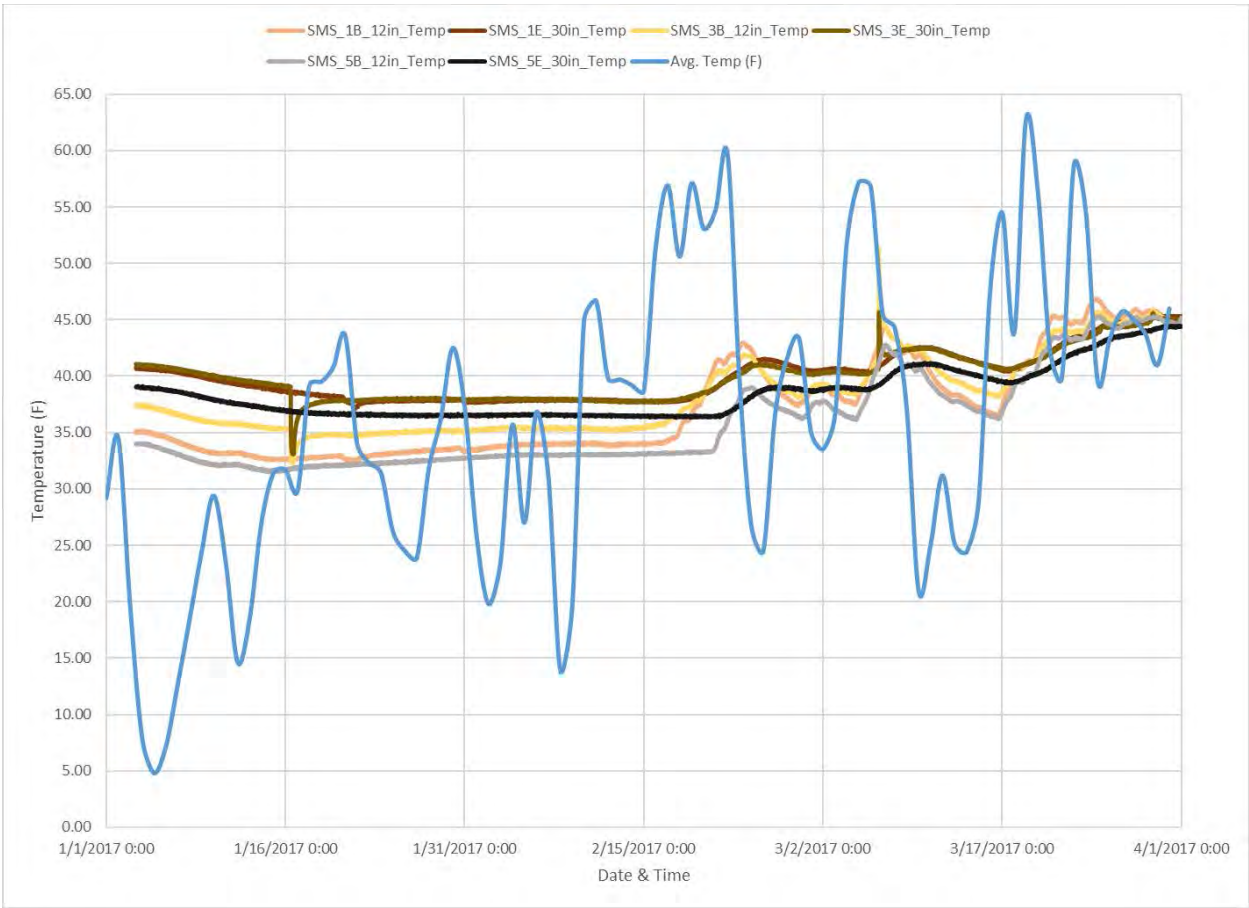

Figure 5-18: January to April 2017 Subsurface Temperatures

The following conclusions can be made on the performance of the UNO Welcome Center:

1. Site does not reach maximum ponding height for water quality event, 1-inch event, or back to back events. Indicates that subsurface conditions exceed design.
2. Wetting front moves vertically through the soil profile.
3. Soils generally dry in order of wetting.
4. Surface soil dries out faster than subsurface soils; encourages use of native plants with deep root structures and deep infiltration practices.
5. Engineered soils have a more moderate change in temperature during cold weather conditions than in-situ soils.

5.0 RECOMMENDATIONS AND NEXT STEPS

Based on the results from the 2017 monitoring period, several general conclusions and ultimately recommendations have been developed for the next study period. First, as described throughout the report, equipment issues and malfunctioning led to large gaps in the data. This, in turn reduced the number of rainfall events that could be analyzed and resulted in more abbreviated conclusions on the performance at each site.

The primary conclusion for the year is that data needs to be collected and analyzed on a more frequent basis, especially during the wet spring and summer months, to ensure that the field equipment is working properly. This notwithstanding, the following includes a summary of the performance of the sites evaluated and the next steps for each:

- Orchard Park
  - Repair/replace malfunctioning equipment in spring of 2018
    - Rain gauge
    - Pressure transducer in stilling basin
    - Data loggers (check batteries and replace as needed)
- Creighton Prep
  - Repair/replace malfunctioning equipment in spring of 2018
    - Rain gauge
    - Pressure transducers (replace pressure transducers that were transferred to other sites and repair or replace malfunctioning pressure transducers)
      - Stilling Well 2
      - Stilling Well 3
      - Stilling Basin
    - Flow meter (check batteries and replace as needed)
- UNO Welcome Center
  - Repair/replace malfunctioning equipment in spring of 2018
    - Pressure transducers (replace pressure transducers that were transferred to other sites and repair or replace malfunctioning pressure transducers)
      - Stilling Basin 1
      - Stilling Basin 2
- Dundee Elementary

- Install monitoring equipment procured in 2017 during the spring of 2018
  - Rain gauge on the Dundee Elementary School roof
  - Pressure transducer within the 500-gallon rain silo
  - Camera on the building

- Adams Park
  - Install monitoring equipment and begin study during spring of 2018
    - Rain gauge on the Adams Park Community Center roof
    - Pressure transducers on the future park road bridge near the box culvert and one additional site within the wetland to monitor water depth.
    - Flow meter on outlet structure

APPENDIX A WEATHER REPORTS

Daily Weather Observations January 2017*

2017	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Jan	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	37	29	21	24	20	14	78	64	44	30.06	29.97	29.92	10	10	10	13	9	22	0	
2	39	35	31	34	30	24	89	79	56	30.01	29.89	29.8	10	4	1	18	8	26	0.01	Rain
3	34	21	8	26	8	-1	82	64	48	30.41	30.25	29.99	10	10	6	28	24	37	0	
4	12	10	7	4	0	-5	77	65	37	30.42	30.3	30.19	10	6	2	17	13	-	0.03	Snow
5	10	6	1	3	-2	-6	77	66	47	30.32	30.26	30.19	10	10	9	21	10	25	0	Snow
6	18	9	0	3	-2	-9	73	61	38	30.47	30.39	30.32	10	10	10	9	5	-	0	
7	21	13	5	7	3	-2	77	66	49	30.78	30.67	30.45	10	10	7	17	7	-	0	
8	28	17	6	17	9	-1	76	66	49	30.71	30.43	30.24	10	10	9	24	10	32	0	
9	34	24	14	26	15	7	78	67	55	30.3	29.97	29.56	10	10	10	24	12	29	0	
10	36	31	25	30	22	15	89	70	51	29.95	29.67	29.37	10	9	3	33	12	43	0.12	Rain , Snow
11	34	24	13	27	14	2	78	67	56	30.03	29.82	29.65	10	9	4	30	16	37	T	Snow
12	22	17	11	10	5	-1	73	58	43	30.63	30.37	30.05	10	10	6	18	10	22	T	Snow
13	28	21	13	9	3	-2	61	44	27	30.77	30.67	30.58	10	10	10	14	7	16	0	
14	37	28	18	19	12	9	74	53	32	30.61	30.55	30.47	10	10	10	8	2	10	0	
15	35	32	28	29	23	15	85	67	49	30.47	30.29	30.16	10	7	2	10	4	12	0.15	Rain
16	35	34	32	31	29	28	89	86	82	30.16	30.01	29.89	7	4	1	17	9	22	0.38	Rain
17	34	30	25	29	24	21	89	82	75	30.14	30.09	30	10	7	4	20	9	22	T	Snow
18	49	37	24	40	30	20	88	79	70	30.15	30.01	29.89	10	9	5	18	11	21	0	
19	45	38	30	40	35	27	89	86	82	29.88	29.73	29.61	10	3	0	14	5	17	T	Fog , Rain
20	44	41	37	40	37	34	92	87	82	29.62	29.54	29.4	10	3	0	13	6	15	0.04	Fog , Rain
21	52	41	29	39	36	27	92	76	59	29.59	29.46	29.38	10	6	0	14	4	17	0.01	Fog
22	40	33	25	33	28	23	85	80	75	29.93	29.78	29.58	10	8	4	20	10	25	0	
23	36	34	31	28	27	26	85	80	75	29.95	29.89	29.81	10	9	6	17	8	23	0	
24	36	33	30	29	28	26	85	80	75	29.84	29.66	29.54	9	5	1	22	10	31	0.07	Snow
25	33	29	24	29	24	18	85	80	75	30.04	29.79	29.59	7	3	0	26	18	33	0.05	Rain , Snow
26	29	25	21	20	18	14	81	75	68	30.18	30.14	30.04	10	10	5	21	13	25	T	Snow
27	36	25	14	25	17	7	75	63	51	30.18	30.1	30.04	10	10	9	25	14	30	T	Snow
28	38	33	27	30	26	21	82	73	64	30.06	30.02	29.97	10	8	2	21	13	25	T	Rain , Snow
29	42	37	31	33	30	27	82	75	67	30.08	30.04	29.98	10	10	10	20	9	24	0	
30	56	41	26	33	27	22	85	60	35	30.02	29.89	29.8	10	10	7	30	12	35	0	
31	44	39	34	31	28	25	75	65	55	30.12	30.01	29.91	10	10	10	17	10	25	0	

*Source: Eppley Airfield Weather Station, Omaha, NE
https://www.wunderground.com/history/airport/KOMA/

Eppley Precip. 0.86 inches
0 # event > 0.5 in
0 # event > 1.0 in

Daily Weather Observations February 2017*

2017	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Feb	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	35	28	20	27	18	7	75	65	54	30.53	30.33	30.13	10	10	5	25	16	30	T	Snow
2	28	22	15	10	8	5	67	57	46	30.63	30.56	30.51	10	10	10	21	10	25	0	
3	32	25	17	13	9	4	68	51	34	30.66	30.54	30.36	10	10	10	18	8	21	0	
4	50	37	24	27	19	12	69	52	34	30.33	29.98	29.78	10	10	10	30	16	39	0	
5	37	29	20	21	18	14	77	61	44	30.18	30.09	29.98	10	10	7	22	8	27	0	
6	46	36	25	38	32	20	82	76	69	29.95	29.67	29.49	9	6	4	14	6	16	0	
7	44	33	21	38	23	12	89	75	60	29.99	29.73	29.49	10	7	2	26	16	32	T	Snow
8	21	14	6	15	8	0	80	67	54	30.42	30.12	29.93	10	5	0	22	14	26	0.17	Snow
9	30	19	7	16	8	0	73	62	51	30.47	30.3	29.98	10	10	10	21	11	25	0	
10	61	44	27	40	29	17	89	66	42	29.92	29.75	29.66	10	10	8	23	9	29	0	
11	55	44	32	41	35	28	89	72	54	30.17	29.91	29.78	10	10	7	18	10	22	0	
12	50	39	27	36	24	17	85	57	29	30.52	30.43	30.18	10	10	10	24	12	30	0	
13	54	39	24	28	22	17	75	51	26	30.44	30.23	30.07	10	10	10	21	9	26	0	
14	51	39	27	32	27	23	85	64	42	30.14	30.08	30.03	10	10	10	22	11	26	0	
15	51	37	23	27	24	21	88	59	30	30.15	30.04	29.85	10	10	10	17	7	22	0	
16	67	49	31	31	28	24	78	52	26	29.83	29.69	29.6	10	10	10	14	7	16	0	
17	75	55	34	37	32	28	82	51	19	29.72	29.62	29.54	10	10	10	18	11	23	0	
18	67	49	30	37	33	27	85	56	26	29.86	29.8	29.73	10	10	10	12	4	13	0	
19	71	56	40	52	45	32	79	63	47	29.91	29.84	29.79	10	10	9	25	13	32	0	
20	61	50	38	56	51	35	93	82	71	29.95	29.79	29.71	10	7	3	26	9	31	0.21	Rain
21	72	52	32	43	34	29	92	60	27	30.02	29.92	29.76	10	6	0	21	9	24	0	Fog
22	75	58	41	40	36	33	76	51	25	29.81	29.69	29.61	10	10	10	21	10	26	0	
23	45	39	33	36	32	28	89	80	70	29.82	29.69	29.58	10	8	1	24	15	32	0.5	Rain , Snow , Thunderstorm
24	35	29	23	30	22	15	89	79	68	30.09	29.8	29.57	10	4	0	31	21	41	0.13	Rain , Snow
25	34	24	14	21	15	10	80	61	41	30.19	30.08	29.92	10	10	10	21	9	26	0	
26	45	36	26	25	21	18	78	59	40	30.04	29.96	29.89	10	10	10	17	7	21	0	
27	57	40	23	30	25	18	81	55	29	30.03	29.89	29.7	10	10	10	28	8	34	0	
28	48	42	35	41	35	29	89	80	70	29.78	29.66	29.56	10	8	6	23	9	27	0.03	Fog , Rain

*Source: Eppley Airfield Weather Station, Omaha, NE
https://www.wunderground.com/history/airport/KOMA/

Eppley Precip. 1.04 inches
1 # event > 0.5 in
0 # event > 1.0 in

Daily Weather Observations March 2017*

2017	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Mar	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	44	35	25	32	26	20	82	63	43	30.3	30.06	29.78	10	10	7	30	15	36	0	
2	46	33	20	25	21	17	88	64	40	30.56	30.42	30.29	10	10	10	23	6	27	0	
3	52	37	21	23	19	15	81	55	29	30.57	30.39	30.2	10	10	10	28	13	35	0	
4	73	51	28	39	27	20	72	46	19	30.19	30.05	29.92	10	10	10	29	14	34	0	
5	66	59	52	50	48	43	77	64	51	29.93	29.8	29.65	10	10	10	30	19	38	0	
6	78	59	39	54	45	27	78	55	31	29.73	29.4	29.16	10	10	2	39	26	53	0.07	Rain , Thunderstorm
7	58	48	37	24	17	4	59	35	11	30.11	29.95	29.77	10	10	10	33	15	42	0	
8	57	46	34	21	15	7	44	30	16	30.26	30.16	30.06	10	10	10	17	7	22	0	
9	50	39	27	26	19	14	63	44	24	30.51	30.22	30.07	10	10	10	25	13	32	0	
10	28	23	17	15	3	-6	74	50	25	30.69	30.58	30.48	10	10	10	23	11	27	T	Snow
11	31	27	22	15	13	4	68	55	42	30.58	30.54	30.49	10	10	10	13	7	16	T	
12	41	33	25	31	22	12	70	58	46	30.52	30.16	29.95	10	9	2	30	16	37	0.03	Rain , Snow
13	32	24	21	27	20	13	86	76	57	30.45	30.22	29.97	10	7	2	29	17	36	0	Rain , Snow
14	33	27	20	15	13	11	68	58	47	30.51	30.46	30.4	10	9	6	13	6	16	T	Snow
15	40	29	18	18	14	10	67	54	40	30.52	30.4	30.25	10	10	10	22	13	25	0	
16	66	50	33	44	30	17	71	54	37	30.23	29.99	29.78	10	10	10	28	16	43	0	
17	68	52	35	41	34	20	83	49	15	30.32	30.09	29.82	10	10	8	32	14	40	0	
18	58	43	27	26	22	14	69	44	19	30.41	30.33	30.23	10	10	10	14	7	18	0	
19	82	61	40	51	36	23	71	50	29	30.21	29.99	29.81	10	10	10	25	14	31	0	
20	68	57	45	42	37	26	83	54	24	30.21	30.01	29.83	10	10	10	24	14	31	0	
21	49	43	37	36	29	22	79	60	40	30.46	30.35	30.19	10	10	7	29	13	35	0.01	Rain
22	51	42	33	24	21	16	59	43	26	30.47	30.36	30.17	10	10	10	24	15	29	T	Rain
23	76	61	45	52	37	21	52	45	37	30.15	29.85	29.6	10	10	10	41	20	49	T	Thunderstorm
24	71	57	42	52	44	37	89	67	44	30.01	29.87	29.66	10	6	2	22	14	27	0.6	Rain
25	44	42	40	38	37	36	86	83	79	30	29.96	29.92	10	8	2	24	14	30	0.45	Rain
26	50	45	40	42	39	36	92	82	71	29.98	29.93	29.89	10	8	3	12	6	13	T	Rain
27	52	46	40	42	40	35	89	76	63	30.04	29.97	29.93	10	10	9	12	5	14	T	Rain
28	51	42	33	42	38	31	89	79	68	30.15	30.09	30.03	10	9	7	17	8	21	T	
29	49	46	42	42	40	37	89	83	76	30.11	29.94	29.76	10	6	2	29	17	37	1.21	Rain
30	45	43	41	39	38	37	86	81	76	29.84	29.74	29.7	10	8	2	22	15	26	T	Rain
31	56	49	41	40	38	36	86	71	55	30.14	29.97	29.84	10	10	7	16	9	20	0	

