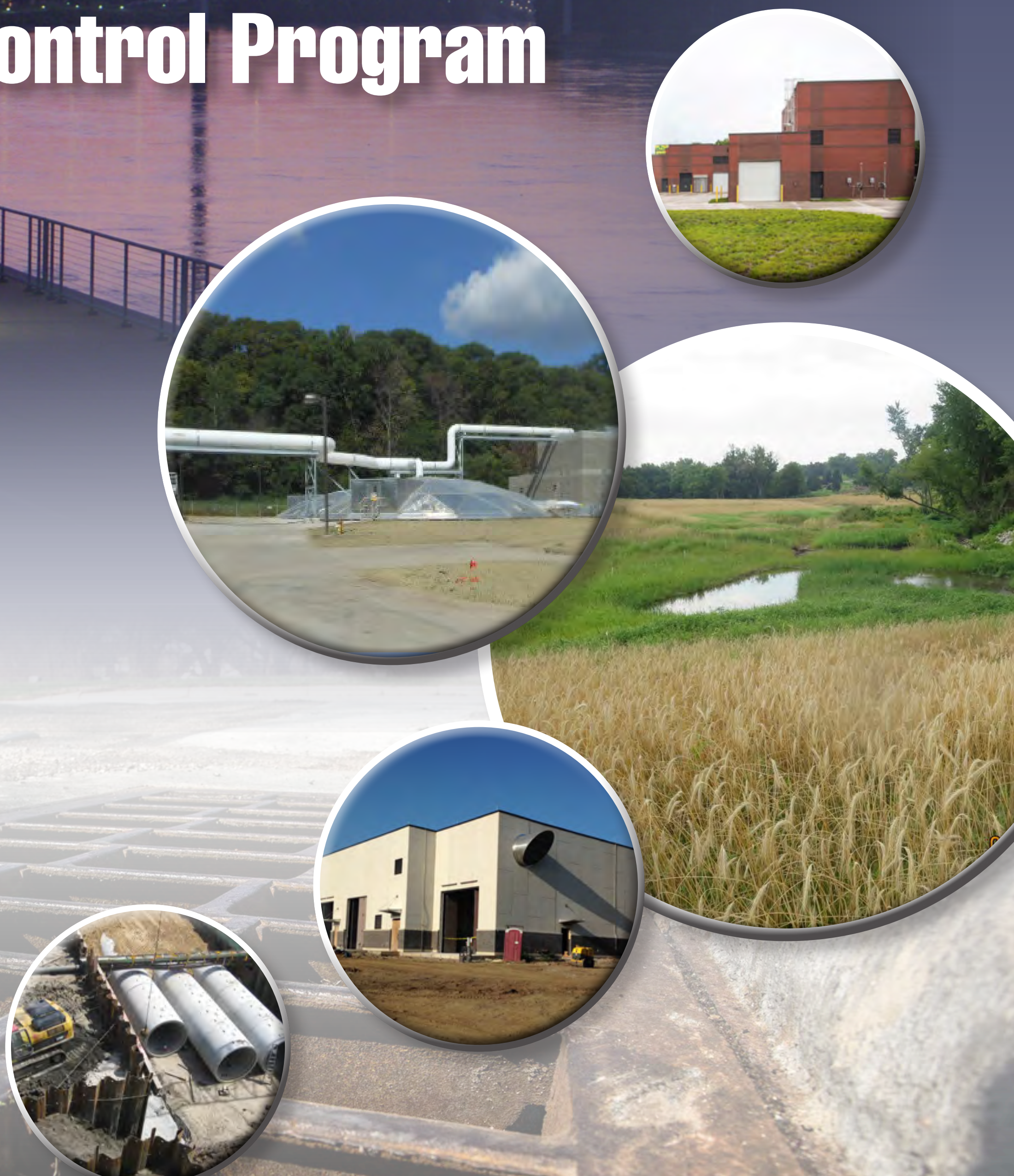
FINAL

Update to Long-Term Control Plan for the Omaha Combined Sewer Overflow Control Program



Submitted by:

CSO! Clean Solutions for Omaha

CITY OF OMAHA, NEBRASKA INCORPORATED FEBRUARY 2, 1857

October 2014

Update to the Long Term Control Plan for the Omaha Combined Sewer Overflow Control Program

Prepared by

City of Omaha

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Acronyms and Abbreviations/Terms

2009 LTCP	*City of Omaha Long Term Control Plan for the Omaha Combined Sewer Overflow Control Program (*City of Omaha, 2009a)
2011 Flood	2011 Missouri River Flood
Amended Consent Order	2007 Consent Order as amended in in 2012
BAP	Basin Advisory Panel
BCDMH	Bromochlorodimethylhydantoin
BOD	Biochemical Oxygen Demand
CBP	Community Basin Panel
cfs	cubic feet per second
cfu	colony-forming units
City	City of Omaha
Consent Order	Complaint and Compliance Order by Consent 2007, Amended in 2012
CSO	combined sewer overflow
CSS	combined sewer system
CSO Permit	NPDES Permit No. NE0133680
CWA	Clean Water Act
ENRCCI	Engineering News Record Construction Cost Index
EPA	United States Environmental Protection Agency
ft	feet
GIS	geographic information system
hr	hour
HRT	high-rate treatment
HVAC	heating, ventilation and air conditioning
in	inches
JCB	John A. Creighton Boulevard

LTCP	Long Term Control Plan
MAF	million acre-feet
MG	million gallons
mg/L	milligrams per Liter
mgd	million gallons per day
mL	milliliter
MLRS	Minne Lusa Relief Sewer
MRWWTP	Missouri River Wastewater Treatment Plant
MS4	Municipal Separate Stormwater Sewer System
MUD	Metropolitan Utilities District
NDEQ	Nebraska Department of Environmental Quality
NDOR	Nebraska Department of Roads
NDNR	Nebraska Department of Natural Resources
NET	Nebraska Environmental Trust
NMC	Nine Minimum Controls
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
OPPD	Omaha Public Power District
ORD	EPA Office of Research and Development
org	Organisms
PCB	polychlorinated biphenyl
PCWWTP	Papillion Creek Wastewater Treatment Plant
PMRNRD	Papio-Missouri River Natural Resources District
PMT	Program Management Team
PRPP	City of Omaha Parks, Recreation, and Public Property Department
RNC	Combined Sewer Renovation
RTB	Retention Treatment Basin
SIFM	South Interceptor Force Main
SOIA	South Omaha Industrial Area

SOIASS	South Omaha Industrial Area Sewer Separation
TKN	Total Kjeldahl Nitrogen
TM	Technical Memorandum
TMDL	total maximum daily load
TSS	total suspended solids
UPRR	Union Pacific Railroad
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
UV	ultraviolet light
VFD	variable frequency drive
VTS	vertical treatment shaft
WERF	Water Environment Research Foundation
WQS	water quality standards
WWTP	Wastewater Treatment Plant

Glossary

Adaptive Management Approach - As defined by the EPA, is "the process by which new information about the health of a watershed is incorporated into the watershed management plan." The City has applied this process to the CSO LTCP and implementation of individual controls within the LTCP by continually evaluating existing controls, identifying new potential controls, and determining the most cost-effective way to achieve water quality objectives.

Best Management Practice – Methods that have been determined to be the most effective, practical means of preventing or reducing pollution from non-point sources. Usually used to refer to stormwater controls.

Biochemical Oxygen Demand (BOD) - A measure of the amount of oxygen consumed in the biological processes that break down organic matter in water. The greater the biochemical oxygen demand, the greater the degree of pollution.

Capture (Percent Capture) – The percentage by volume of combined sewer flow in the combined sewer system that receives treatment or is otherwise controlled.

Clean Water Act – An act passed by the US Congress to control water pollution. The Federal Water Pollution Control Act passed in 1972 (Public Law [PL] 92-500). It was amended in 1977 (the Clean Water Act, PL 95-217) and again in 1987 (the Water Quality Act, PL 100-4).

Combined Sewer Overflow (CSO) - Discharge of a mixture of stormwater and domestic/industrial/commercial wastewater. The overflow occurs when the flow capacity of a combined sewer system is exceeded during a rain event.

CSO Control Policy - EPA's CSO Control Policy is a national framework for control of CSOs through the National Pollutant Discharge Elimination System (NPDES) permitting program. The Policy resulted from negotiations among municipal organizations, environmental groups, and State agencies. It provides guidance to municipalities and State and Federal permitting authorities on how to meet the Clean Water Act's pollution control goals as flexibly and cost-effectively as possible (http://water.epa.gov/polwaste/npdes/cso/). The Policy has since been incorporated into the CWA through the Wet Weather Water Quality Act of 2000.

Combined Sewer System (CSS) - A sewer system that carries both sewage and stormwater runoff. Normally, the entire flow goes to a wastewater treatment plant, but during a heavy storm, the volume of water may be so great as to cause overflows of untreated mixtures of stormwater and sewage into receiving waters.

Combined Sewer System Model (CSS Model) – A comprehensive Model, organized into three model elements: hydrologic runoff to simulate wet weather flow, dry-weather flow to simulate sanitary flows, and the hydraulic collection system to simulate the separated and combined sewer systems.

Community Enhancements - Efforts undertaken by either the City of Omaha or a neighborhood to implement positive green and/or aesthetic changes during the planning and construction of a CSO Project. Such enhancements include tree planting and landscaping, installing or replacing sidewalks, and incorporating public art into an area.

Deactivated CSO – Combined sewer overflow location which no longer discharges from the combined sewer system.

Detention - The delay or holding of the flow of water and/or water-carried wastes in a pipe system. This can be caused by a restriction in the pipe, a stoppage, or a dip. Detention also means the time water is held or stored in a basin or a wet well.

Demonstration Approach – As defined by the EPA CSO Control Policy:

- The planned CSO control program adequate to meet WQS [Water Quality Standards} and protect designated uses, unless WQS or uses cannot be met as a result of natural background conditions or pollution sources other than CSO.
- The CSO discharges remaining after implementation of the planned control program will not preclude the attainment of WQS or the receiving waters' designated uses or contribute to their impairment. Where WQS and designated uses are not met in part because of natural background conditions or pollution sources other than CSOs, a total maximum daily load, including a wasteload allocation, a load allocation or other means should be used to apportion pollutant loads;
- The planned control program will provide the maximum pollution reduction benefits reasonably attainable; and
- The planned control program is designed to allow cost-effective expansion or cost-effective retrofitting if additional controls are subsequently determined to be necessary to meet WQS or designated uses.

Dewater –The draining or remove water or sewerage from a tank or RTB.

Disinfection – The process designed to kill or inactivate most microorganisms in water or wastewater, including essentially all pathogenic (disease-causing) bacteria. There are several ways to disinfect, with chlorination being the most frequently used in water and wastewater treatment plants.

Dissolved Oxygen - The oxygen freely available in water, vital to fish and other aquatic life and for the prevention of odors. Dissolved oxygen levels are considered the most important indicator of a water body's ability to support desirable aquatic life. Secondary and advanced waste treatments are generally designed to ensure adequate dissolved oxygen in waste-receiving waters.

Diversion Structure (Chamber) – A chamber or box that contains a device for diverting or drawing off all or part of a flow for discharging portions of the total flow to various outlets.

Drop Shaft – A vertical opening used to provide access to a tunnel.

***Escherichia coli* (*E. coli*) –** One of the species of bacteria in the fecal coliform group. It is found in large numbers in the gastrointestinal tract and feces of warm-blooded animals and man. Its presence is considered indicative of fresh fecal contamination, and it is used as an indicator organism for the presence of less easily detected pathogenic bacteria.

Existing Conditions – The combined sewer system as it was in the year 2002, which is the year the City of Omaha's first CSO National Pollutant Discharge Elimination System permit was issued by the Nebraska Department of Environmental Quality.

Floatables Control – Technologies designed to reduce or eliminate the visible solid waste that is often present in CSO discharges.

Force Main – A pressure pipe joining the pump discharge at a water or wastewater pumping station with a point of gravity flow.

Full Sewer Separation – Public and private sewer separation.

Gravity Flow (Sewer) - Water or wastewater flowing from a higher elevation to a lower elevation due to the force of gravity. The water does not flow due to energy provided by a pump. Wherever possible, wastewater collection systems are designed to use the force of gravity to carry waste liquids and solids.

Green Infrastructure (aka Green Solutions) – Green infrastructure uses natural systems and or engineered systems designed to mimic natural processes to manage urban stormwater and reduce receiving water impacts. These systems are often soil or vegetation-based and include planning approaches such as tree preservation and impervious cover reduction, as well as structural interventions such as rain gardens and permeable pavements. By maintaining or restoring the hydrologic function of urban areas, green infrastructure treats precipitation as a resource rather than waste, and can play a critical role in achieving community development as well as water quality goals.

Grit Removal - Grit removal is accomplished by providing an enlarged channel or chamber that causes the flow velocity to be reduced and allows the heavier grit to settle to the bottom of the channel where it can be removed.