*Source: Eppley Airfield Weather Station, Omaha, NE
https://www.wunderground.com/history/airport/KOMA/

Eppley Precip. 2.37 inches
2 # event > 0.5 in
1 # event > 1.0 in

Daily Weather Observations April 2017*

2017	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Apr	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	51	46	40	40	37	35	85	73	61	30.27	30.2	30.11	10	10	10	15	6	18	T	Rain
2	54	50	45	48	44	39	89	80	71	30.1	29.91	29.72	10	7	2	15	6	17	0.06	Rain
3	56	53	49	48	47	46	93	83	72	29.72	29.61	29.54	10	6	0	16	9	19	0.04	Fog , Rain
4	60	54	48	47	42	35	86	63	39	29.91	29.79	29.67	10	10	9	22	11	26	T	Rain
5	61	52	43	40	35	27	83	56	28	30.06	29.93	29.83	10	10	10	25	13	33	0	
6	59	48	36	38	31	26	79	55	30	30.25	30.19	30.07	10	10	10	22	12	30	0	
7	65	50	34	36	32	28	82	56	30	30.25	30.09	29.83	10	10	10	28	14	34	0	
8	77	65	53	53	46	36	78	59	40	29.81	29.65	29.54	10	10	10	23	16	29	0	
9	82	68	53	59	53	48	86	61	35	29.7	29.51	29.42	10	10	8	32	13	37	0.01	Rain , Thunderstorm
10	57	48	38	47	39	30	83	75	66	30.25	29.95	29.64	10	10	10	25	12	30	T	
11	63	47	30	35	30	25	78	54	30	30.37	30.27	30.18	10	10	10	14	5	18	0	
12	73	60	46	54	45	35	72	61	49	30.21	30.14	30.03	10	10	7	24	11	29	0.06	Rain
13	80	65	49	61	54	44	86	67	48	30.14	30.07	30.01	10	9	7	15	6	19	T	Fog , Rain , Thunderstorm
14	71	66	60	63	59	55	93	78	63	30.02	29.89	29.75	10	6	1	29	14	38	0.33	Rain , Thunderstorm
15	79	69	58	61	57	53	84	69	54	29.89	29.78	29.73	10	10	8	21	10	28	T	Rain , Thunderstorm
16	73	60	47	56	41	29	84	52	20	30.14	30.08	29.93	10	10	10	21	9	26	0	
17	73	58	43	47	44	39	86	61	35	30.18	30.1	29.99	10	10	10	18	7	22	0	
18	72	65	58	61	55	47	86	73	60	30	29.94	29.88	10	9	1	24	10	31	0.32	Rain , Thunderstorm
19	80	65	50	63	52	45	86	70	54	30.01	29.87	29.69	10	10	5	23	12	28	0.1	Rain , Thunderstorm
20	62	54	45	46	42	39	80	66	51	30.17	30.05	29.97	10	10	10	26	13	33	0.01	
21	60	50	39	40	37	34	89	63	37	30.19	30.16	30.11	10	10	8	21	9	25	0	
22	69	54	39	41	35	28	89	56	22	30.27	30.22	30.17	10	10	10	18	8	24	0	
23	73	57	40	41	32	26	79	48	17	30.19	30.06	29.87	10	10	10	25	10	30	0	
24	76	65	53	44	38	34	52	39	25	29.87	29.65	29.49	10	10	10	36	19	42	0	
25	62	52	42	46	41	37	89	78	66	29.61	29.53	29.44	10	8	2	24	15	34	0.06	Rain
26	45	41	37	37	33	31	85	74	62	29.71	29.66	29.58	10	10	4	26	17	33	T	
27	59	48	36	36	32	27	75	57	39	29.78	29.72	29.66	10	10	10	18	8	24	0	
28	49	44	38	38	36	32	86	71	56	30.09	29.88	29.78	10	6	2	25	12	34	0.45	Rain
29	47	44	41	38	36	33	82	74	65	30.14	30.06	29.97	10	9	3	30	17	40	0.03	Rain
30	44	42	39	40	37	35	89	84	79	29.98	29.69	29.47	10	5	1	36	16	47	0.95	Rain , Thunderstorm

*Source: Eppley Airfield Weather Station, Omaha, NE
https://www.wunderground.com/history/airport/KOMA/

Eppley Precip. 2.42 inches
1 # event > 0.5 in
0 # event > 1.0 in

Daily Weather Observations May 2017*

2017	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
May	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	55	46	37	39	36	32	86	69	51	29.78	29.57	29.42	10	8	1	30	15	42	0.17	Rain
2	66	54	42	43	39	37	82	58	34	30.04	29.94	29.77	10	10	10	17	7	23	0	
3	66	55	43	49	42	38	89	65	40	30.13	30.05	30.01	10	10	10	18	6	22	0.02	Rain
4	72	56	39	46	40	36	92	60	28	30.11	30.07	30.02	10	9	6	26	10	32	0	
5	79	60	41	46	39	36	93	57	21	30.04	29.96	29.83	10	10	9	17	5	21	0	Fog
6	80	66	51	45	39	33	71	45	19	29.94	29.88	29.81	10	10	10	20	6	24	0	
7	85	68	51	51	44	39	64	46	27	29.98	29.9	29.79	10	10	10	23	12	31	0	
8	93	80	66	60	55	51	63	45	26	29.89	29.82	29.74	10	10	10	23	14	29	T	Rain , Thunderstorm
9	83	72	60	55	52	45	78	58	37	29.96	29.89	29.83	10	10	10	20	9	24	0	
10	67	60	53	60	54	46	87	72	56	29.98	29.87	29.81	10	8	2	24	10	29	0.64	Rain , Thunderstorm
11	73	62	50	54	47	40	89	63	37	30.05	30.01	29.96	10	9	7	18	9	24	0	
12	77	61	44	49	42	38	83	55	27	30.08	30.03	29.96	10	10	10	17	6	21	0	
13	82	67	52	50	44	36	77	49	21	29.97	29.87	29.75	10	10	10	26	11	33	0	
14	89	76	63	60	54	51	70	51	32	29.78	29.71	29.64	10	10	10	28	11	33	T	Rain
15	93	79	64	65	61	57	87	59	30	29.76	29.68	29.59	10	10	10	24	12	30	T	Rain
16	92	77	61	66	61	56	73	57	41	29.68	29.56	29.43	10	8	1	51	15	64	1.35	Rain , Hail , Thunderstorm
17	78	69	59	62	57	50	90	70	50	29.6	29.41	29.27	10	10	7	37	18	48	0.1	Rain , Thunderstorm
18	65	59	53	51	49	48	83	72	60	30.01	29.88	29.61	10	10	5	25	13	35	0.53	Rain , Thunderstorm
19	56	53	49	51	48	45	89	83	77	30.03	29.98	29.91	10	6	1	18	11	27	0.94	Rain
20	59	53	47	52	47	41	89	80	71	29.94	29.81	29.72	10	6	1	20	11	28	0.55	Rain , Thunderstorm
21	69	57	44	46	41	37	80	59	37	30.09	30.03	29.91	10	10	7	24	13	33	T	Rain
22	75	62	49	52	49	44	86	61	35	30.07	29.92	29.82	10	10	10	23	9	31	T	Rain , Thunderstorm
23	61	54	47	47	45	42	86	71	55	29.91	29.87	29.82	10	10	6	25	11	33	0.02	Rain
24	69	59	49	49	45	42	86	62	37	29.81	29.73	29.66	10	10	10	17	8	21	0	
25	77	63	49	54	49	44	80	61	41	29.67	29.61	29.52	10	10	10	26	13	33	T	
26	81	69	57	59	54	49	84	59	33	29.85	29.73	29.61	10	10	10	20	8	25	T	
27	72	64	55	58	53	49	86	72	57	29.94	29.88	29.83	10	10	4	23	8	30	0.28	Rain , Thunderstorm
28	83	68	53	53	47	39	83	53	23	29.91	29.88	29.84	10	10	10	28	8	35	0	
29	76	65	53	49	43	37	67	46	25	30.02	29.96	29.85	10	10	10	26	10	34	0	
30	81	66	51	47	42	36	77	49	20	30.05	30.01	29.95	10	10	10	23	9	29	0	
31	78	62	46	51	45	41	80	54	27	30.12	30.06	30.01	10	10	10	12	4	14	0	

*Source: Eppley Airfield Weather Station, Omaha, NE
https://www.wunderground.com/history/airport/KOMA/

Eppley Precip. 4.6 inches
5 # event > 0.5 in
1 # event > 1.0 in

Daily Weather Observations June 2017*

2017	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Jun	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	85	69	52	62	54	46	83	63	43	30.07	30.01	29.92	10	10	9	18	8	23	0	
2	90	79	67	67	62	55	84	58	32	29.99	29.95	29.88	10	10	7	21	12	27	0.01	Rain , Thunderstorm
3	91	78	65	63	61	58	87	61	34	29.99	29.94	29.88	10	10	10	16	8	23	0	
4	94	80	66	65	62	55	81	55	28	29.92	29.84	29.76	10	10	10	13	3	15	0	Thunderstorm
5	95	78	60	59	51	43	84	51	17	29.91	29.84	29.81	10	10	10	16	7	19	0	
6	87	76	65	55	51	47	68	48	27	30.04	30	29.93	10	10	10	14	8	18	0	
7	85	72	59	54	50	46	78	53	27	30.11	30.05	29.99	10	10	10	13	6	16	0	
8	88	75	62	53	50	47	67	47	27	30.02	29.93	29.82	10	10	10	16	9	21	0	
9	91	78	64	60	55	51	68	48	27	29.83	29.75	29.66	10	10	10	22	13	27	0	
10	94	83	72	70	66	61	73	59	44	29.65	29.62	29.56	10	10	10	28	18	35	0	
11	96	86	75	69	68	65	74	59	44	29.73	29.65	29.61	10	10	10	32	21	41	0	
12	85	79	73	73	69	66	79	71	63	29.88	29.78	29.73	10	10	2	28	13	35	0.03	Rain , Thunderstorm
13	95	82	69	71	67	55	74	62	49	29.77	29.69	29.59	10	10	4	35	22	42	0.31	Rain , Thunderstorm
14	89	78	66	67	63	58	81	59	36	29.86	29.78	29.68	10	9	1	26	7	32	0.28	Rain , Thunderstorm
15	96	79	62	68	63	58	90	60	30	29.86	29.79	29.7	10	10	2	20	9	23	0.22	Rain , Thunderstorm
16	91	80	69	74	67	61	90	71	52	29.78	29.66	29.5	10	9	0	51	10	60	1.13	Fog , Rain , Thunderstorm
17	84	74	63	68	64	56	93	70	47	29.78	29.66	29.58	10	10	10	20	7	27	0.01	Rain
18	82	71	60	57	53	47	78	54	30	29.88	29.84	29.78	10	10	7	26	12	33	0	
19	87	74	60	59	52	46	78	52	25	29.99	29.95	29.89	10	10	10	21	6	27	0	
20	94	78	62	60	55	49	78	50	22	29.98	29.91	29.84	10	10	10	16	8	22	0	
21	97	83	69	69	62	55	68	51	33	29.86	29.74	29.63	10	10	10	26	15	36	0	
22	92	83	73	72	64	58	67	56	44	29.73	29.63	29.58	10	10	10	25	13	31	T	Rain
23	78	69	59	63	54	48	78	58	38	30.09	29.92	29.78	10	10	10	25	13	31	0	Thunderstorm
24	82	67	52	48	43	36	77	49	20	30.19	30.14	30.09	10	10	10	24	9	29	0	
25	78	65	52	46	44	40	77	52	26	30.32	30.24	30.18	10	10	10	22	8	28	0	
26	79	68	56	58	52	48	84	60	35	30.22	30.15	30.09	10	10	9	16	7	21	0.14	Rain , Thunderstorm
27	82	68	53	65	57	48	83	65	47	30.14	29.96	29.73	10	10	10	29	15	34	0	
28	93	79	65	71	65	61	81	61	41	29.8	29.67	29.57	10	10	7	29	13	40	0.18	Rain , Thunderstorm
29	84	74	64	68	64	58	84	70	55	29.9	29.77	29.68	10	9	1	25	9	33	0.74	Rain , Thunderstorm
30	81	72	63	63	61	57	90	69	48	29.99	29.91	29.8	10	9	2	23	8	28	0.09	Rain , Thunderstorm

*Source: Eppley Airfield Weather Station, Omaha, NE
https://www.wunderground.com/history/airport/KOMA/