Groundwater Infiltration – The quantity of groundwater that leaks into a pipe through joints, porous walls, or breaks.

Headworks - The initial structures and devices of a water or wastewater treatment plant.

High-Rate Treatment – Treatment processes intended to provide a treatment level equivalent to primary treatment, as required by U.S. Environmental Protection Agency's CSO Control Policy, plus disinfection to achieve an effluent quality of 126 *E. coli* organisms per 100 milliliters. Alternative high-rate treatment processes are sand ballasted sedimentation or retention treatment basins.

Lift Station – A structure that contains pumps and appurtenant piping, valves, and other mechanical and electrical equipment for pumping water, wastewater, or other liquid. Also called a pumping station.

Major Projects – Facility projects and sewer separation projects linked to these facility projects identified in the Long Term Control Plan.

Missouri River Watershed – The watershed that includes those study basins where the combined sewage flows through sewers and is ultimately pumped to the MRWWTP.

National Pollutant Discharge Elimination System (NPDES) Permit – the regulatory agency document issued by either a federal or state agency that is designed to control all discharges of potential pollutants from point sources and stormwater runoff into US waterways. NPDES permits regulate discharges into US waterways from all point sources of pollution, including industries, municipal wastewater treatment plants, sanitary landfills, large animal feedlots, and return irrigation flows.

Nine Minimum Controls - includes minimum technology based controls that can be used without extensive engineering studies or significant construction costs, prior to the implementation of long-term controls.

Papillion Creek Watershed – The watershed that includes those study basins with combined sewers that flow into the Papillion Creek Interceptor and to the Papillion Creek WWTP.

Preliminary Treatment - Unit operations, such as screening, comminution, and grit removal, that prepare the wastewater for subsequent major treatment.

Presumption Control Level (Approach) – an approach that meets the presumption approach criteria as defined by the U.S. Environmental Protection Agency CSO Control Policy. The presumption approach means that either the capture of at least 85 percent by volume, annually, of the combined sewage entering the collection system during wet weather, or no more than 4 to 6 untreated overflows during an average year.

Primary Treatment - The first major treatment in a wastewater treatment facility, used for the purpose of sedimentation. Wastewater treatment processes usually consist of clarification with or without chemical treatment to accomplish solid–liquid separation.

Private Sewer Separation – Elimination of inflow sources on private property.

Program – The effort to implement the LTCP for the City of Omaha.

Program Management Team – The members of the City, CH2M HILL, HDR Engineering Inc., and Lamp Rynearson & Associates, Inc. who are working on the CSO Program.

Public Sewer Separation – Separation of sewers within public rights of way, not including the elimination of inflow sources on private property.

Representative Year – The year (1969) selected for the development of baseline CSO hydrographs for evaluating CSO controls, based on statistical analysis of historic precipitation data from Eppley Airfield.

Retention Treatment Basins – Large settling basins to which chemicals are added for disinfection and dechlorination. During smaller wet weather events, the entire CSO volume will be captured and pumped out to an existing wastewater treatment plant. During larger events, the basins will discharge treated water to a receiving stream.

Sanitary Sewer - A sewer that carries only liquid and waterborne wastes from residences, commercial buildings, industrial plants, and institutions together with minor quantities of ground, storm, and surface water that are not admitted intentionally to a wastewater treatment plant for treatment.

Screen - A device with openings, generally of uniform size, used to retain or remove suspended or floating solids in flow stream preventing them from passing a given point in a conduit. The screening element may consist of parallel bars, rods, wires, grating, wire mesh, or perforated plate.

Secondary Treatment - Sometimes used interchangeably with the concept of biological wastewater treatment, particularly the activated-sludge process. Commonly applied to treatment that consists chiefly of clarification followed by a biological process with separate sludge collection and handling.

Storm Sewer – A sewer that carries only storm flow.

Stormwater Runoff - Water flowing over land during and immediately following a rainstorm or snowmelt. Stormwater carries nutrient laden sediment, heavy metals, oils, and other materials that have accumulated on the land between rain events and flushes them into streams, rivers, and lakes.

Sustainability – The three primary components of sustainability as they relate to CSO Program goals are economic growth, environmental stewardship, and social progress.

Total Maximum Daily Load - A Total Maximum Daily Load (or TMDL) is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources.

Total Suspended Solids - A measure of the suspended solids in wastewater, effluent, or water bodies, determined by tests for "total suspended non-filterable solids".

Watershed - The region or land area that contributes to the drainage or catchment area above a specific point on a stream or river.

Wet Well - A compartment or tank in which wastewater is collected. The suction pipe of a pump may be connected to the wet well or a submersible pump may be located in the wet well.

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Executive Summary

The City of Omaha (City), in compliance with the requirements of the Clean Water Act, the United States Environmental Protection Agency (EPA) Combined Sewer Overflow (CSO) Control Policy of 1994, and its Administrative Consent Order with the Nebraska Department of Environmental Policy (NDEQ), developed a plan to control overflows from its combined sewer system (CSS). This plan was presented in detail in the document entitled *City of Omaha Long Term Control Plan for the Omaha Combined Sewer Overflow Control Program* (City of Omaha, 2009). The Long Term Control Plan (LTCP) was submitted to NDEQ in September 2009, and was approved by NDEQ in February 2010. Implementation of the CSO controls described in the LTCP started in 2009.

The City's CSO Permit and Amended Compliance Order (May 30, 2012) (see Appendix A) require the City to update the LTCP by October 1, 2014. This report provides information on the status of LTCP implementation, describes the LTCP Update process, documents evaluations that have been conducted to improve the LTCP, and summarizes the outcome of the update effort.

This Executive Summary is intended to provide a brief overview of the LTCP Update, and makes reference to sections of the LTCP Update report. The LTCP Update builds upon the 2009 LTCP rather than replacing it. Because of this, the 2009 LTCP should be consulted for additional information.

The LTCP Update process, and the information presented in the report, demonstrate that the goals of the 2009 LTCP and the requirements of the Clean Water Act and EPA CSO Control Policy are being met by the City. Although a significant amount of work has taken place since 2009 through adaptive management of the CSO Program, the controls defined in the 2009 LTCP are the same in most cases.

ES.1 Introduction

The LTCP Update report consists of the following sections:

- Section 1 – Introduction
- Section 2 – Current Conditions
- Section 3 – Control Alternatives
- Section 4 – Program Financing and Financial Considerations
- Section 5 – Updated CSO Controls
- Section 6 – Public Participation Process
- Section 7 – Post Construction Monitoring Plan and Wet Weather Operations Strategy Update
- Section 8 – Future Considerations and Challenges

In addition, a Glossary of terms and several Appendices supplement information presented in this report.