Eppley Precip. 3.14 inches
2 # event > 0.5 in
1 # event > 1.0 in

Daily Weather Observations July 2017*

2017	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Jul	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	86	73	60	64	58	52	90	63	36	30.06	30	29.95	10	10	10	14	5	19	0	
2	84	76	68	69	64	61	87	73	58	30.07	29.99	29.95	10	10	6	24	7	29	0.16	Rain , Thunderstorm
3	89	78	66	74	68	64	93	74	55	29.99	29.95	29.9	10	10	7	23	5	29	T	Fog , Rain , Thunderstorm
4	87	78	69	71	67	64	84	68	51	30.04	29.99	29.96	10	9	2	28	7	32	0.26	Rain , Thunderstorm
5	91	78	65	69	66	63	93	69	44	30.09	30.05	29.99	10	8	0	12	3	16	0	Fog
6	95	83	70	74	69	66	79	64	49	30.06	29.97	29.89	10	10	10	16	7	21	0	
7	83	76	68	73	62	58	85	65	45	30.11	30.05	29.94	10	10	10	18	8	23	0	
8	88	76	64	67	63	61	87	65	43	30.12	30.04	29.99	10	10	10	14	5	16	T	
9	95	81	67	71	68	64	93	70	46	30.02	29.89	29.7	10	10	10	24	11	30	0	
10	92	85	78	75	70	65	69	60	51	29.81	29.77	29.71	10	10	10	17	8	23	0	
11	96	84	71	76	72	66	90	70	49	29.93	29.79	29.68	10	10	10	23	12	29	0.02	Rain , Thunderstorm
12	90	82	74	74	70	62	87	67	46	30	29.84	29.71	10	10	10	32	8	43	0.03	Rain , Thunderstorm
13	86	79	72	71	69	67	87	73	59	30.13	30.07	29.98	10	9	5	14	4	15	0.15	Rain
14	89	77	65	70	67	61	90	71	52	30.17	30.13	30.08	10	10	10	10	5	16	0	
15	95	83	71	73	70	68	90	67	43	30.12	30.07	29.99	10	10	10	15	8	20	0	
16	98	84	70	75	70	66	90	64	38	30.01	29.96	29.89	10	10	10	13	6	17	0	
17	96	86	75	74	69	65	82	61	39	29.96	29.91	29.86	10	10	10	21	11	27	0	
18	91	84	76	75	72	69	82	66	49	30	29.96	29.91	10	10	10	18	9	23	0.03	Thunderstorm
19	96	87	78	78	73	69	74	62	49	30.04	29.95	29.86	10	10	10	26	15	32	T	Thunderstorm
20	98	89	80	77	72	69	72	57	42	29.94	29.9	29.83	10	10	10	16	8	20	0	
21	103	93	82	75	72	70	69	53	37	29.86	29.76	29.66	10	10	10	21	12	26	0.01	
22	93	84	75	77	74	67	91	71	50	29.91	29.79	29.67	10	10	7	21	9	23	T	Rain
23	92	80	68	72	66	58	100	68	36	29.98	29.92	29.89	10	6	0	18	6	22	0	Fog
24	87	74	60	67	62	58	90	68	46	30.02	29.98	29.93	10	10	10	18	8	24	0	
25	97	86	74	74	69	64	74	61	48	29.99	29.95	29.89	10	10	10	22	15	27	0	
26	83	77	71	75	72	70	94	84	74	30.02	29.96	29.89	10	8	1	20	7	24	0.57	Rain , Thunderstorm
27	86	77	67	70	65	62	93	69	45	30.04	30.01	29.97	10	8	0	16	8	21	0	Fog
28	85	75	64	69	64	62	93	72	51	30.05	30.02	29.99	10	10	9	10	5	20	T	
29	85	77	68	65	62	61	87	67	47	30.12	30.08	30.03	10	10	10	15	8	19	0	
30	84	75	66	63	58	56	68	56	43	30.2	30.16	30.12	10	10	10	15	8	20	0	
31	84	74	63	63	59	56	78	62	46	30.16	30.13	30.07	10	10	10	13	5	17	0	

*Source: Eppley Airfield Weather Station, Omaha, NE
https://www.wunderground.com/history/airport/KOMA/

Eppley Precip. 1.23 inches
1 # event > 0.5 in
0 # event > 1.0 in

Daily Weather Observations August 2017*

2017	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Aug	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	90	79	67	67	64	61	87	65	46	30.11	30.08	30.03	10	10	10	23	5	28	T	
2	87	75	63	69	65	60	87	69	50	30.09	30.05	29.99	10	10	10	12	5	16	0	
3	76	66	56	67	59	52	84	67	49	30.15	30.03	29.94	10	10	10	25	12	32	0	
4	81	67	52	55	51	47	83	58	32	30.16	30.11	30.02	10	10	10	15	5	18	0	
5	70	66	62	60	56	52	84	71	58	30.04	29.97	29.9	10	10	7	17	8	22	0.09	Rain
6	79	71	63	63	60	58	90	72	54	30.03	29.97	29.94	10	10	10	12	5	15	0	
7	83	72	60	62	59	58	93	68	43	30.17	30.1	30.03	10	9	5	16	7	18	0	
8	83	70	56	62	57	53	93	68	43	30.22	30.16	30.08	10	10	9	15	8	18	0	
9	83	74	65	62	61	59	84	66	47	30.12	30.06	30	10	10	10	18	10	24	T	Rain
10	83	74	65	66	63	60	87	72	54	30.12	30.06	30.02	10	9	1	18	7	23	0.24	Rain , Thunderstorm
11	83	70	57	62	58	55	93	67	40	30.14	30.1	30.06	10	10	10	13	6	16	0	
12	83	72	61	58	55	53	84	62	39	30.14	30.08	29.99	10	10	10	15	7	19	0	
13	82	74	66	63	59	55	73	59	45	30.02	29.92	29.8	10	10	10	23	12	28	0.01	Rain
14	88	78	67	68	64	55	84	59	34	29.83	29.79	29.76	10	10	10	15	7	19	0	Thunderstorm
15	88	78	67	71	65	60	90	73	55	29.93	29.86	29.78	10	9	1	24	12	35	0.59	Rain , Thunderstorm
16	84	76	68	70	66	61	87	69	51	29.88	29.76	29.68	10	10	7	21	11	29	0.12	Rain
17	84	75	65	63	60	56	84	61	37	29.91	29.87	29.8	10	10	10	22	10	28	0	
18	88	77	66	67	62	59	87	63	39	29.92	29.89	29.84	10	10	10	14	6	17	T	
19	88	74	59	63	60	55	90	63	35	29.97	29.9	29.81	10	10	10	18	8	25	0.03	Thunderstorm
20	85	77	69	69	66	64	84	68	51	29.99	29.92	29.83	10	10	2	25	9	29	0.5	Rain , Thunderstorm
21	83	75	66	73	65	61	79	71	62	30.08	29.97	29.89	10	8	2	32	17	40	1.07	Rain , Thunderstorm
22	78	68	58	64	58	47	93	64	35	30.17	30.09	29.99	10	9	7	17	7	22	0	
23	80	69	57	58	55	49	86	62	38	30.16	30.1	30.01	10	10	10	15	5	19	0	Fog
24	82	73	63	60	58	57	78	62	45	30.05	30	29.94	10	10	10	25	14	32	0	
25	84	74	64	66	62	58	87	71	55	30.12	30.05	30	10	9	4	24	14	29	0.64	Rain , Thunderstorm
26	87	78	68	72	66	61	93	74	55	30.13	30.04	29.99	10	10	10	18	10	26	0	
27	85	74	63	69	66	61	93	74	55	30.08	30.04	30	10	6	0	15	7	19	T	Fog , Rain
28	80	70	59	61	59	55	93	71	48	30.12	30.08	30.05	10	10	10	15	7	19	0	
29	79	68	56	64	57	54	97	73	48	30.14	30.1	30.05	10	6	0	10	4	13	0	Fog
30	85	70	55	63	59	53	93	70	47	30.13	30.09	30.05	10	9	7	8	3	13	0	Fog
31	85	72	58	64	61	55	93	70	47	30.14	30.09	30.05	10	9	4	15	5	21	0	Fog

*Source: Eppley Airfield Weather Station, Omaha, NE
https://www.wunderground.com/history/airport/KOMA/

Eppley Precip. 3.29 inches
4 # event > 0.5 in
1 # event > 1.0 in

Daily Weather Observations September 2017*

2017	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Sep	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	79	71	63	65	61	57	87	73	58	30.11	30.06	30.01	10	8	6	18	11	21	T	Rain
2	84	74	63	68	64	60	90	74	58	30.03	29.99	29.97	10	9	4	14	7	17	0	
3	89	76	62	69	64	59	97	72	46	30.08	29.99	29.83	10	5	0	21	10	26	0	Fog
4	78	68	58	66	60	54	84	65	45	30.09	29.92	29.78	10	10	7	17	10	22	0	
5	71	60	48	52	45	40	86	59	31	30.18	30.14	30.1	10	10	9	25	10	32	0	
6	72	60	47	49	45	40	86	59	31	30.21	30.16	30.12	10	10	10	15	6	20	0	
7	81	66	50	51	47	44	86	57	28	30.13	30.08	29.99	10	10	10	14	6	21	0	Fog
8	87	72	56	62	55	49	80	59	37	30.09	30.06	30.04	10	10	10	15	7	18	0	
9	85	74	62	59	57	54	78	59	40	30.22	30.15	30.1	10	10	10	20	10	24	0	
10	85	75	65	63	60	57	78	59	40	30.27	30.18	30.12	10	10	10	24	11	28	T	Rain , Thunderstorm
11	85	74	62	60	58	55	78	59	40	30.18	30.13	30.06	10	10	10	15	8	18	0	
12	86	71	56	62	59	54	93	67	40	30.06	29.96	29.83	10	9	7	9	2	14	0	
13	90	76	61	63	59	55	90	62	34	29.83	29.75	29.68	10	10	7	15	6	17	0	
14	96	82	67	61	57	51	73	48	23	29.72	29.69	29.63	10	10	10	30	15	39	0	
15	92	79	66	67	61	56	74	56	38	29.8	29.74	29.69	10	10	10	30	16	35	0	
16	76	67	57	68	61	54	84	79	74	30.1	29.93	29.8	10	9	2	23	11	28	1.05	Rain , Thunderstorm
17	72	61	50	54	50	46	86	65	44	30.22	30.14	30.06	10	10	10	18	7	22	0	Rain , Thunderstorm
18	74	69	64	66	63	55	87	80	73	30.05	29.95	29.86	10	8	2	17	9	22	0.26	Rain , Thunderstorm
19	90	79	67	68	66	64	93	69	44	29.88	29.72	29.55	10	8	3	33	19	39	0	
20	81	70	59	69	58	51	84	60	36	29.88	29.74	29.56	10	10	10	24	11	28	0	
21	93	76	59	73	66	54	79	64	49	29.88	29.79	29.69	10	10	10	29	15	36	0	
22	95	86	77	72	69	67	79	61	43	29.85	29.8	29.77	10	10	10	30	20	36	0	
23	92	82	72	68	66	62	84	63	41	29.94	29.88	29.83	10	10	10	26	15	35	0	
24	89	77	64	71	66	60	87	68	48	29.94	29.88	29.83	10	10	3	26	10	35	0.2	Rain , Thunderstorm
25	69	64	59	63	60	56	93	89	84	29.99	29.94	29.88	10	7	1	21	9	28	1.05	Rain , Thunderstorm
26	65	60	54	56	52	50	87	77	67	30.19	30.08	29.96	10	8	3	18	9	23	0.03	Rain
27	73	61	49	54	49	46	93	67	41	30.31	30.24	30.19	10	6	0	9	3	12	0	Fog
28	79	63	47	53	49	45	93	63	32	30.27	30.22	30.15	10	8	0	12	3	15	0	Fog
29	81	64	47	52	49	44	89	60	30	30.28	30.23	30.18	10	10	2	13	6	17	0	Fog
30	79	69	59	49	47	44	57	45	32	30.26	30.17	30.05	10	10	10	23	15	28	0	

*Source: Eppley Airfield Weather Station, Omaha, NE
https://www.wunderground.com/history/airport/KOMA/

Eppley Precip. 2.59 inches
2 # event > 0.5 in
2 # event > 1.0 in

Daily Weather Observations October 2017*

2017	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Oct	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	81	70	58	55	51	46	63	53	42	30.04	29.86	29.74	10	10	3	30	19	39	0.08	Rain , Thunderstorm
2	84	73	62	65	59	51	84	68	51	29.85	29.8	29.74	10	9	2	28	16	36	0.73	Rain , Thunderstorm
3	77	67	57	65	59	52	87	74	60	30.35	30.07	29.8	10	9	2	23	10	31	0.09	Rain , Thunderstorm
4	71	62	52	51	48	45	89	67	44	30.43	30.35	30.24	10	10	10	13	7	16	0	
5	67	62	57	63	59	50	93	81	69	30.21	30.06	29.97	10	5	1	13	6	14	0.68	Rain
6	72	65	57	68	59	54	93	89	84	29.98	29.74	29.51	10	4	0	20	7	25	1.15	Fog , Rain , Thunderstorm
7	73	64	55	54	52	49	93	69	44	29.66	29.56	29.45	10	8	2	21	9	26	0.29	Rain
8	78	65	52	53	51	46	86	63	40	29.78	29.65	29.6	10	10	10	15	9	20	0	
9	62	52	42	43	38	33	71	54	36	30.23	30.06	29.82	10	10	5	30	18	37	0.14	Rain , Thunderstorm
10	48	44	40	37	36	35	82	72	61	30.3	30.26	30.23	10	9	4	21	12	26	0.54	Rain , Thunderstorm
11	63	50	36	45	38	32	85	64	43	30.26	30.19	30.1	10	10	10	14	5	17	0	
12	68	58	48	52	48	44	86	70	53	30.11	30.02	29.89	10	9	3	22	12	27	0	
13	59	57	54	51	50	47	86	79	72	30.07	30.03	29.99	10	10	10	17	8	20	T	
14	60	55	49	56	52	41	93	82	71	30.07	29.91	29.76	10	8	2	30	11	40	0.28	Rain , Thunderstorm
15	62	52	41	40	36	33	76	56	36	30.38	30.29	30.1	10	10	10	29	10	36	0	
16	74	57	39	41	37	34	85	54	23	30.36	30.25	30.11	10	10	10	21	10	27	0	
17	72	59	46	47	43	39	77	58	38	30.12	30.06	29.99	10	10	10	13	9	16	0	
18	78	63	47	51	46	43	86	61	36	30.04	29.95	29.91	10	10	10	16	9	21	0	
19	78	60	42	54	48	39	89	64	39	30.09	30.02	29.96	10	10	10	16	9	20	0	Fog
20	78	67	56	58	54	49	83	66	48	29.98	29.84	29.69	10	10	10	33	20	42	T	
21	76	64	51	62	55	39	84	68	51	29.99	29.7	29.6	10	10	7	29	16	36	0.08	Rain , Thunderstorm
22	69	56	42	41	35	28	77	50	22	30.13	30.04	29.96	10	10	10	15	6	18	0	
23	66	56	46	40	35	29	65	50	34	30.08	29.97	29.86	10	10	10	38	18	47	T	
24	56	48	40	33	28	23	57	42	27	30.14	30.09	30.01	10	10	10	38	20	44	0	
25	70	55	40	41	34	27	70	51	31	30.05	29.84	29.63	10	10	10	13	7	15	0	
26	63	53	42	40	35	23	76	58	39	30.07	29.72	29.48	10	10	10	40	17	50	0	
27	38	33	27	22	21	19	75	64	52	30.14	30.1	30.06	10	10	9	33	20	43	T	Snow
28	50	35	20	22	16	5	81	48	15	30.17	30.07	29.92	10	10	10	10	7	12	0	
29	68	50	31	42	28	17	77	53	28	29.9	29.79	29.65	10	10	10	24	10	31	T	Rain
30	49	41	32	33	22	17	56	48	39	30.25	30.06	29.89	10	10	10	35	20	45	0	
31	38	31	23	27	20	14	75	60	44	30.29	30.15	29.94	10	10	9	17	8	21	T	Snow

*Source: Eppley Airfield Weather Station, Omaha, NE
https://www.wunderground.com/history/airport/KOMA/