The City developed the LTCP Update in compliance with the requirements of the EPA "CSO Control Policy" (59 *Federal Register 18688*); the August 8, 2007 Complaint and Compliance Order by Consent (Consent Order) as amended in 2012 (Amended Consent Order); and the City's NPDES permits for the combined sewer system.

When the City's first CSO Permit was issued in 2002, there were 29 permitted CSO outfalls. Shortly after issuance of the permit, work related to the development of a detailed computer model for the CSS identified three additional CSO outfalls. This resulted in a total of 32 permitted CSO outfalls. Prior to submission of the 2009 LTCP, the City deactivated or reclassified three CSOs: 116 – Homer Street; CSO 206 – 43rd and S Street; and CSO 120 – Arena and Convention Center. This brought the number of CSO outfalls back down to 29. Over the past 5 years, the City has performed projects that have deactivated three more overflows: CSO 104 – Mormon Street; CSO 113 – Spring Street; and CSO 209 – 44th and Harrison. With these deactivations, there are currently 26 remaining CSO outfalls rather than the permitted number of 29. During the next permit cycle, an additional two of these 26 outfalls will have the necessary projects complete and be evaluated for permanent deactivation (CSO 211 – 69th & Pierce and CSO 103 – Bridge Street Lift Station). An additional eight CSO outfalls are planned to be deactivated beyond the next permit cycle, but within the LTCP implementation schedule. Those eight CSO outfalls are listed in Section 1 of this report.

In the first 5 years of LTCP implementation, a number of challenges have been encountered and dealt with. These include:

- Flood Events
- Political Changes
- Project Cost Adjustments from the 2009 LTCP

The initial effort to update the LTCP, which is required by the City's CSO Permit, was increased in 2011 when Former Mayor Suttle asked the Program Management Team (PMT) to consider elimination of the CSO Deep Tunnel from the LTCP. Current Mayor Stothert has challenged the PMT to work on project designs and evaluate technological solutions that are cost effective and could lower the overall cost of the Program. The LTCP Update report presents the results of efforts to improve the 2009 LTCP and reduce its cost. Issuance of the report does not mark the end of the City's efforts to continue adaptive management of the LTCP.

ES.2 Current Conditions

The CSO controls presented in the 2009 LTCP include:

- Improvements to the Missouri River Wastewater Treatment Plant (MRWWTP) to treat a continuous flow of 150 million gallons per day (mgd) during wet weather, and to separately treat high-strength industrial wastewater through primary and secondary treatment. Up to 64 mgd is planned in the LTCP to be treated through full secondary treatment, with the remainder being disinfected prior to discharge to the Missouri River. In addition to improvements at the MRWWTP, the LTCP describes several new or updated facilities to convey flow, including: the South Interceptor Force Main; Leavenworth Lift Station; Riverview Lift Station; Burt-Izard Lift Station;

Monroe Street Lift Station; and the Ohern/Monroe Industrial Lift Station, Force Main and Gravity Sewer.

- Extensive sewer separation throughout the CSS service area.
- Stormwater Collector Sewer and associated facilities in the Minne Lusa Basin.
- A CSO Deep Tunnel 5.4 miles long and 17 feet in diameter.
- Two high-rate treatment units, referred to as Retention Treatment Basins.
- Two storage tanks.

In addition, the 2009 LTCP stated that the City's Green Solutions (referred to in the LTCP Update report as Green Infrastructure) Program would be expanded to better define how to incorporate Green Solutions into the Program.

The cost estimate for the controls described in the 2009 LTCP was approximately $1.66 billion in April 2009 dollars. Following implementation of the LTCP controls, it was estimated that approximately 94 percent of the average annual volume of combined sewage in Omaha would be controlled, and not more than four CSO events would occur in each watershed per year during Representative Year precipitation. Out of the 29 CSO outfalls permitted at the time of the 2009 LTCP, nine were planned to be deactivated.

The schedule presented in the 2009 LTCP demonstrated the City's intent to complete the CSO controls within the 15-year implementation period. The 2009 LTCP schedule was based on information available at the time, and anticipated that the City would identify and resolve uncertainties and adjust the schedule accordingly. It was also stated in the 2009 LTCP that over the 15-year implementation period there would likely be unanticipated situations that would affect the City's ability to meet the schedule. Following the 2011 Missouri River Flood (2011 Flood), the implementation period was extended to 18 years by the NDEQ.

Schedule milestone dates were established in the 2009 LTCP for inclusion in the City's CSO permits with NDEQ using a phased approach. The City divided the implementation of the Major Projects into four phases, and the implementation of Sewer Separation projects into seven phases. Estimated reductions in *E. coli* loading over time as projects are implemented were included in the LTCP. The results of water quality modeling indicated that downstream of the CSOs, the Missouri River would be in compliance with water quality standards for *E. coli* during recreation season following implementation of the CSO controls. In addition, modeling indicated that the remaining CSOs would not preclude the Papillion Creek from being in compliance with water quality standards.

The City has made tremendous progress in implementing the CSO controls. By October of 2015, the following LTCP projects are expected to be completed:

- Ohern/Monroe Industrial Flow Area Sewer Separation
- Ohern/Monroe Industrial Lift Station, Force Main, and Gravity Sewer
- Missouri River WWTP Improvements (Schedule A only)
- Leavenworth Lift Station Replacement
- Aksarben Village Phases A & B Sewer Separation

- Bohemian Cemetery Sewer Separation
- Miller Park to Pershing Detention Basin Sewer Separation
- Webster Street Sewer Separation Phase 2
- 42nd Street & X Street Sewer Separation
- 24th Street and Ogden Street Sewer Separation
- Spring Street Sewer Separation
- 36th Street Sewer Separation
- Nicholas Street Phase 1(10th Street to 16th Street)
- Martha Street Sewer Separation Phase 1
- Nicholas & Webster Sewer Separation Phase 1
- CSO 211 Sewer Separation
- Cole Creek CSO 204 Sewer Separation Phase 1
- Martha Street Sewer Separation Phase 2

South Omaha Industrial Area Lift Station *(photo courtesy of Wade Trim)*

The following LTCP projects are expected to be under construction in October 2015:

- South Interceptor Force Main
- MRWWTP Improvements (schedules B1 and B2)
- Saddle Creek CSO 205 – 64th & Dupont Retention Treatment Basin
- Minne Lusa Stormwater Conveyance Sewer and Minne Lusa Storz Detention Basin Improvements
- Missouri Avenue Sewer Separation Phase 1
- Nicholas Street Phase 2 (to 23rd & Grace)
- Gilmore Avenue Sewer Separation Phase 1 and Phase 2
- Minne Lusa – 105-1 JCB & Miami Phase 1 and Phase 2

Through July 2014, 11 of the 92 LTCP projects had been completed, 28 were in progress, and 53 had not yet started. In terms of construction costs, $31 million had been completed, $269 million of construction is ongoing, and $314 million is estimated to be in design. The City has expended approximately $126 million for CSO controls since the start of implementation. By October 2015, it is anticipated that 16 LTCP projects will be completed, 11 will be under construction, and 17 will be under design.

The City's Green Infrastructure Program, established in 2007, is an important element of the LTCP. As part of the implementation of the CSO Program, all Project Teams are required to evaluate green infrastructure elements. Where cost effective, these elements are implemented in the design. Thus far, the CSO Program, in conjunction with the City of Omaha Parks and Recreation, has been successful in creating large-scale centralized stormwater management practices that will save Omaha ratepayers over $30 million in gray infrastructure for CSO controls. In June 2013, a consulting firm was selected to identify and evaluate potential Green Infrastructure Projects in select areas of the CSS that could reduce the volume of stormwater entering the system. A final list of potential projects to implement has been developed.

Elmwood Park Green Infrastructure Project *(photo courtesy of CH2M HILL)*

A computer model representing the hydrologic and hydraulic elements of Omaha's combined and sanitary sewer system was created to support the development of the LTCP using InfoWorks software. Since the original model was completed in 2004, several cycles of updating, calibrating, and extending the model have been undertaken to update the model with sewer system changes, improve the model's representation of the sewer system, and prepare it to be used for a wider range of evaluations to aid effective implementation of the LTCP. The *2024 Model* was used for the 2009 LTCP, and *2027 Model* was used for the LTCP Update. Changes that were made to evolve from the *2024 Model* to the *2027 Model* included:

- Added detail in Papillion Creek Watershed Separate Sanitary Sewer System
- Updated population to 2010 Census data
- Updated to reflect recent sewer system changes
- Further calibration based on 2010 flow monitoring data
- Updated real-time controls at several lift stations
- Changed to reflect recent information for projects that have been constructed or designed to a 90 percent completion level, or designed to a lower level of completion if deemed significant

In conjunction with changes to the InfoWorks Model, the Program's Water Quality Model was updated and was used to make water quality projections for the LTCP Update. The update incorporated recent water quality sampling data, including data collected by the United States Geological Survey (USGS) since contracting with the City in 2012 to implement a Missouri River water quality monitoring program.

The 2011 Flood was the result of a greater than normal snowfall late in the season in the Northern Rocky Mountains, followed by excessive amounts of rain in May and June in the Upper Missouri River Basin states. The 2011 Flood had a significant impact on implementation of the CSO Program, and resulted in 3 years being added to the LTCP implementation period. The 2011 Flood continues to affect the City's sewer system and the CSO Program. For example, in the spring of 2013 a significant failure of the Missouri River bank adjacent to the MRWWTP, in close proximity to proposed upgrades under the Missouri River WWTP Improvement Project, was discovered by MRWWTP staff. This failure has caused the construction of treatment facilities to be delayed, and a bank stabilization project to be planned.

ES.3 Control Alternatives

In addition to meeting regulatory requirements and obtaining community acceptance, one of the key goals of the CSO Program is to minimize cost impacts to ratepayers. This is one of the primary focuses of the CSO Program – to continually evaluate existing controls, identify new potential controls, and determine the most cost effective way to achieve water quality objectives. With information gained since the beginning of implementation, the City has conducted several evaluations as part of the LTCP Update to seek more cost effective approaches. These evaluations have been categorized as follows:

- Systemwide Source Control Evaluations
- Watershed Control Updates and Evaluations
- Basin Control Updates

The evaluations have led to some changes to the LTCP projects, as described in Section 3, and to the approach to compliance, as described in Section 5. Section 3 also contains information on projects anticipated to be under design in October 2015, along with future projects.

The compliance approach that has taken form as part of the LTCP Update complies with the Presumption Approach under EPA's CSO Control Policy (EPA, 1995). The overall volumetric capture of wet weather flows is approximately the same as what was proposed in the 2009 LTCP (approximately 94 percent). The Missouri River is predicted to be in compliance with the water quality standard for *E. coli*, and compliance with water quality standards in Papillion Creek will not be precluded by remaining CSOs.

The project schedule shown in Section 5 has been developed to achieve this level of control by October 2027 and is based on the most recent Rate Model developed by the City. However, as explained in Section 4, an Affordability Study conducted in 2013 predicts a high economic burden on portions of the Omaha community beginning in 2018. This may require future modifications to the implementation of CSO controls. Such modifications could take the form of schedule changes, project cost controls, alternative sources of funding, and/or changes to the ultimate level of control.

ES.4 Program Financing and Financial Considerations

In 2013, Omaha's sewer enterprise financial plan and cost-of-service rate model were updated by a consultant. On July 15, 2014, the City Council adopted an updated ordinance that established sewer rates for the period 2015—2018. The impact of these rate increases on a typical household is to increase sewer use fees by 13 percent in 2015 and 9 percent per year through 2018. The average resident who paid $10 per month in 2006 is now paying $37 per month in 2014. By 2018, it is expected that the sewer use fee for that same household will exceed $50 per month.

These projections do not include impacts from new or stricter regulatory requirements that may be mandated in the future. Some type of integrated planning will be needed if additional requirements are implemented.

In May 2013, the University of Cincinnati completed a financial capability assessment for Omaha's wastewater enterprise fund. One of the key conclusions of the report is that by

2018 the Omaha wastewater service area, as a whole, will be at a "Medium Burden" level as defined by EPA. However, the report also estimates that some "Communities of Concern" within the service area will approach the "High Burden" threshold in 2018, and by the end of 2027, the entire service area may be near "High Burden." The report recommends that Omaha closely monitor costs associated with its LTCP and to "manage the overall Program approach, level of control and schedule." The report also recommends that the City work with NDEQ to "ensure solutions that are financially and environmentally sustainable."

With the adoption of the July 2014 rate ordinance, Omaha has clearly shown a continued commitment to the goals of the LTCP Update and is making a very significant investment to do so. However, the City believes that it is not too early to establish a dialog with NDEQ on how Omaha can continue to improve water quality without creating an unsustainable burden on area residents and businesses.

ES.5 Updated CSO Controls

The processes undertaken to evaluate the controls in the 2009 LTCP are described in Section 3. Tables ES-1 and ES-2 summarize the CSO controls in the 2009 LTCP and any changes to the controls in the LTCP Update. The majority of projects have not changed from the 2009 LTCP.