Eppley Precip. 4.06 inches
4 # event > 0.5 in
1 # event > 1.0 in

Daily Weather Observations November 2017*

2017	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Nov	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	50	41	32	37	30	24	85	71	56	29.92	29.73	29.61	10	10	10	25	11	30	T	
2	55	44	32	36	33	28	85	66	46	30.3	29.99	29.73	10	10	7	22	11	29	0	
3	50	39	28	34	28	24	78	62	46	30.38	30.24	30.04	10	10	7	15	7	21	T	Rain
4	54	49	43	40	37	35	83	69	54	30.04	29.9	29.78	10	9	7	10	5	13	0	
5	48	39	30	40	32	21	76	59	41	30.2	29.94	29.79	10	10	9	25	14	32	0	
6	46	36	25	23	20	19	75	56	37	30.32	30.27	30.22	10	10	10	13	7	16	0	
7	46	36	26	28	24	19	81	63	44	30.48	30.43	30.35	10	10	10	16	6	19	0	
8	52	38	23	28	24	19	88	63	38	30.44	30.29	30.15	10	9	7	16	8	22	0	Fog
9	40	32	23	29	16	6	70	53	35	30.53	30.41	30.19	10	10	10	25	14	32	0	
10	36	28	19	16	11	8	62	50	38	30.54	30.39	30.21	10	10	10	23	14	27	0	
11	46	41	36	39	33	17	89	67	44	30.21	30.13	30.06	10	6	0	18	7	23	0.01	Fog , Rain
12	50	40	30	38	32	26	85	66	46	30.45	30.38	30.2	10	8	2	13	5	15	0.12	Rain
13	45	37	28	40	34	24	89	83	76	30.44	30.33	30.17	10	5	0	21	10	25	0	Fog
14	56	51	45	52	47	39	89	83	76	30.15	29.95	29.83	10	6	2	15	8	19	T	Rain
15	53	40	27	49	32	21	89	64	38	30.25	30.11	29.9	10	10	8	25	13	31	0	
16	49	37	24	28	24	19	81	63	45	30.25	30.12	29.87	10	10	10	23	11	28	0	
17	61	51	41	53	44	29	86	70	53	29.84	29.6	29.5	10	8	4	25	11	32	0.01	
18	49	39	29	41	30	20	85	67	49	30.23	29.94	29.57	10	10	5	32	17	41	0.22	Rain
19	55	39	23	29	23	17	81	54	27	30.25	30.11	29.91	10	10	10	17	9	21	0	
20	59	46	32	29	26	25	75	52	28	29.89	29.72	29.6	10	10	10	20	10	24	0	
21	43	31	18	28	17	10	75	58	40	30.47	30.19	29.73	10	10	10	32	16	39	T	Rain
22	41	28	15	20	14	9	80	57	34	30.48	30.29	30.05	10	10	10	20	9	23	0	
23	62	45	28	38	31	20	75	58	40	30.05	29.94	29.73	10	10	10	14	7	14	0	
24	72	55	37	41	37	29	76	54	32	29.99	29.67	29.47	10	10	10	35	13	45	0	
25	60	45	29	35	31	26	85	59	32	30.24	30.16	30.01	10	10	10	15	3	20	0	
26	57	45	33	37	33	28	82	65	47	30.22	30.11	29.99	10	10	10	12	6	12	0	
27	67	52	37	45	38	31	76	57	37	29.96	29.75	29.6	10	10	7	22	13	28	0	
28	56	43	29	42	30	19	83	55	27	30.37	30.07	29.66	10	10	10	28	12	37	0	
29	52	37	22	25	19	12	81	51	21	30.37	30.23	30.09	10	10	7	21	7	24	0	Fog
30	57	43	29	28	24	18	78	51	24	30.32	30.25	30.19	10	10	10	22	6	28	0	

*Source: Eppley Airfield Weather Station, Omaha, NE
https://www.wunderground.com/history/airport/KOMA/

Eppley Precip. 0.36 inches
0 # event > 0.5 in
0 # event > 1.0 in

Daily Weather Observations December 2017*

2017	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Dec	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	58	44	29	27	23	21	69	47	25	30.21	30.1	30.01	10	10	10	21	10	25	0	
2	59	42	25	27	24	19	78	51	23	30.2	30.13	30.08	10	10	10	9	4	10	0	
3	60	46	32	51	38	24	77	65	53	30.1	29.87	29.54	10	10	8	20	11	24	0	
4	63	46	29	55	35	14	86	64	41	30.08	29.66	29.39	10	10	10	39	18	48	T	
5	44	35	26	27	16	9	53	45	36	30.18	30.11	30.06	10	10	10	31	16	39	0	
6	45	32	18	28	21	10	82	66	49	30.46	30.26	30.12	10	9	2	30	16	38	0.01	Snow
7	28	20	11	9	6	4	67	53	38	30.53	30.38	30.14	10	10	10	23	11	29	0	
8	37	27	17	25	19	8	75	68	61	30.1	30.03	29.96	10	10	9	21	9	25	0	
9	37	31	24	24	20	17	75	63	51	30.24	30.14	29.98	10	10	10	23	13	30	0	
10	54	40	25	26	23	19	78	57	35	30.13	30.08	30.02	10	10	10	22	10	26	0	
11	49	37	25	32	24	16	69	51	33	30.37	30.08	29.92	10	10	10	38	20	48	0	
12	41	28	14	25	18	9	80	66	51	30.41	30.19	29.79	10	10	10	21	7	24	0	
13	52	40	28	31	26	21	78	58	37	30.01	29.8	29.63	10	10	10	38	19	48	0	
14	42	38	33	27	26	24	75	63	51	30.15	30.09	30.01	10	10	10	17	7	22	0	
15	49	40	31	25	24	22	70	55	39	30.15	29.95	29.75	10	10	10	22	10	28	0	
16	53	41	29	28	24	20	70	53	35	30.01	29.87	29.75	10	10	10	17	7	20	0	
17	37	32	27	28	25	22	85	75	64	30.09	30.02	29.97	10	8	4	16	7	19	T	Rain , Snow
18	55	40	24	31	26	20	88	60	32	30.01	29.94	29.86	10	8	1	16	9	21	0	
19	50	38	26	29	22	13	82	53	23	30.2	30.09	29.91	10	10	10	18	9	22	0	
20	46	34	22	26	15	10	60	44	27	30.17	30.01	29.84	10	10	10	21	11	26	0	
21	43	34	24	32	25	19	85	67	49	30.13	29.95	29.81	10	5	2	25	12	31	0.14	Rain , Snow
22	28	22	15	19	15	11	81	76	71	30.29	30.19	30.1	10	10	9	17	9	22	T	Snow
23	23	19	15	16	12	9	80	73	65	30.39	30.32	30.22	10	7	1	17	8	20	0.06	Snow
24	23	18	12	14	11	4	80	67	54	30.38	30.33	30.28	10	6	1	17	10	22	0.17	Snow
25	14	8	2	4	-1	-6	76	64	52	30.64	30.51	30.39	10	9	2	21	9	24	T	Snow
26	6	1	-5	-4	-8	-13	79	64	49	30.84	30.75	30.65	10	10	10	16	7	19	0	
27	7	-1	-9	1	-6	-15	87	68	49	30.87	30.72	30.53	10	6	1	18	9	20	0.03	Snow
28	25	16	7	11	6	-1	76	66	55	30.55	30.46	30.36	10	8	1	22	11	24	T	Snow
29	18	12	6	13	7	-2	80	74	67	30.55	30.34	30.17	10	6	0	23	10	27	T	Fog , Snow
30	6	3	-1	-2	-7	-9	72	64	56	30.69	30.62	30.55	10	9	2	24	14	29	0.01	Snow
31	-1	-7	-14	-10	-15	-22	72	65	58	30.98	30.87	30.62	10	10	4	20	12	23	T	Snow

*Source: Eppley Airfield Weather Station, Omaha, NE
https://www.wunderground.com/history/airport/KOMA/

Eppley Precip. 0.42 inches
0 # event > 0.5 in
0 # event > 1.0 in

Daily Weather Observations January 2017*

2017	Temperature			Dew Pot			Humidity			Speed			Pressure			Precip. Accum.
Jan	High	Avg	Low	High	Avg	Low	High	Avg	Low	High	Avg	Gust	High	Avg	Low	Sum
1	36.7	29.2	22	25	21	16.6	80	71	59	17	4	17	30.05	29.97	29.9	0
2	36.5	34.5	32	34	31	22.8	95	87	66	23	4	23	30	29.9	29.79	0
3	32.4	19.6	7	29	9	0.3	90	73	61	31	10	31	30.41	30.2	30	0
4	11.3	7.9	4	4	0	-3	84	71	54	23	5	23	30.43	30.35	30.26	0
5	8.3	4.8	1	4	0	-4.2	86	76	64	22	4	22	30.33	30.27	30.21	0
6	16	7.2	-1	5	0	-6	81	70	59	12	2	12	30.49	30.41	30.33	0
7	18.9	12.8	6	8	4	1.2	81	72	58	20	3	20	30.78	30.62	30.46	0
8	27.5	18.6	9	18	11	3.3	82	74	66	25	6	25	30.74	30.49	30.24	0
9	35.3	24.5	13	29	16	7.4	80	74	64	16	6	18	30.31	29.94	29.57	0
10	35.7	29.4	23	32	23	15.8	92	76	59	34	5	34	29.94	29.65	29.36	0.11
11	35.7	23.5	11	29	16	3.8	82	76	69	29	8	29	30.02	29.83	29.63	0
12	20	14.6	9	10	6	0.2	81	69	47	16	5	16	30.65	30.33	30.02	0
13	25.5	18.5	11	9	4	0.2	73	57	36	13	4	13	30.79	30.71	30.62	0
14	35.7	27.1	18	16	12	7.9	74	55	39	6	1	6	30.65	30.56	30.46	0
15	33.1	31.4	29	29	21	14.7	93	70	52	11	2	11	30.47	30.31	30.16	0.11
16	32.4	31.7	31	31	30	29.1	95	95	93	14	4	14	30.17	30.03	29.9	0.32
17	35.2	29.8	24	30	26	22.4	95	89	77	17	3	17	30.14	30.06	29.98	0
18	50.9	39.2	27	41	32	25.5	93	83	69	16	3	16	30.14	30.01	29.87	0
19	43.2	39.5	35	40	37	33.1	96	92	85	10	2	10	29.87	29.73	29.59	0
20	42.6	40.8	39	41	39	37.8	96	95	94	14	3	14	29.6	29.49	29.39	0.01
21	51.2	43.6	36	41	38	33.3	96	85	66	16	2	16	29.56	29.47	29.37	0
22	38.9	34	29	34	30	27.3	93	90	83	19	5	19	29.91	29.74	29.56	0
23	35.7	32.3	29	29	28	26.9	93	86	77	17	4	17	29.95	29.89	29.82	0
24	34	31.4	28	29	28	27	95	91	84	26	6	26	29.83	29.68	29.53	0.06
25	30.8	26.2	21	29	25	19	95	93	89	26	5	26	30.04	29.82	29.59	0.09
26	28.1	24.5	20	21	19	16.3	90	83	75	17	4	17	30.2	30.12	30.04	0
27	35.2	23.9	12	26	19	8.4	86	76	61	25	5	25	30.17	30.11	30.05	0
28	36.7	31.8	27	31	27	23.3	88	83	72	21	4	21	30.08	30.03	29.98	0
29	40.1	36.2	32	35	31	28.1	88	83	76	18	3	18	30.07	30.03	30	0
30	55.7	42.5	29	36	29	26.6	91	69	37	20	3	22	30	29.9	29.81	0
31	41.2	37.3	33	31	29	26.3	82	72	58	17	4	17	30.11	30.01	29.9	0

*Source: UNO Department of Geography / Geology Station, Omaha, NE

https://www.wunderground.com/weather/us/ne/omaha/KNEOMAHA52

Precip.	0.7
# event > 0.5 in	0
# event > 1.0 in	0

Daily Weather Observations February 2017*

2017	Temperature			Dew Pot			Humidity			Speed			Pressure			Precip. Accum.
Feb	High	Avg	Low	High	Avg	Low	High	Avg	Low	High	Avg	Gust	High	Avg	Low	Sum
1	33.4	25.8	18	28	19	6.3	84	72	58	23	7	23	30.53	30.32	30.1	0
2	24.7	19.8	14	10	8	5.9	75	63	52	22	4	22	30.64	30.58	30.51	0
3	30.2	23.5	16	14	10	6	68	60	42	16	4	16	30.68	30.52	30.36	0
4	48.4	35.7	23	29	21	13.4	78	60	43	29	7	29	30.36	30.07	29.77	0
5	35.2	27	19	23	19	14.5	83	70	53	19	4	22	30.17	30.07	29.97	0
6	45.4	36.8	28	40	32	22.8	88	82	74	12	2	12	29.97	29.73	29.49	0
7	43.5	31.2	19	39	23	13	94	82	71	30	7	30	30.01	29.74	29.48	0
8	18.9	13.9	9	14	8	2.3	89	79	59	21	6	21	30.43	30.19	29.94	0
9	30.1	19.5	9	18	9	3.3	78	67	59	21	4	21	30.49	30.24	29.99	0
10	61.4	45	28	41	31	18.1	79	63	48	18	3	18	29.99	29.83	29.67	0
11	53.4	46.7	40	41	37	35.2	85	74	59	18	5	18	30.16	29.95	29.74	0
12	46.7	39.8	33	38	26	19	89	62	34	21	5	21	30.5	30.32	30.14	0
13	51.4	39.7	28	30	23	18.3	71	53	31	22	3	22	30.46	30.26	30.06	0
14	47.9	39.2	30	34	29	26.2	85	72	53	21	6	21	30.12	30.07	30.01	0
15	50.5	38.7	26	28	26	22	90	63	37	26	4	26	30.15	29.99	29.83	0
16	67.2	51.5	35	36	30	26	69	50	30	8	2	8	29.83	29.7	29.57	0
17	73.1	56.9	40	40	35	30	72	52	25	18	4	18	29.68	29.6	29.52	0
18	64.5	50.6	36	38	35	32.1	84	57	34	11	3	11	29.82	29.76	29.69	0
19	69.4	57.1	44	54	46	33.8	86	68	50	22	5	22	29.87	29.81	29.75	0
20	59.8	53.1	46	57	51	40.6	95	86	71	21	4	21	29.91	29.79	29.67	0.14
21	71.5	54.7	37	44	39	35.3	92	63	27	17	4	17	29.99	29.85	29.72	0
22	71.5	59.7	47	43	38	34.9	70	50	31	21	6	21	29.76	29.67	29.59	0
23	47.9	39.8	31	38	34	30.2	94	87	70	27	8	27	29.78	29.67	29.56	0.51
24	32	26.7	21	30	23	18	94	92	87	26	8	26	30.1	29.83	29.56	0.07
25	33.7	24.5	15	22	17	11.4	88	72	42	19	3	19	30.21	30.06	29.92	0.01
26	43.4	36.7	29	26	23	20.4	76	60	42	14	2	14	30.01	29.95	29.89	0
27	53.5	41.6	29	36	27	21.5	74	59	35	24	4	24	30.02	29.85	29.67	0
28	52.3	43.3	34	47	38	32	91	84	66	23	4	23	29.77	29.66	29.55	0.04

*Source: UNO Department of Geography / Geology Station, Omaha, NE
https://www.wunderground.com/weather/us/ne/omaha/KNEOMAHA52

Precip.	0.77
# event > 0.5 in	1
# event > 1.0 in	0

Daily Weather Observations March 2017*

2017	Temperature			Dew Pot			Humidity			Speed			Pressure			Precip. Accum.
Mar	High	Avg	Low	High	Avg	Low	High	Avg	Low	High	Avg	Gust	High	Avg	Low	Sum
1	40.4	35	29	32	26	23.2	91	75	54	27	6	27	30.28	30.01	29.74	0
2	42.2	33.5	24	27	23	19.6	88	71	44	19	3	19	30.55	30.42	30.28	0
3	50.4	36.5	22	26	21	17.4	82	61	38	28	5	28	30.57	30.37	30.17	0
4	71.3	51.9	32	41	30	23.2	69	49	22	24	5	24	30.18	30.05	29.91	0
5	63.5	57.2	50	52	49	41.2	81	75	63	28	7	28	29.92	29.76	29.61	0
6	76.2	56.8	37	56	47	26.8	82	63	33	37	1	37	29.7	29.41	29.12	0
7	55.9	45.5	35	26	20	6.9	64	41	14	27	4	27	30.1	29.9	29.7	0
8	56.2	44.3	32	20	17	11.8	54	35	21	17	2	17	30.25	30.14	30.03	0
9	47.4	37.2	26	29	20	16.1	65	52	30	25	7	25	30.49	30.26	30.03	0
10	26.8	21	15	16	4	-2.6	74	50	30	22	6	22	30.68	30.58	30.47	0
11	29.7	25	20	16	13	4.5	76	64	46	14	3	14	30.58	30.53	30.49	0
12	38.6	31.2	23	32	21	13.9	89	69	58	34	6	34	30.54	30.26	29.97	0.03
13	30.1	25.2	20	27	18	14.2	92	84	76	33	8	33	30.45	30.23	30	0
14	30.6	24.4	18	16	14	12.9	83	70	53	11	4	11	30.5	30.45	30.4	0
15	38.1	28.6	19	20	15	11.2	72	62	48	20	6	20	30.51	30.38	30.24	0
16	64.5	47.7	31	48	32	18.5	69	57	46	25	7	25	30.24	30.01	29.77	0
17	66.1	54.5	42	48	36	22.3	82	56	20	27	6	27	30.28	30.03	29.79	0
18	57.7	43.8	29	30	23	18.4	70	47	24	19	3	19	30.39	30.3	30.2	0
19	80.9	62.8	44	55	37	21.6	58	42	33	24	6	24	30.2	29.99	29.78	0
20	64.8	56.2	47	46	40	30.2	80	56	28	25	6	25	30.17	29.98	29.79	0
21	49.7	42.3	35	36	29	24.6	89	59	46	27	6	27	30.43	30.28	30.14	0.01
22	48.6	39.9	31	27	23	17.7	65	52	36	23	7	23	30.45	30.3	30.14	0
23	73.8	58.7	43	55	39	24	63	53	45	38	8	38	30.14	29.85	29.56	0
24	69.3	54.6	39	54	45	38.3	94	87	54	30	7	30	29.99	29.8	29.6	0.57
25	40.9	39.5	38	39	37	36.5	94	93	92	26	6	26	29.99	29.94	29.9	0.31
26	48.1	43.3	38	42	39	37.1	95	89	80	10	2	11	29.97	29.92	29.88	0
27	48.8	45.7	42	42	41	39.8	92	83	75	11	2	11	30.02	29.97	29.91	0
28	48.8	45	41	42	40	37.8	88	83	79	14	2	14	30.13	30.05	29.97	0.0
29	47.5	43.7	39	43	40	38.2	94	92	82	30	8	30	30.09	29.9	29.72	1.2
30	42.7	41	39	39	38	37.7	95	92	87	22	6	22	29.82	29.75	29.68	0.0
31	53.2	46	39	41	39	37.1	94	81	63	16	4	16	30.11	29.97	29.82	0.0

*Source: UNO Department of Geography / Geology Station, Omaha, NE

https://www.wunderground.com/weather/us/ne/omaha/KNEOMAHA52

Precip.	2.1
# event > 0.5 in	2
# event > 1.0 in	1

Daily Weather Observations April 2017*

2017	Temperature			Dew Pot			Humidity			Speed			Pressure			Precip. Accum.
Apr	High	Avg	Low	High	Avg	Low	High	Avg	Low	High	Avg	Gust	High	Avg	Low	Sum
1	48.2	43.9	39	40	38	36.7	90	82	72	14	3	14	30.24	30.17	30.09	0.00
2	52.7	48.4	44	48	44	40.2	93	86	79	13	2	13	30.1	29.9	29.7	0.03
3	56.1	51.9	47	49	48	46.3	96	90	78	15	4	15	29.75	29.63	29.51	0.07
4	57.4	51.6	45	46	42	37.4	94	74	48	19	5	19	29.89	29.77	29.65	0.00
5	57.6	50.4	43	41	36	30.3	78	62	38	22	6	22	30.05	29.93	29.81	0.01
6	55.3	46.4	37	39	32	25.2	84	59	33	21	6	21	30.24	30.15	30.05	0.00
7	63.4	50	36	39	34	29.5	78	53	36	21	5	21	30.22	30.01	29.8	0.00
8	75.3	63	50	56	48	38.5	72	59	48	23	6	23	29.81	29.65	29.49	0.00
9	79.2	67.3	55	60	56	47.9	86	70	39	24	6	26	29.64	29.5	29.36	0.03
10	55.4	45.5	35	48	40	30.7	88	82	74	29	5	29	30.22	29.9	29.58	0.00
11	62.9	46.8	30	37	32	27.5	89	61	34	13	2	13	30.37	30.27	30.17	0.00
12	70.4	59.5	48	55	46	37.2	77	64	54	23	4	23	30.19	30.09	29.99	0.08
13	79.5	66.2	52	60	56	48.8	87	69	51	13	2	13	30.1	30.03	29.95	0.00
14	70	65.4	60	64	59	55.8	95	85	74	17	5	23	29.97	29.83	29.69	0.36
15	77.5	68	58	63	58	54.3	91	75	57	20	3	20	29.84	29.76	29.67	0.02
16	70.7	60.8	51	57	41	30.8	85	54	24	24	5	24	30.1	29.98	29.85	0.00
17	72.7	60.9	49	49	46	42.1	79	59	43	16	2	16	30.15	30.05	29.94	0.00
18	71	63.7	56	61	55	48.2	93	77	59	24	4	24	29.96	29.9	29.83	0.32
19	78.8	63.6	48	65	53	46	92	82	59	22	6	22	29.98	29.81	29.64	0.33
20	60	53.2	46	46	43	39.1	91	74	55	27	6	27	30.14	30.02	29.9	0.00
21	56.9	49.8	42	41	39	36	87	67	47	18	4	19	30.16	30.11	30.07	0.00
22	66.2	54.5	42	39	35	29.2	81	50	26	19	4	19	30.24	30.18	30.13	0.00
23	72	57.3	42	41	34	27.7	79	44	21	22	2	22	30.16	30	29.84	0.00
24	73.7	62.8	51	46	40	34.9	57	44	31	33	6	33	29.84	29.64	29.44	0.00
25	63.2	51.6	40	46	42	38	93	80	54	22	6	22	29.59	29.49	29.4	0.09
26	40.8	37.7	34	38	33	31.3	93	82	74	28	8	28	29.71	29.63	29.55	0.00
27	57.7	46	34	37	33	28.6	81	64	43	17	2	17	29.76	29.7	29.65	0.00
28	50.4	43	35	38	36	33.1	94	86	58	25	5	25	30.07	29.9	29.74	0.50
29	44	41.4	38	38	36	34.5	93	82	74	32	7	32	30.12	30.03	29.93	0.06
30	41.9	39.3	36	40	37	35.2	94	94	92	35	8	35	29.95	29.7	29.45	0.84

*Source: UNO Department of Geography / Geology Station, Omaha, NE
https://www.wunderground.com/weather/us/ne/omaha/KNEOMAHA52

Precip.	2.7
# event > 0.5 in	2
# event > 1.0 in	0

Daily Weather Observations May 2017*

2017	Temperature			Dew Pot			Humidity			Speed			Pressure			Precip. Accum.
May	High	Avg	Low	High	Avg	Low	High	Avg	Low	High	Avg	Gust	High	Avg	Low	Sum
1	54.1	44.2	34	40	36	32.8	95	82	56	34	6	34	29.75	29.58	29.42	0.14
2	67	56.2	45	46	41	39.1	81	61	40	16	1	16	30	29.88	29.75	0.00
3	67	58.8	50	50	43	37.6	84	63	39	15	0	15	30.09	30.02	29.96	0.05
4	68.6	56.5	44	46	41	36.9	91	60	33	21	3	21	30.08	30.03	29.99	0.00
5	78.7	62.2	45	46	39	35.3	77	46	22	15	1	15	30.01	29.9	29.78	0.00
6	79.1	66.9	54	44	40	34.4	66	39	21	17	0	17	29.89	29.83	29.77	0.00
7	84.4	70.8	57	53	46	39	54	43	30	22	2	22	29.93	29.83	29.73	0.00
8	92.3	79.9	67	62	56	53.2	67	52	28	21	3	21	29.84	29.76	29.68	0.00
9	82.5	70.7	58	57	53	46.4	80	59	40	19	1	19	29.9	29.83	29.76	0.00
10	63.7	59.7	55	61	54	46.8	95	86	55	17	2	17	29.94	29.84	29.74	0.59
11	69.8	60.7	51	53	48	38.8	87	64	42	18	1	18	30.02	29.97	29.91	0.00
12	76.3	62.4	48	45	41	38.3	70	47	31	13	0	13	30.04	29.98	29.92	0.00
13	79.8	66.9	54	51	45	38.3	70	47	25	23	2	23	29.93	29.81	29.69	0.00
14	90.2	75.5	60	59	55	51.3	75	53	34	22	2	22	29.72	29.65	29.58	0.01
15	92.7	78.4	64	66	62	57	83	59	35	23	3	23	29.71	29.61	29.52	0.00
16	90	74.8	59	67	62	56.8	94	67	42	28	5	28	29.62	29.48	29.34	1.16
17	74.3	66.1	58	63	57	51.5	95	83	56	25	6	25	29.54	29.37	29.19	0.2
18	61.8	56.7	51	52	50	48.7	92	79	69	23	6	23	29.96	29.74	29.53	0.36
19	52.4	49.3	46	50	47	45	95	94	92	24	6	24	29.99	29.92	29.86	0.89
20	55.5	50.9	46	52	47	42.7	97	91	81	17	4	17	29.92	29.81	29.69	0.55
21	66	53.9	41	45	41	37.4	91	68	42	21	4	21	30.08	29.99	29.89	0.00
22	73.5	62.3	51	55	50	44.4	87	69	38	18	1	18	30.04	29.91	29.77	0.01
23	57.7	52.8	47	49	45	43.3	91	77	61	20	3	20	29.88	29.83	29.79	0.06
24	66.7	57	47	48	45	43.1	91	71	44	15	2	15	29.79	29.71	29.62	0.00
25	74.2	63.1	52	55	50	45.3	84	65	49	27	4	27	29.63	29.55	29.47	0.00
26	78.7	70.4	62	59	54	48.3	85	60	38	18	1	18	29.78	29.67	29.56	0.00
27	70.3	62.8	55	59	52	46.3	90	67	50	17	1	17	29.89	29.83	29.77	0.26
28	80.2	67.3	54	54	47	37.7	87	53	24	28	1	28	29.88	29.84	29.8	0.00
29	74.2	65.1	56	50	43	36.4	69	45	27	21	1	22	29.97	29.88	29.8	0.00
30	79.3	66.1	52	46	41	34.3	71	43	21	19	0	19	30.02	29.96	29.9	0.00
31	77	65.1	53	47	43	38.5	68	45	31	8	0	8.0	30.07	30.01	29.95	0.00

*Source: UNO Department of Geography / Geology Station, Omaha, NE

https://www.wunderground.com/weather/us/ne/omaha/KNEOMAHA52

Precip.	4.1
# event > 0.5 in	4
# event > 1.0 in	1

Daily Weather Observations June 2017*

2017	Temperature			Dew Pot			Humidity			Speed			Pressure			Precip. Accum.
Jun	High	Avg	Low	High	Avg	Low	High	Avg	Low	High	Avg	Gust	High	Avg	Low	Sum
1	82.8	70.8	59	62	54	44.8	73	57	48	14	2	14	30.03	29.94	29.86	0.00
2	87	76.8	66	67	62	56.5	92	66	38	20	2	20	29.94	29.88	29.82	0.07
3	89.2	77	64	65	61	58.5	86	61	38	13	0	13	29.93	29.86	29.8	0.00
4	93	81.2	69	66	62	55.3	80	55	34	10	0	10	29.86	29.78	29.69	0.00
5	92.5	79.2	66	64	54	40.4	83	46	19	13	0	13	29.84	29.78	29.73	0.00
6	83.9	75	66	55	52	48.9	66	46	31	15	1	15	29.99	29.92	29.84	0.00
7	83.4	73.4	63	55	50	47.7	65	46	31	9	0	9	30.06	29.99	29.93	0.00
8	86.2	74.2	62	55	51	46.6	65	45	28	14	0	16	29.97	29.86	29.76	0.00
9	88.5	76.4	64	62	57	52.4	72	51	33	20	2	20	29.79	29.69	29.59	0.00
10	91.5	80.4	69	71	67	61.8	80	66	50	24	4	24	29.6	29.55	29.5	0.00
11	93	82.9	72	72	69	66.1	80	65	49	28	4	28	29.66	29.6	29.55	0.00
12	82.5	76.2	69	73	69	66.1	90	78	64	27	2	27	29.79	29.71	29.63	0.08
13	90.6	82.1	73	74	70	57.1	82	68	49	29	3	29	29.74	29.62	29.51	0.00
14	88	76.1	64	68	63	58	93	70	41	24	1	24	29.88	29.78	29.69	0.42
15	95.8	80.9	65	68	62	57.9	89	57	31	14	0	14	29.9	29.81	29.72	0.16
16	88.5	78.1	67	73	67	62.1	94	76	57	47	5	47	29.82	29.64	29.46	1.56
17	83.5	73.9	64	69	64	56.1	96	81	48	21	3	21	29.82	29.71	29.6	0.03
18	80.5	70.3	60	57	52	46.6	80	57	31	17	2	27	29.93	29.86	29.79	0.00
19	85.2	73.8	62	55	51	45.4	74	47	26	20	0	20	30.04	29.98	29.92	0.00
20	94	80.4	66	60	54	48.6	68	44	23	18	1	18	30.01	29.9	29.79	0.00
21	95.3	82.2	69	71	64	57	74	55	38	24	6	24	29.8	29.68	29.56	0.00
22	92.2	82.3	72	70	65	60.3	76	59	48	22	5	22	29.67	29.58	29.5	0.00
23	73.9	67.9	62	64	53	47.5	81	61	45	24	4	24	30.04	29.85	29.67	0.00
24	81.5	66.9	52	47	42	36.9	72	43	21	21	3	21	30.14	30.09	30.04	0.00
25	76.5	64.9	53	45	43	41.2	69	45	29	14	4	18	30.26	30.19	30.12	0.00
26	76.2	65.3	54	59	52	44.1	92	64	43	16	2	16	30.16	30.1	30.03	0.36
27	79	68.6	58	66	58	49.3	76	68	58	27	6	27	30.09	29.88	29.66	0.00
28	90.9	76.9	62	72	66	60.8	93	71	44	25	5	25	29.78	29.65	29.52	0.3
29	82.9	73.7	64	70	65	59.9	93	73	58	23	4	23	29.8	29.69	29.59	0.57
30	80	70.4	61	64	60	54.5	94	77	49	20	2	20	29.94	29.83	29.72	0.05

*Source: UNO Department of Geography / Geology Station, Omaha, NE
https://www.wunderground.com/weather/us/ne/omaha/KNEOMAHA52