Figure ES-1 summarizes CSO controls that are planned to exist at the end of implementation, 2027. The LTCP Update cost for the entire CSO Program is estimated to be approximately $2 billion in December 2013 dollars.

TABLE ES-1
Updated Summary of CSO Control Projects in the Missouri River Watershed

Basin	2009 LTCP Sewer Separation Area (Acres)	2009 LTCP Projects	Proposed Changes in LTCP Update
Bridge Street (CSO 103)	36	Replace Bridge Street Lift Station Construct parallel force main Deactivate CSO 103 – Bridge Street Lift Station outfall Floatables control at CSO Deep Tunnel Drop Shaft	No changes proposed
Minne Lusa (CSOs 104, 105, 106, and 107)	2,234	Construct two phased storage tanks as part of a single facility: Phase 1 = 1.0 MG and Phase 2 = 2.7 MG Deactivate CSO 104 – Mormon Street outfall Construct 12.5-foot-diameter stormwater conveyance sewer and associated collector sewers Construct CSO Deep Tunnel Drop Shaft Complex for CSOs 106 and 107 Install floatables control at CSO 105 – Minne Lusa Avenue outfall	Changed storage tank concept to a single 4.0 MG tank facility to be constructed later in the CSO Program schedule Sewer separation area reduced to 1,629 acres because of removal of projects Increase diameter of stormwater conveyance sewer to 14 feet Floatable controls will be addressed with the construction as part of the CSO 105 – Minne Lusa Avenue Tank

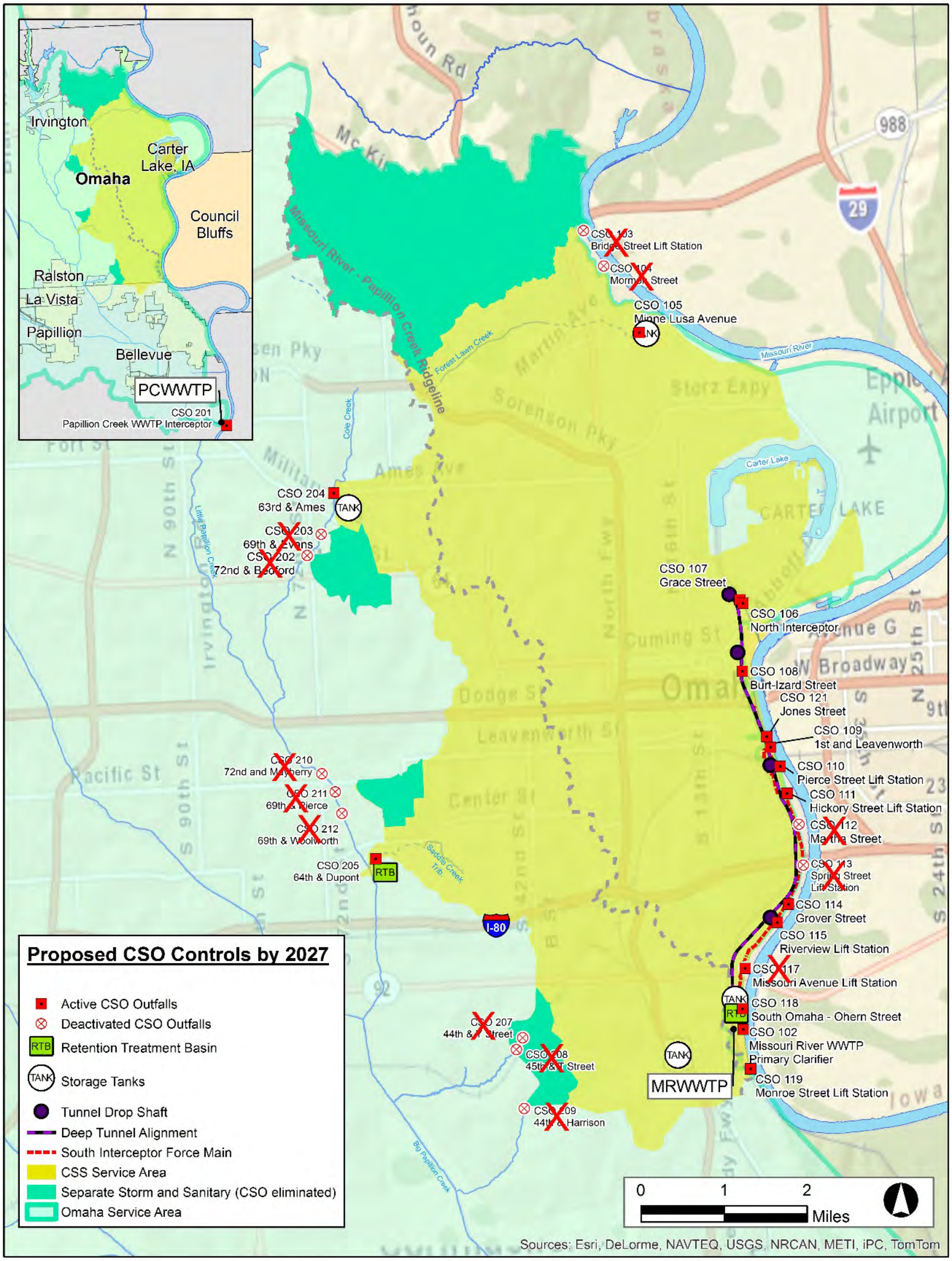
TABLE ES-1
Updated Summary of CSO Control Projects in the Missouri River Watershed