Precip.	3.3
# event > 0.5 in	2
# event > 1.0 in	1

Daily Weather Observations July 2017*

2017	Temperature			Dew Pot			Humidity			Speed			Pressure			Precip. Accum.
Jul	High	Avg	Low	High	Avg	Low	High	Avg	Low	High	Avg	Gust	High	Avg	Low	Sum
1	86.2	72.3	58	65	58	49.3	92	65	37	13	1	13	30	29.94	29.89	0.00
2	84.2	75.1	66	69	64	60.9	90	75	55	14	2	14	30.03	29.95	29.88	0.11
3	90.3	80.7	71	73	69	66.6	91	76	52	14	3	14	29.92	29.86	29.81	0.05
4	86	77.8	69	71	67	64.6	87	72	56	21	3	21	29.98	29.93	29.88	0.00
5	91.4	79.8	68	69	66	64.1	89	66	42	10	2	10	30.04	29.98	29.92	0.00
6	94.5	83.4	72	75	70	65.5	81	64	51	15	4	15	29.99	29.9	29.82	0.00
7	83.4	76.7	70	73	61	57	74	60	45	18	5	18	30.05	29.95	29.86	0.00
8	88.5	76.5	64	67	63	60.7	89	66	44	13	2	13	30.06	29.99	29.92	0.00
9	93.7	82.5	71	73	69	64.8	81	64	48	22	4	22	29.95	29.8	29.64	0.00
10	91.8	85	78	76	71	66.5	77	65	56	21	4	21	29.74	29.69	29.64	0.00
11	93.7	82	70	77	72	65.9	89	73	58	23	6	23	29.83	29.72	29.6	0.01
12	87.7	80.6	73	74	69	65	88	72	51	24	4	24	29.93	29.78	29.63	0.32
13	85.8	77.7	69	71	69	67.1	95	80	58	10	2	10	30.05	29.98	29.91	0.23
14	89.8	78.1	66	71	67	61.8	87	71	48	11	2	11	30.11	30.06	30.01	0.00
15	94.6	82.8	71	75	71	67.3	89	70	48	12	2	12	30.06	29.99	29.91	0.00
16	98.1	85.6	73	74	69	66.3	82	60	36	9	2	11	29.95	29.88	29.81	0.00
17	92.5	83.3	74	74	70	66.4	84	65	44	18	4	18	29.89	29.83	29.77	0.00
18	89.3	81.7	74	76	72	68.7	88	74	58	14	4	14	29.92	29.87	29.82	0.01
19	94.1	85.7	77	80	74	70.2	81	71	60	26	5	26	29.95	29.86	29.77	0.00
20	96.8	87.2	77	78	73	69.7	78	65	47	17	2	17	29.87	29.81	29.75	0.00
21	100	89.9	79	78	73	70.7	78	60	42	19	4	19	29.77	29.67	29.58	0.01
22	90.3	83.2	76	77	73	67.2	92	75	55	19	4	19	29.83	29.71	29.59	0.00
23	88.8	79.1	69	71	66	59.9	94	68	42	18	3	18	29.91	29.85	29.8	0.00
24	85.1	74.6	64	68	63	59.4	85	68	53	15	4	15	29.96	29.9	29.85	0.00
25	94.2	83	71	77	70	65.6	82	70	50	22	6	22	29.93	29.86	29.8	0.00
26	82.5	76.8	71	73	71	67.9	96	89	73	25	3	25	29.93	29.87	29.81	0.48
27	84.3	75.3	66	70	65	62.4	96	74	51	16	3	16	30.0	29.95	29.9	0.00
28	84.7	75.3	66	68	64	62.2	88	71	49	12	1	12	29.99	29.95	29.92	0.00
29	83.9	76.1	68	66	63	61.3	80	67	53	16	3	16	30.06	30.01	29.96	0.00
30	86.3	75.9	65	63	60	57.1	74	61	45	14	3	14	30.14	30.09	30.05	0.00
31	83.2	73.8	64	63	60	56.9	80	64	51	10	2	10	30.11	30.06	30.01	0.00

*Source: UNO Department of Geography / Geology Station, Omaha, NE

https://www.wunderground.com/weather/us/ne/omaha/KNEOMAHA52

Precip.	1.2
# event > 0.5 in	0
# event > 1.0 in	0

Daily Weather Observations August 2017*

2017	Temperature			Dew Pot			Humidity			Speed			Pressure			Precip. Accum.
Aug	High	Avg	Low	High	Avg	Low	High	Avg	Low	High	Avg	Gust	High	Avg	Low	Sum
1	88.5	77.8	67	68	64	60.7	83	67	49	20	2	20	30.06	30.01	29.96	0.00
2	87.3	76.1	64	69	65	60.3	87	70	54	10	2	10	30.03	29.98	29.92	0.00
3	76.8	68.1	59	67	58	50.9	85	71	57	22	6	28	30.09	29.99	29.88	0.00
4	79.6	66.4	53	55	52	49.5	88	62	38	13	1	13	30.12	30.05	29.97	0.00
5	67.2	63.7	60	60	56	52.3	88	75	62	17	4	17	29.99	29.92	29.84	0.06
6	76.7	69.2	61	63	60	58.7	91	78	59	12	3	12	29.97	29.92	29.88	0.00
7	80.4	71.3	62	62	60	58.5	90	73	49	15	3	15	30.11	30.04	29.97	0.00
8	82.7	71.5	60	62	59	56.2	87	67	48	15	2	15	30.16	30.08	30.01	0.00
9	79.3	71.5	63	65	61	58.7	84	71	59	16	3	16	30.06	29.99	29.93	0.00
10	81.4	73.4	65	66	63	59.3	90	79	53	16	2	16	30.04	30	29.95	0.24
11	81	70.4	59	62	59	56.9	91	69	48	12	2	12	30.1	30.05	29.99	0.00
12	81.3	71.8	62	59	56	54.4	77	60	46	13	2	13	30.07	29.99	29.92	0.00
13	79.8	72.1	64	64	60	55.4	86	69	55	20	5	20	29.96	29.84	29.73	0.01
14	88.8	78.5	68	70	64	57.2	94	70	42	13	3	13	29.76	29.73	29.7	0.01
15	85	75.4	65	72	65	60.8	93	80	66	22	6	22	29.84	29.76	29.69	0.66
16	81.5	73.8	66	70	66	61.8	93	83	62	20	4	20	29.79	29.7	29.61	0.18
17	82.9	72.8	62	62	60	57.4	89	68	45	21	3	21	29.86	29.8	29.74	0.00
18	88	77.4	66	67	63	60.8	82	65	44	17	2	17	29.88	29.83	29.77	0.00
19	87.4	73.9	60	66	61	53.5	90	64	36	20	4	20	29.9	29.82	29.74	0.00
20	83.9	75.4	66	69	66	63.5	93	78	57	21	5	21	29.9	29.81	29.73	0.35
21	82.6	73.8	65	74	67	61.9	94	83	73	30	7	30	29.98	29.9	29.81	0.96
22	75.8	68.8	61	63	55	46.3	95	68	40	16	2	16	30.12	30	29.88	0.01
23	79.7	68.3	57	59	55	51.8	89	65	41	12	2	12	30.12	30.03	29.95	0.00
24	80	71.3	62	63	59	56.1	81	70	53	20	5	20	30.0	29.94	29.88	0.00
25	81.7	71.8	62	68	62	59.1	93	76	61	23	6	23	30.06	30	29.94	0.47
26	86	76.1	66	72	66	61.2	87	76	59	17	4	17	30.09	30.01	29.92	0.00
27	83.2	75.8	68	70	67	63	95	78	58	16	3	16	30.0	29.97	29.93	0.00
28	77.1	68.4	59	63	59	56.7	90	73	54	19	4	19	30.07	30.03	30.0	0.00
29	78.2	68.7	59	60	59	56.9	93	73	53	11	2	11	30.08	30.03	29.99	0.00
30	84.3	72.4	60	63	61	58	92	71	48	9	1	9	30.09	30.04	29.99	0.00
31	83	72.7	62	64	62	59.1	90	70	52	11	2	11	30.08	30.03	29.98	0.00

*Source: UNO Department of Geography / Geology Station, Omaha, NE

https://www.wunderground.com/weather/us/ne/omaha/KNEOMAHA52

Precip.	3.0
# event > 0.5 in	2
# event > 1.0 in	0

Daily Weather Observations September 2017*

2017	Temperature			Dew Pot			Humidity			Speed			Pressure			Precip. Accum.
Sep	High	Avg	Low	High	Avg	Low	High	Avg	Low	High	Avg	Gust	High	Avg	Low	Sum
1	78	70.2	62	65	62	59	91	79	64	17	5	17	30.05	29.99	29.94	0.00
2	82.5	73.2	64	69	65	60.7	90	78	63	13	3	13	29.97	29.94	29.91	0.00
3	87	75.9	64	70	66	62.7	95	76	52	18	3	18	30	29.88	29.76	0.00
4	76.7	69.8	62	67	60	53.8	90	71	48	21	5	21	30.03	29.88	29.73	0.00
5	68.3	59.8	51	54	45	41.2	77	60	39	33	5	33	30.15	30.09	30.03	0.00
6	69.3	58.9	48	49	45	44.1	86	64	42	16	3	16	30.17	30.12	30.08	0.00
7	79.9	65.1	50	53	48	46	87	59	34	9	2	12	30.1	30.02	29.94	0.00
8	85.4	72.3	59	63	56	50.9	77	60	43	9	4	12	30.05	30.02	29.99	0.00
9	83.5	73.7	63	62	58	54.2	72	60	44	15	5	20	30.17	30.1	30.03	0.00
10	83.7	75.1	66	65	60	58.7	79	65	45	16	5	20	30.21	30.13	30.06	0.01
11	84.2	73.5	63	61	59	55.8	78	63	45	12	4	12	30.13	30.06	30	0.00
12	85	73.8	62	62	60	57.7	86	64	45	11	1	11	30	29.89	29.77	0.00
13	88.2	76	63	62	60	57.2	85	62	40	11	2	11	29.78	29.7	29.62	0.00
14	92.8	80.2	67	61	58	54.8	77	53	29	26	6	26	29.67	29.62	29.58	0.03
15	89.7	78.4	68	68	60	57.8	74	61	50	27	6	27	29.73	29.67	29.62	0.00
16	76.6	65.3	55	68	62	53.2	94	86	80	19	6	19	30.04	29.89	29.73	0.69
17	69.8	58.7	50	51	49	46.5	90	78	55	18	4	18	30.18	30.1	30.01	0.01
18	71.8	67.2	63	66	62	54.1	95	90	75	18	4	18	30.01	29.91	29.81	0.29
19	79.1	78.5	77	69	69	69.3	76	74	72	9	8	29	29.51	29.51	29.51	0.00
20	77.6	72.1	66	55	53	51.2	63	55	45	7	3	10	29.81	29.77	29.74	0.00
21	90.2	77.8	65	74	67	53	83	70	57	24	7	24	29.82	29.73	29.64	0.00
22	93.8	84.4	75	73	70	68.4	85	68	45	26	7	26	29.78	29.74	29.69	0.00
23	89.2	79.9	70	70	67	64.2	87	67	46	26	6	26	29.87	29.81	29.75	0.00
24	87.5	75.1	62	71	66	59.1	89	74	48	27	5	27	29.89	29.83	29.76	0.14
25	65.2	61.1	57	63	59	55.9	96	95	88	15	3	15	29.92	29.86	29.81	1.07
26	62.5	57.2	52	56	52	50.6	96	86	70	17	4	17	30.15	30.03	29.91	0.06
27	71.3	60.7	50	52	50	47.8	93	71	47	10	2	10	30.28	30.21	30.14	0.00
28	77.5	64	50	54	50	47.2	91	64	36	11	1	11	30.23	30.17	30.11	0.00
29	79.5	66.6	53	56	51	48.4	83	62	34	16	3	16	30.23	30.18	30.14	0.00
30	76.2	67.1	58	52	49	45.3	64	54	42	23	7	23	30.22	30.1	29.98	0.00

*Source: UNO Department of Geography / Geology Station, Omaha, NE
https://www.wunderground.com/weather/us/ne/omaha/KNEOMAHA52

Precip.	2.3
# event > 0.5 in	2
# event > 1.0 in	1

Daily Weather Observations October 2017*

2017	Temperature			Dew Pot			Humidity			Speed			Pressure			Precip. Accum.
Oct	High	Avg	Low	High	Avg	Low	High	Avg	Low	High	Avg	Gust	High	Avg	Low	Sum
1	78.4	67.4	56	58	53	46.7	87	62	49	31	8	31	30	29.83	29.65	0.21
2	81.3	70.9	60	68	61	53.1	91	75	57	27	6	27	29.8	29.74	29.67	0.67
3	74.9	65.8	56	65	59	50.5	92	82	72	24	4	24	30.3	30.01	29.72	0.09
4	68.8	61	53	51	48	46	79	66	49	10	3	11	30.41	30.3	30.19	0.00
5	64.1	60.4	56	62	57	50.4	96	90	72	9	1	9	30.19	30.06	29.92	0.64
6	68.2	61.8	55	67	59	54.3	97	97	94	20	3	20	29.93	29.69	29.46	0.64
7	71.3	61.8	52	56	53	51.2	97	81	53	20	3	20	29.62	29.51	29.41	0.38
8	76.8	65.4	54	55	51	45.4	80	65	46	23	4	23	29.74	29.65	29.56	0.00
9	58.8	49.8	40	45	38	33.3	87	62	45	31	9	31	30.21	29.98	29.75	0.06
10	45.6	41.7	37	39	36	35.4	93	84	70	20	6	20	30.28	30.23	30.18	0.57
11	61.8	48	34	46	38	32	91	71	45	14	3	14	30.25	30.17	30.08	0.00
12	66	56.7	47	54	49	45.2	94	81	64	21	6	21	30.08	29.97	29.85	0.00
13	57.6	55.1	52	52	50	48.2	90	85	80	17	4	17	30.03	29.99	29.94	0.00
14	57.2	52.3	47	56	51	42	96	92	81	30	4	35	30.04	29.89	29.73	0.2
15	60.9	50.2	39	41	37	34.4	83	65	38	24	4	25	30.36	30.2	30.04	0.00
16	72.8	56.2	39	42	39	35	85	57	30	19	3	19	30.33	30.2	30.08	0.00
17	72.7	59.7	46	48	44	40.3	80	61	41	12	3	12	30.09	30.01	29.94	0.00
18	78.5	63.9	49	53	48	44.5	84	63	39	15	3	15	29.99	29.92	29.86	0.00
19	76.6	63.4	50	57	51	44.8	84	64	48	16	4	16	30.04	29.97	29.9	0.00
20	75.8	66.2	56	60	55	50.4	84	70	59	32	7	32	29.92	29.77	29.63	0.00
21	74.6	62.5	50	64	54	40.4	90	74	58	25	7	25	29.94	29.74	29.55	0.06
22	69	56	42	41	36	30.6	83	54	25	16	2	16	30.1	30.01	29.92	0.00
23	62.7	54.7	46	42	35	30.9	64	49	33	42	7	42	30.05	29.93	29.82	0.00
24	53.2	46.7	40	35	29	23.4	61	51	32	37	9	37	30.12	30.06	30	0.00
25	71.3	56.3	41	42	35	29.2	65	49	33	12	3	12	30.05	29.82	29.59	0.00
26	59.7	48.4	37	41	36	23.6	75	58	47	39	1	39	30.05	29.74	29.44	0.00
27	37.1	33.5	30	23	21	19.9	69	61	57	31	9	31	30.13	30.08	30.04	0.00
28	50.8	36.8	22	23	15	5.5	79	50	16	12	1	12	30.16	30.03	29.9	0.00
29	67.5	51	34	42	27	11.2	77	51	34	25	2	25	29.9	29.76	29.63	0.00
30	49	41.4	33	36	24	18	62	53	43	39	7	39	30.23	30.04	29.85	0.00
31	36.2	30.6	25	27	20	16	85	66	52	19	2	19	30.27	30.1	29.92	0.00

*Source: UNO Department of Geography / Geology Station, Omaha, NE

https://www.wunderground.com/weather/us/ne/omaha/KNEOMAHA52

Precip.	3.3
# event > 0.5 in	4
# event > 1.0 in	0

Daily Weather Observations November 2017*

2017	Temperature			Dew Pot			Humidity			Speed			Pressure			Precip. Accum.
Nov	High	Avg	Low	High	Avg	Low	High	Avg	Low	High	Avg	Gust	High	Avg	Low	Sum
1	48.8	39.5	30	39	31	25.2	85	75	65	20	4	20	29.92	29.76	29.6	0.00
2	51.7	44.1	36	38	36	30.3	91	76	54	21	5	21	30.27	29.99	29.7	0.00
3	46.9	38.3	29	35	29	25.4	85	70	54	13	3	16	30.35	30.19	30.03	0.00
4	52.7	47.8	42	41	38	35.3	81	75	62	9.0	0	9.0	30.04	29.89	29.74	0.00
5	46.9	38	29	41	30	19.6	84	69	43	25	6	25	30.2	29.98	29.75	0.00
6	43	34.6	26	24	21	20.1	80	65	42	14	3	14	30.31	30.25	30.19	0.00
7	43.2	36.8	30	29	25	22.4	80	66	50	14	2	14	30.47	30.39	30.31	0.00
8	51	38.2	25	31	26	22.4	89	65	45	18	2	18	30.42	30.27	30.13	0.00
9	38.8	30.5	22	30	17	7.5	77	59	43	22	6	22	30.51	30.33	30.14	0.00
10	34.2	26.2	18	18	12	8.4	68	57	49	21	6	21	30.52	30.36	30.2	0.00
11	43.6	38.9	34	39	32	18.4	93	75	52	16	2	16	30.21	30.13	30.05	0.00
12	48.9	42.8	36	39	33	28.8	94	75	48	13	1	13	30.43	30.31	30.19	0.05
13	43.7	37.4	31	41	35	27.8	93	89	76	18	2	18	30.42	30.28	30.15	0.00
14	54.1	48.9	43	52	47	40.8	95	92	89	16	3	16	30.15	29.98	29.81	0.00
15	51.8	41.1	30	50	32	21.1	95	69	48	17	5	24	30.22	30.04	29.86	0.00
16	46.7	36.8	27	30	25	20	79	66	52	22	4	22	30.23	30.04	29.85	0.00
17	60.2	50.6	40	55	45	30.1	91	80	64	23	4	23	29.85	29.66	29.47	0.00
18	46.2	37.8	29	41	30	22.2	93	74	56	33	8	33	30.21	29.88	29.54	0.16
19	54	39.3	24	32	25	19.9	84	61	34	17	1	17	30.25	30.07	29.89	0.00
20	57.3	46.3	35	31	28	25.6	68	51	35	12	2	18	29.89	29.74	29.58	0.00
21	44.7	32.3	20	29	18	10.2	68	55	39	32	7	32	30.45	30.07	29.69	0.00
22	40.2	28.2	16	21	15	9.7	79	60	41	17	1	17	30.46	30.25	30.05	0.00
23	62.4	47.6	32	41	34	20.9	78	59	45	9.0	1	9.0	30.05	29.88	29.7	0.00
24	69.3	56.5	43	44	40	33.8	69	57	38	34	5	34	29.95	29.69	29.44	0.00
25	59.8	47	34	37	34	30.2	87	65	40	11	0	11	30.21	30.08	29.95	0.00
26	59.5	48.7	37	40	36	31	78	65	49	8.0	0	8.0	30.2	30.08	29.95	0.00
27	67.3	54.5	41	47	40	32.6	74	62	44	21	4	21	29.95	29.76	29.57	0.00
28	55.1	47.9	40	47	32	19.4	81	56	31	25	7	25	30.33	29.97	29.6	0.00
29	49.7	39	28	25	20	15.9	72	46	27	21	3	21	30.33	30.2	30.07	0.00
30	55.7	45	34	29	24	21.1	72	48	27	13	2	18	30.31	30.24	30.17	0.00

*Source: UNO Department of Geography / Geology Station, Omaha, NE
https://www.wunderground.com/weather/us/ne/omaha/KNEOMAHA52

Precip.	0.2
# event > 0.5 in	0
# event > 1.0 in	0

Daily Weather Observations December 2017*

2017	Temperature			Dew Pot			Humidity			Speed			Pressure			Precip. Accum.
Dec	High	Avg	Low	High	Avg	Low	High	Avg	Low	High	Avg	Gust	High	Avg	Low	Sum
1	57.9	45.9	34	28	24	21.3	61	47	31	22	3	22	30.19	30.08	29.98	0.00
2	57.1	43.8	30	28	25	22.8	75	50	27	8.0	1	8.0	30.17	30.11	30.05	0.00
3	57.9	48	38	51	40	25.5	81	70	49	20	5	20	30.1	29.81	29.52	0.00
4	61.4	44.5	27	56	38	15.3	86	73	54	36	7	36	30.05	29.7	29.35	0.00
5	43	34	25	28	18	10.8	62	52	42	30	5	30	30.19	30.12	30.05	0.00
6	41.7	29.2	16	29	21	10.6	80	71	57	31	7	31	30.45	30.28	30.11	0.00
7	27.2	19	10	10	7	4.7	77	64	46	23	3	23	30.53	30.34	30.15	0.00
8	33.4	26	18	25	20	7.9	80	75	63	20	3	20	30.15	30.06	29.96	0.00
9	34.8	30.1	25	25	21	18.9	82	73	60	20	4	20	30.24	30.11	29.99	0.00
10	52.2	41.1	30	29	26	21.9	72	55	40	20	2	20	30.14	30.08	30.02	0.00
11	46.3	35.8	25	33	24	16.5	71	57	42	40	8	40	30.35	30.13	29.91	0.00
12	41.4	29	16	28	20	12.4	84	72	60	17	2	17	30.39	30.09	29.8	0.00
13	48.9	41.6	34	32	28	24.1	71	58	43	37	8	37	30.0	29.83	29.65	0.00
14	39.1	35.9	32	29	27	25.9	82	71	61	19	2	20	30.15	30.07	29.99	0.00
15	47.5	39.2	30	28	26	23.7	80	62	45	22	3	22	30.15	29.94	29.73	0.00
16	52	43.5	35	29	26	22	74	53	39	16	1	16	29.99	29.86	29.73	0.00
17	36.9	32.3	27	29	26	23.8	87	82	72	12	2	15	30.07	30.0	29.93	0.00
18	53.9	40.2	26	33	29	23.9	92	70	38	16	2	18	30.01	29.94	29.86	0.00
19	46.5	39.5	32	32	25	15	77	55	31	15	3	21	30.16	30.02	29.89	0.00
20	43	36	29	27	17	11.2	63	46	36	17	5	19	30.16	29.99	29.81	0.00
21	40.7	31	21	31	26	19.1	92	80	58	18	5	21	30.11	29.95	29.8	0.06
22	26.1	21.7	17	20	16	13.6	91	82	69	12	3	15	30.28	30.19	30.1	0.02
23	21.5	18.6	15	16	13	11	87	80	72	14	2	16	30.37	30.32	30.26	0.01
24	22.7	17.5	12	14	11	6.3	90	79	64	11	2	15	30.38	30.34	30.3	0.09
25	12.9	7.7	2	6	1	-4.1	81	71	51	18	3	19	30.64	30.51	30.38	0.00
26	5.7	1.4	-2	-1	-6	-10	80	70	58	12	2	14	30.85	30.74	30.63	0.00
27	6.3	0.9	-4	2	-5	-11	84	70	51	14	2	17	30.89	30.75	30.61	0.00
28	10	8.1	6	4	2	1.1	82	77	75	15	6	18	30.6	30.54	30.48	0.00
29	16.3	10.9	5	13	8	0.8	89	82	77	9.0	4	20	30.51	30.35	30.2	0.00
30	5.4	1.3	-2	0	-5	-8.3	80	71	64	14	5	23	30.71	30.62	30.54	0.00
31	-2.9	-5.3	-7	-8	-9	-12	80	79	78	13	4	13	30.77	30.73	30.69	0.00

*Source: UNO Department of Geography / Geology Station, Omaha, NE

https://www.wunderground.com/weather/us/ne/omaha/KNEOMAHA52

Precip.	0.2
# event > 0.5 in	0
# event > 1.0 in	0

APPENDIX B WATER QUALITY SAMPLING PROTOCOL

2016 Water Quality Sampling Protocol

BURNS McDONNELL

Site: Creighton Prep
Date: June 1, 2016

INTRODUCTION/PURPOSE

Performance of the Creighton Prep High School Bio-retention Garden will be assessed utilizing various monitoring technologies. Automatic samplers will be installed on site to collect water quality samples during certain rain events. This Protocol will include inflow and outflow sampler configuration, the procedure to trigger sample collection, the number of samples to collect per rainfall event, and list the water quality parameters to be evaluated. Protocol development will be dependent on feedback from and coordination with the City.

SAMPLING PROTOCOL

Automatic Sampler Configuration

The inflow sampler will collect samples from a 24-inch inflow pipe to the BMP. Upstream contributors to this flow include a parking lot and a field inlet surrounded by baseball and football fields. Flows with large volumes and short durations are expected through this pipe. The 'first flush' is the most telling flow thus samples collected during the initial phase of the rain event are of special interest.

The outflow sampler will collect samples from the 4-inch underdrain pipe and the flow meter is located in the 12-inch outflow pipe that connects the BMP underdrain and overflow to the City's Municipal Separate Storm Sewer System (MS4) system. Expected flows coming from the underdrain will initially have small volumes and long durations. If the rain event is large enough to use the overflow, there will be a large initial volume while water passes through the overflow. Then the flow volume is expected to reduce notably, but will continue for a long duration. The 'first flush' is the most telling flow, thus samples collected during the initial phase of the rain event are of special interest.

The inflow and outflow automatic samplers will be connected to a flow meter. The automatic sampler will be configured to start collecting samples when the flow meter senses a preset flow.

Data and Sample Collection

During the months of April, May, and June up to three (3) sampling events of 0.1" or greater will be conducted. Water quality samples and data will be collected from monitoring equipment after each completed sampling event. A site visit and data collection will be conducted if no sampling event is completed within a thirty (30) day period. Field sheets will be filled out during each site visit and are attached to this document.

For E. coli, a manual grab sample will be collected for the inflow and outflow as soon as possible after the start of an event. The Automatic sampler will collect samples in up to twenty-four (24)

one (1) liter bottles. The amount of samples collected by the samplers will depend on the rain event. The inflow automatic sampler will collect a sample every five (5) minutes for the duration of the storm runoff or up to two (2) hours. The outflow automatic sampler will collect a sample every 15 minutes for the duration of storm runoff or up to six (6) hours.

Two (2) total E.coli/Total Coliform grab samples will be collected for the inflow and another at the outflow, placed within sterile testing bottles provided by MidWest Labs, and delivered to the facility within 6 hours of collection. For quality assurance purposes one (1) duplicate sample will be provided one (1) field blank will be provided for every sampling event. Grab samples and blanks will be labeled per the sample labeling protocol shown in Table 1-1 below.

Table 1-1: Grab Sample Labeling Protocol

Grab Sample Label	Timing	Parameter(s)
Inflow		
CP-In-E. Coli	0 - 15 Min.	E. coli/Total Coliform
Outflow		
CP-Out-E. Coli	0 - 15 Min.	E. coli/Total Coliform

Samples collected in the automatic samplers will be collected, refrigerated, and flow meter/rain gauge data will be assessed within twenty-four (24) hours following the rain event. Samples collected in the automatic samplers will then be examined and a minimum of three (3) composites per sampler will be made to represent the different components of the event hydrograph.

The determination of the composite samples will be made on a per event basis after reviewing retrieved sample volumes and data. The composite samples will be combined in mixing jugs and then poured into testing bottles provided by Midwest labs. Sample preservatives will be provided by Midwest labs and added for the appropriate constituent. For quality assurance purposes one (1) duplicate sample will be provided per every six (6) samples prepared and one (1) field blank will be provided for every sampling event. Composite samples and blanks will be labeled per the labeling protocol shown in Table 1-2 below. Chain of custody paperwork will be filled out per MidWest Labs direction and delivered to the testing facility for processing with samples.

Table 1-2: Composite Sample Labeling Protocol

Composite Sample Label	Timing	Parameter(s)	Preservative
Inflow			
CP-In-1A	0 - 15 Min.	Cd^{2+} & Zn^{2+}	Nitric Acid (HNO3)
CP-In-1B	0 -15 Min.	TKN, N/N, & T-P	Sulfuric Acid (H2SO4)
CP-In-1C	0 -15 Min.	TSS, TDS, & pH	-
CP-In-2A	20 – 45 Min.	Cd^{2+} & Zn^{2+}	Nitric Acid (HNO3)
CP-In-2B	20 – 45 Min.	TKN, N/N, & T-P	Sulfuric Acid (H2SO4)
CP-In-2C	20 – 45 Min.	TSS, TDS, & pH	-
CP-In-3A	50 – 75 Min.	Cd^{2+} & Zn^{2+}	Nitric Acid (HNO3)
CP-In-3B	50 – 75 Min.	TKN, N/N, & T-P	Sulfuric Acid (H2SO4)
CP-In-3C	50 – 75 Min.	TSS, TDS, & pH	-
CP-In-4A	80+ Min.	Cd^{2+} & Zn^{2+}	Nitric Acid (HNO3)
CP-In-4B	80+ Min.	TKN, N/N, & T-P	Sulfuric Acid (H2SO4)
CP-In-4C	80+ Min.	TSS, TDS, & pH	-
Outflow			
CP-Out-1A	0 - 30 Min.	Cd^{2+} & Zn^{2+}	Nitric Acid (HNO3)
CP-Out-1B	0 - 30 Min.	TKN, N/N, & T-P	Sulfuric Acid (H2SO4)
CP-Out-1C	0 - 30 Min.	TSS, TDS, & pH	-
CP-Out-2A	45 – 90 Min.	Cd^{2+} & Zn^{2+}	Nitric Acid (HNO3)
CP-Out-2B	45 – 90 Min.	TKN, N/N, & T-P	Sulfuric Acid (H2SO4)
CP-Out-2C	45 – 90 Min.	TSS, TDS, & pH	-
CP-Out-3A	105 – 150 Min.	Cd^{2+} & Zn^{2+}	Nitric Acid (HNO3)
CP-Out-3B	105 – 150 Min.	TKN, N/N, & T-P	Sulfuric Acid (H2SO4)

CP-Out-3C	105 – 150 Min.	TSS, TDS, & pH	-
CP-Out-4A	165+ Min.	Cd^{2+} & Zn^{2+}	Nitric Acid (HNO3)
CP-Out-4B	165+ Min.	TKN, N/N, & T-P	Sulfuric Acid (H2SO4)
CP-Out-4C	165+ Min.	TSS, TDS, & pH	-

Water Quality Parameters

Water Quality constituents selected for analysis are: pH, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), E.Coli/Total Coliform, Zinc, Cadmium, Total Phosphorous, Dissolved Phosphorous, and Total Nitrogen (Nitrate/Nitrite + Total Kjeldahl Nitrogen).

Table 1-3: Water Quality Parameters and Costs

Water Quality Parameter	Abbreviation	Cost* per sample (MidWest Labs)
Potential of Hydrogen	pH	$ 10.00
Total Suspended Solids	TSS	$15.00
Total Dissolved Solids	TDS	$16.00
E.Coli/Total Coliform	-	$14.00
Metals – Digest Fee	-	$20.00
Zinc	Zn^{2+}	$10.00
Cadmium	Cd^{2+}	$10.00
Total Phosphorous	T-P	$20.90
Phosphorous (dissolved)	-	$20.90

Total Nitrogen:	-	-
Nitrate/Nitrite	N/N	$10.00
Total Kjeldahl Nitrogen	TKN	$22.00
	Total:	**$168.80 per sample**

*Prices shown are per the 2015 contract agreement between Midwest labs and the City; 2016-2017 prices were not available during the development of this document.

Attachments:

Appendix A - BMP Monitoring Site Visit Form

APPENDIX A - BMP MONITORING SITE VISIT FORM

BMP Monitoring Site Visit Form

Site Location: _____

Employee Name(s): _____

Date: _____ Time: _____

Pre Site-Visit Checklist:

- Items to Bring
  - □ Clean Sample bottles
  - □ Laptop and cables to download data

Site Conditions:

Most Recent Rainfall (date/time)	Top Soil Moisture (Dry, Moist, Saturated)	Underdrain Valve (Open/Close/NA)

Site Visit Checklist:

1.) Routine Monthly site visits (if no sampling event is conducted within 30 day period)

- Rain Gauge:
  - □ Verify gauge undamaged and ready for next monitoring period
  - □ Verify connections to power source, and samplers
- Automatic Sampler:
  - □ Visually check flow path not hindered
  - □ Manually purge sample collection line to verify intake/hoses are not clogged
  - □ Verify sample bottles are empty and clean (if not, replace with clean bottles)
  - □ Verify sampler ready for next monitoring period
  - □ Verify programming ready to collect intended storm event
  - □ Verify connections to power source and rain gauge within sampler shelter
- Flow Meter:
  - □ Download data (flow meter also holds automatic sampler and rain gauge data)
  - □ Verify sensor wire is not kinked or damaged within sampler shelter
  - □ Verify connections to power source within sampler shelter
- Sampler Shelter:
  - □ Verify Sampler Shelter secure to ground
  - □ Verify shelter undamaged
  - □ Lock shelter upon completion of site visit

- Stilling Wells:

  IMPORTANT: Only access the data logger end of the Pressure Transducer. Stilling Well caps & seals can only be broken by someone with the appropriate well certifications.