Basin	2009 LTCP Sewer Separation Area (Acres)	2009 LTCP Projects	Proposed Changes in LTCP Update
Burt-Izard (CSO 108)	472	Construct CSO Deep Tunnel Drop Shaft Complex Implement modifications to Burt-Izard Lift Station	Sewer separation acres increased to 556 based on project changes
Leavenworth (CSOs 109 and 121)	None	Construct CSO Deep Tunnel Drop Shaft Complex Install diversion gates at Jones Street Diversion Structure Construct new Leavenworth Lift Station Install floatables control at CSO 109 – 1st and Leavenworth and CSO 121 – Jones Street outfalls	No changes proposed Floatable controls will be addressed with the construction of CSO Deep Tunnel Drop Shaft
South Interceptor (CSOs 110 to 117)	776	Construct CSO Deep Tunnel Drop Shaft Complex Abandon Pierce Street and Hickory Street lift stations and route flow to new Leavenworth Lift Station, along with flow from Martha Street Deactivate CSO 113 – Spring Street Lift Station Abandon Spring Street Lift Station and route flow to CSO 114 – Grover Street Replace Riverview Lift Station Install floatables control at outfalls for the following CSOs: 110 – Pierce Street Lift Station 111 – Hickory Street Lift Station 112 – Martha Street 114 – Grover Street 115 – Riverview Lift Station 117 – Missouri Avenue Lift Station	CSOs 112 and 117 are planned to be deactivated with sewer separation and completion of Martha to Riverview sewer Route flow from the Martha Street area to new Riverview Lift Station instead of Leavenworth Floatable controls will be addressed with the construction of CSO Deep Tunnel Drop Shaft
Ohern/Monroe (CSOs 118 and 119)	365	Construct CSO Deep Tunnel Drop Shaft Complex Construct industrial lift station and force main Implement modifications to Monroe Street Lift Station Install floatables control at CSO118 – South Omaha/Ohern Street and 119 – Monroe Street Lift Station outfalls	The diversion of flows from CSOs 118 and 119 will be to storage tanks facilities rather than to drop shaft / tunnel (see below), stored flow volume will then be pumped to the MRWWTP for treatment following wet weather events Construct at MRWWTP 4.1 MG storage facility for CSO 118 Construct at Industrial Lift Station site a 2.9 MG storage tank facility for CSO 119 Sewer separation area reduced to 111 acres, because the 20th and U Sewer Separation project has been removed Floatables control will be addressed with the construction of the CSO – 118 and 119 storage tanks

TABLE ES-2
Summary of CSO Control Projects in the Papillion Creek Watershed

Basin	Sewer Separation Area (Acres)	Other Projects	Proposed Changes in LTCP Update
Cole Creek (CSOs 202, 203 and 204)	860	Construct storage tank at CSO 204 – 63rd and Ames, 0.08 MG Install floatables control at CSOs 202 – 72nd and Bedford, 203 – 69th and Evans, and 204 – 63rd and Ames outfalls	Sewer separation reduced to 776 acres CSO 204 storage tank reduced to 0.05 MG due to model update and recalibration CSOs 202 & 203 are planned to be deactivated
Papillion Creek North (CSOs 210, 211, and 212)	219	Deactivate CSOs 211 – 69th and Pierce, and 212 – 69th and Woolworth Deactivate outfall or install floatables control at CSO 210 – 72nd and Mayberry outfall	Sewer separation increased to 238 acres based on mapping CSO 210 is planned to be deactivated
Saddle Creek (CSO 205)	549	Construct Retention Treatment Basin at 64th and Dupont for flow rate of 315 mgd Install floatables control at outfall	Sewer Separation Projects Complete (reduced to 305 acres based on refined Aksarben Service area) No major proposed changes Floatables control will be addressed with the construction of the RTB
Papillion Creek South (CSOs 206, 207, 208, and 209)	186	Deactivate CSOs 207 – 44th and Y Street, 208 – 45th and T Street, and 209 – 44th and Harrison	No changes proposed

FIGURE ES-1
Omaha Combined Sewer System in 2027



The Presumption Approach being met by the LTCP Update is:

> "The elimination or the capture for treatment of no less than 85% by volume of the combined sewage collected in the combined sewer system during precipitation events on a system-wide annual average basis."

In the Missouri River Watershed, 91 percent of wet weather combined sewer flows are predicted to be controlled during Representative Year precipitation. In the Papillion Creek Watershed, this percentage is 98 percent. For the overall system, approximately 94 percent is predicted to be controlled following implementation of CSO controls, which is equal to the percentage in the 2009 LTCP.

The Program's Water Quality Model shows that the Missouri River downstream of the CSOs (and above the Papillion Creek confluence) does not meet the *E. coli* water standard of 126 organisms/100 milliliters under Existing Conditions. However, the Missouri River above the confluence can meet the standard after implementation of the updated LTCP. The future value downstream of the Papillion Creek confluence is predicted to barely exceed the standard and is probably within the margin of error of the model. Once the total maximum daily load for the Papillion Creek Watershed is fully implemented, it is anticipated that the Missouri River below Papillion Creek would meet the standard.

In Papillion Creek, the LTCP Update controls will not result in compliance despite a significant reduction in the *E. coli* load from CSOs. However, the CSOs do not preclude or prevent the standard for *E. coli* from being met.

The City developed a preliminary LTCP Update implementation schedule based on the 2009 LTCP schedule. As needed, the project interrelationships, priorities, and construction sequencing were factored into the schedule. The schedule was then adjusted to conform to the City's financing capability and the effects of the extension of implementation brought about by the 2011 Flood.

Figure ES-2 shows the schedule of the Major Projects, with the "start" dates as the beginnings of final design and the "end" dates when the controls are operational. The phases for the Major Projects are the same as in the 2009 LTCP. Projects that have been completed have been removed from the schedules.

Figure ES-3 shows the schedule of sewer separation controls, with the "start" dates as the beginning of bidding, and the "end" dates when the controls are operationally complete. This schedule addresses the elimination of separate rehabilitation projects, projects (such as 26^{th} & Corby projects) that are being re-assigned to the City's Combined Sewer Renovation sewer separation program, and the addition of projects identified since the preparation of the 2009 LTCP. The phases shown in this figure are unique and are not the same as those presented in the 2009 LTCP for sewer separation.