  - □ Download data
  - □ Verify Pressure Transducer and well cap are secure

- Stilling Basin:
  - □ Download data
  - □ Verify Pressure Transducer is undamaged and secure

2.) Post Rain Event site visits (site visit within 24 hours of event)

- Rain Gauge:
  - □ Follow 'Monthly' Monitoring Procedure (see above)
- Automatic Sampler:
  - □ Download data
  - □ Manually purge sample collection line to verify intake/hoses are not clogged
  - □ Collect samples
  - □ Replace sample bottles with clean bottles
  - □ Verify sampler ready for next monitoring period
  - □ Verify programming ready to collect intended storm event
  - □ Verify connections to power source and rain gauge within sampler shelter
- Flow Meter, Sampler Shelter, Stilling Wells and Stilling Basin:
  - □ Follow 'Monthly' Monitoring Procedure (see above)

Post Site-Visit Checklist:

- Samples and Sample Bottles
  - □ Follow Water Quality Sampling Protocol & discussion with Andy Sauer &/or Mitch Klein to determine which samples to analyze
  - □ Deliver samples for Water Quality analysis to Mid-West labs
  - □ Return Dirty sampling bottles to City of Omaha for cleaning
- Data Analysis
  - □ Upload data to Server

Field Notes

Field Photo(s)

2017 Orchard Park Water Quality Sampling Protocol

Site: Orchard Park
Date: July 31, 2017

INTRODUCTION/PURPOSE

This document is a continuation of Appendix D of the Draft Final Revision 1 Stormwater BMP Monitoring Plan for the City of Omaha.

D.4 SITE SAMPLING

Small-scale monitoring currently being conducted at Orchard Park which includes continual evaluation utilizing soil moisture sensors, ponding depth, and rainfall. Water quality samples will also be utilized to assess BMP performance. One (1) water quality sampling event will be conducted during the summer months. This event will have at least 72 hours of dry weather prior to the rain event and with at least 0.1 inches of rain. Due to the nature of stormwater events, collecting samples are only possible while flow is available. The following sampling schedule will be attempted, success is contingent on sufficient event duration and flow at sampling locations. Timing and locations are approximate, actual sample collection times and locations will be recorded.

D.4.1 Sample Control Area

Inflow samples collected from the curb and gutter of 66th street prior to the curb-cut will be compared to effluent samples to assess BMP performance.

D.4.2 Grab Sampling Procedures

Inflow sampling locations at Orchard Park will be collected at the curb-cut along N. 66th Street as flow enters the first bioretention garden if able. If unable to collect at curb cut, a grab sample will be taken from the forebay where ponding occurs. Upstream contributors to this flow include N. 66th Street and associated residences. The outflow samples will be collected from the 4-inch underdrain pipe that connects the BMP underdrain to Cole Creek.

The first flush of runoff is defined as the first ½ inch of stormwater within the first 45 minutes of a storm. This initial runoff is the most telling of the incoming flow quality and thus the potential performance of the green infrastructure. For this reason, the inflow samples will be acquired soon after flow is observed. The underdrain valve will be closed and a cap placed on the underdrain pipe at Cole Creek prior to the event if possible. Once water has accumulated in the basin, the valve will be opened ¼ to ½ open and allowed to discharge for 5 minutes to flush

stagnant water from the outflow pipe. Then, an outflow sample will be collected to enable analysis of the first flush through the outflow pipe.

D.4.3 Sampling Equipment

Samples will be placed within pre-cleaned and pre-preserved testing bottles provided by Midwest Labs and delivered to the facility within 6 hours of collection. For quality assurance purposes one (1) duplicate sample will be provided for the sampling event.

D.4.4 Method for Grab Sample Collection

- The sample container will be inserted and withdrawn slowly and carefully to avoid agitation of the bottom sediments
- The sample container will be filled to the appropriate necessary volume
- The sample will be labeled
- The time of sampling will be recorded
- Sample will be stored on ice in a cooler

D.4.5 Monitoring Parameters and Timing

E. coli is the only TMDL pollutant for the receiving water body. However, the City will sample additional parameters to evaluate the overall effectiveness of the BMP. These parameters include:

- Bacteria (E.coli)
- Dissolved Oxygen (onsite - test equipment provided by City)
- pH (onsite)
- Nitrate-Nitrogen
- TKN
- Phosphorous
- TSS
- TDS

The first set of inflow and outflow samples will be collected as soon as possible after the start of an event. If possible, depending on storm duration, additional samples will be collected. A second set of inflow samples will be collected 10-15 minutes after the first set and a third set of inflow samples will be collected 20-25 minutes after the first set. A second set of outflow samples will be collected 30 minutes after the first set and a third set of outflow samples will be collected 60 minutes after the first set. An example sampling schedule is listed in Tables 1 and 2 below.

Table 1-1: Inflow Sample Analysis

Grab Sample Label	Time from observed initial flow	Parameter(s)	Bottle Size
Inflow			
In-1A	0 - 5 Min.	E. coli	125mL
In-1B	0 - 5 Min.	TKN, N/N, & T-P	0.5L
In-1C	0 - 5 Min.	TSS & TDS	0.5L
In-2A	10 -15 Min.	E. coli	125mL
In-2B	10 -15 Min.	TKN, N/N, & T-P	0.5L
In-2C	10 -15 Min.	TSS & TDS	0.5L
In-3A	20 - 25 Min.	E. coli	125mL
In-3B	20 - 25 Min.	TKN, N/N, & T-P	0.5L
In-3C	20 - 25 Min.	TSS & TDS	0.5L

Table 1-2: Outflow Sample Analysis

Grab Sample Label	Time from observed initial flow	Parameter(s)	Bottle Size
Outflow			
Out-1A	0 - 5 Min.	E. coli	125mL
Out-1B	0 - 5 Min.	TKN, N/N, & T-P	0.5L
Out-1C	0 - 5 Min.	TSS & TDS	0.5L
Out-2A	30 - 35 Min.	E. coli	125mL
Out-2B	30 - 35 Min.	TKN, N/N, & T-P	0.5L
Out-2C	30 - 35 Min.	TSS & TDS	0.5L
Out-3A	60 - 65 Min.	E. coli	125mL
Out-3B	60 - 65 Min.	TKN, N/N, & T-P	0.5L
Out-3C	60 - 65 Min.	TSS & TDS	0.5L

APPENDIX C MONITORING DATA-PROVIDED ELECTRONICALLY

BURNS McDONNELL

CREATE AMAZING.

Burns & McDonnell World Headquarters
9400 Ward Parkway
Kansas City, MO 64114
O 816-333-9400
F 816-333-3690
www.burnsmcd.com

Attachment G

City of Papillion

- Added MS4 Area
- Lakes/Ponds/Creek
- Proposed Dam Site
- City of Papillion City Limits
- City of Papillion Extraterritorial Jurisdiction Limits

N
W E
S

0 675 1,350 2,700 4,050 Feet

1 inch = 1,350 feet

March 23, 2018

Attachment H

CONTRACT FOR CONSULTANT SERVICES PAPILLION-LA VISTA STORM WATER MANAGEMENT 2017 PUBLIC EDUCATION & OUTREACH: 2017 Final Report

Prepared by Chris Madden, Upstream Weeds, for the City of Papillion and the City of La Vista Public Works' Departments, March 2018

2017 Final Report – Papillion - La Vista Stormwater Outreach

As stipulated in the "CONTRACT FOR CONSULTANT SERVICES PAPILLION-LA VISTA STORM WATER MANAGEMENT 2017 PUBLIC EDUCATION & OUTREACH" between the City of Papillion, the City of La Vista, and Upstream Weeds (UW) pertaining to the Papillion La Vista Stormwater Outreach (PLVSO) program; Upstream Weeds is to provide both Cities with a final report of the years activities. Here within is a final summary report of Upstream Weeds' contracted activities relating to the previously-mentioned agreement as required as completion of said contract.

This was a difficult year for the due primarily to decreased funding. Beyond the optimistic future for PLVSO, the gritty truth about this year is that the first seven months, January – July, went very well; whereas the last 5 months, August – December, were less productive.

A comprehensive list of the contracted activities performed by UW, and the statistical results of these efforts, are itemized below.

Outreach Event Participation and Hosting

Direct Youth Educational Involvement and Engagement programming

1. La Vista West Elementary 5th grade Bio Blitz Public Event Hosting – October 2nd. This event was cancelled due to a) La Vista West Elementary had difficulty with scheduling, and b) UW suffered a recent death in the family.

Public Promotion and Outreach programming

1. Nebraska Science Festival, Durham Public Exposition booth – April 22nd, 9am – 1pm, accommodated 1500+ guests using the standard PLVSO platforms, displays, and literature distribution along with the customary elderberry and pollinator seed packet give-a-ways.
2. La Vista's Salute to Summer festival booth – May 25th – May 28th, exact attendance numbers are unknown to UW (roughly estimated several hundred to a few thousand), however several hundred elderberry plants and trifold brochures were distributed at this event using the standard PLVSO booth, banners, literature, and displays. Several meaningful interactions concerning PLVSO topics occurred throughout the event.
3. Papillion Days carnival booth – June 15th – June 18th, attendance numbers are unknown to UW, roughly estimated at several hundred before a tornadic thunderstorm interrupted the event.

Pre-storm activities went very well using the standard PLVSO booth, banners, literature, and displays yielding several meaningful interactions concerning PLVSO topics. Give-a-ways included elderberries, pollinator plant seed packets and stickers. No PLVSO activities occurred post-storm due to the PLVSO platform being demolished. The banners and literature survived.

4. La Vista Public Works Day - attendance numbers are unknown to UW but could be estimated at 100- 200 attendees. Here again the standard PLVSO booth, banners, literature, and displays were used with give-a-ways including elderberries and pollinator plant seed packets; several meaningful conversations were had revolving around PLVSO topics.
5. Papillion Farmers Market booths:
    a. August 16th – attendance estimated at less than 100. Standard PLVSO platform; banners, literature, and displays were used with give-a-ways including elderberries and pollinator plant seed packets.
    b. August 23rd - attendance estimated at less than 100. Standard PLVSO platform; banners, literature, and displays were used with give-a-ways including elderberries and pollinator plant seed packets.
6. World "O" Water booth – September 9th, noon-4pm. Upstream Weeds cancelled participation at this event due to a death in the family.
7. Host Informational Tours and Presentation in each City to those interested, promoting and publishing the PLVSO initiatives, platforms and programming; should third parties be interested in such activities.

These below-listed are extra-contractual activities conducted in the name of PLVSO to promote its stated objectives:

a. Earth Wellness Festival – March 22nd, hosted approximately 2000 5th grade students using the standard PLVSO booth, banners, literature, and displays. We also gave away seed packets and stickers.
b. Papillion- La Vista Afterschool Foundation – May 4th. Hosted about 20-25 after-school students to an on-site Thompson Creek Restoration exploration outing to help plant sedges.
c. Taste of La Vista – July 19th, 5pm – 8pm. Attendance numbers are unknown to UW but can easily be estimated in the low hundreds. Not much literature was distributed at this event, but several dozen meaningful conversations occurred centered on PLVSO-centric topics.
d. Platteview High School AP student outings (Kyle Madden Remembrance Walks) – Sep 16th at Prairie Queen with approximately 12 students, October 24th at Walnut Creek with 4 students, November 11th at Prairie Queen with 7 students.

Engagement Initiatives and Programs

1. Maintain and refine the PLVSO's existing online social media presence: (a. through b. ii.) – To date, all social media and online presence of PLVSO has been taken down by UW; and all information has been made available to Civic Nebraska, should they wish to coordinate with the Cities to revive these initiatives.
2. Maintain and/or install the 3 agreed-upon CrowdHydrology installations (sponsored by USGS and University of Buffalo) at Thompson Creek, Walnut Creek, and Prairie Queen; … - All contact information, materials, and equipment for this initiative has been passed along to Civic

Nebraska to continue. UW has assured Civic Nebraska that it will help with any future installations. New signage needs to be addressed for each location.

3. Promotion and facilitation of each Cities' Rain Barrel programs, specifically La Vista's rain barrel reimbursement program and Papillion's newly formed barrel-repurposing program. UW's success at promoting La Vista's program is unknown to UW, however we do now that we have repurposed over 2 dozen plastic barrel from the City of Papillion for residents. All information and equipment for this initiative has been passed along to Civic Nebraska to continue, who has accepted it eagerly.
4. Continuation of the Thompson Creek Learning Station Signage effort facilitation, … - This project was completed in 2017.
5. Facilitate the production and dissemination of a short video in partnership with the City of Papillion, using existing infrastructures. All information and contacts for this initiative has been passed along to Civic Nebraska to continue.
6. Pursue external sources of funding, such as grants, to expand PLVSO's activities; … [a) through d) ii.] – All of these efforts yielded no results for UW, except for the successful transfer of the 2018 CONTRACT FOR CONSULTANT SERVICES PAPILLION-LA VISTA STORM WATER MANAGEMENT PUBLIC EDUCATION & OUTREACH between the City of Papillion, the City of La Vista, to Civic Nebraska from Upstream Weeds.

Estimated Promotional Materials Distribution Totals

Exact numbers of the below-listed items from each event have been lost, however UW did compile the following totals of promotional materials distributed to the public from surviving notes, emails, and texts. As such, the Cities can be certain that these are conservative estimates, as they do not include data from every day of activity.

A. 1350 Elderberry bush yearlings, *sambucus nigra L. ssp. Canadensis (L.) Bolli*, provided by Papio Missouri River Natural Resources District were distributed.
B. 2800 Pollinator Seeds packets also provided by Papio Missouri River Natural Resources District were distributed.
C. 600 PLVSO Trifold flyers and other associated literature disseminated.
D. 1500+ PLVSO children's stickers were given away.
E. 6 - 9 In-depth sustainable landscaping and water management packets were given to residents with intense interest in our initiatives.
F. 15 maps of recreational areas provided by the City of Papillion and Papio Missouri River Natural Resources District.

PLVSO Contract Transfer

CONTRACT FOR CONSULTANT SERVICES PAPILLION-LA VISTA STORM WATER MANAGEMENT PUBLIC EDUCATION & OUTREACH for 2018 between the City of Papillion, the City of La Vista, and Civic Nebraska (CN) has been successfully approved by all parties. This culminates the transfer of the PLVSO and its efforts formally from Upstream Weeds to Civic Nebraska for the future.

The material transfer of all equipment, platform materials, event displays, and a comprehensive informational binder have all been transferred to Civic Nebraska. In addition, UW has completed a

PLVSO administrative orientation for Civic Nebraska management, and UW has hosted CN staff training sessions. UW has offered more training if needed, as Civic Nebraska gears up for the season.

This now concludes final summary report of Upstream Weeds' contracted activities relating to the "CONTRACT FOR CONSULTANT SERVICES PAPILLION-LA VISTA STORM WATER MANAGEMENT 2017 PUBLIC EDUCATION & OUTREACH" between the City of Papillion, the City of La Vista, and Upstream Weeds (UW) pertaining to the Papillion La Vista Stormwater Outreach (PLVSO) program; and has been fully prepared by Chris Madden, Sole Proprietor and Director of Upstream Weeds, to be formally submitted to The City of La Vista and The City of Papillion as successful completion of the fore-mentioned contract.

Chris Madden

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