FIGURE ES-2
Schedule of Major CSO Control Phases

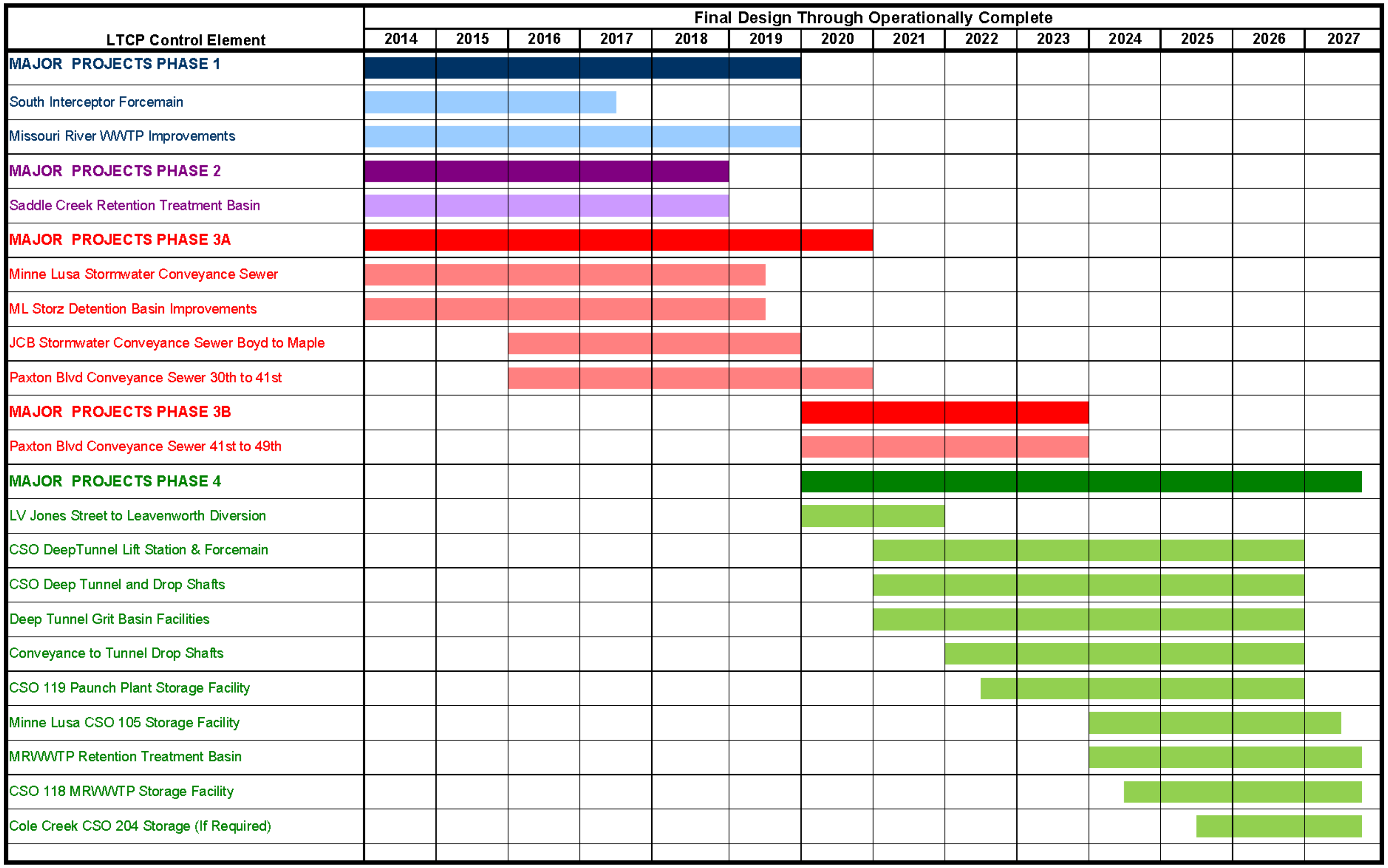


FIGURE ES-3
Schedule of Sewer Separation Control Phases

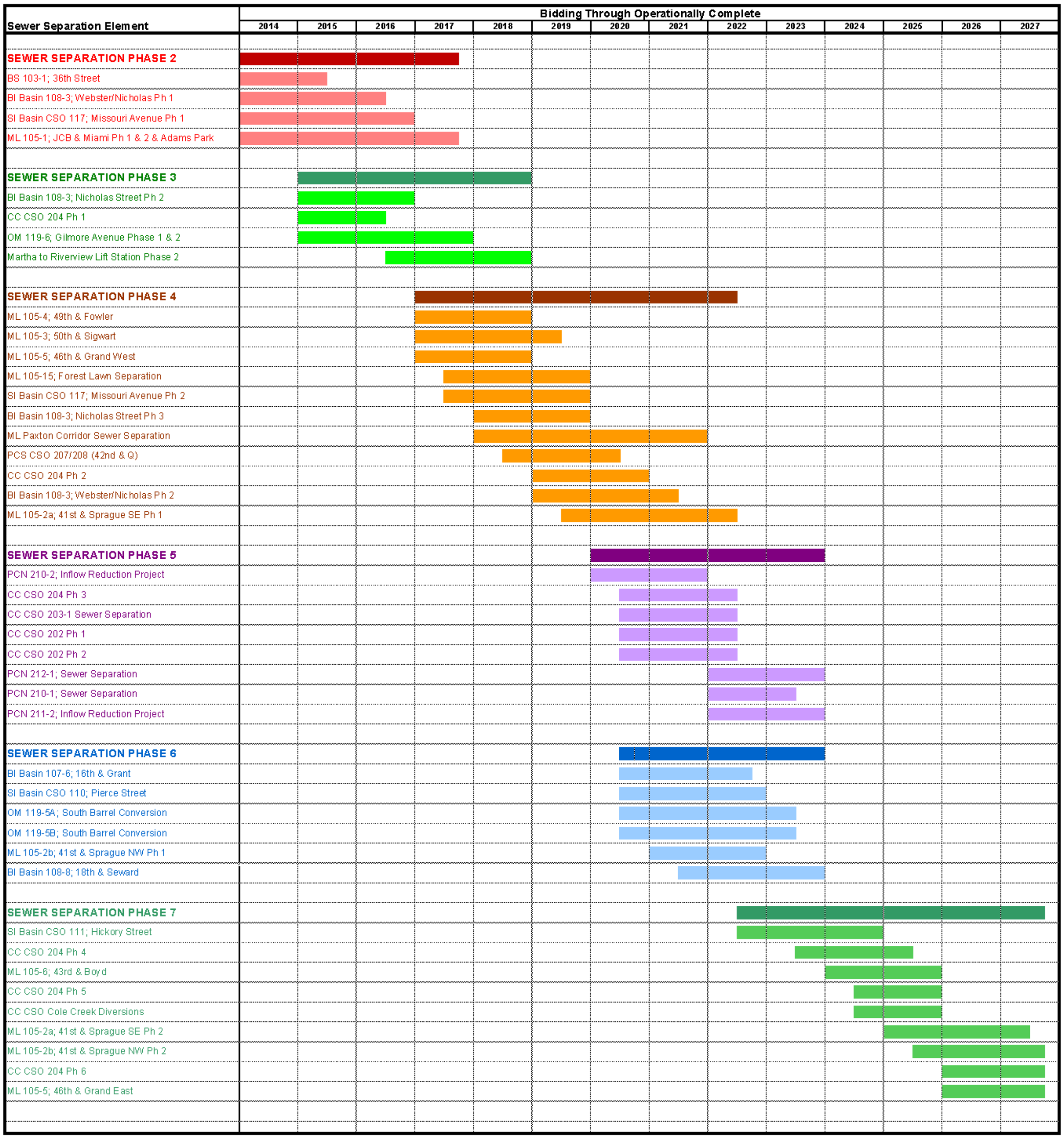
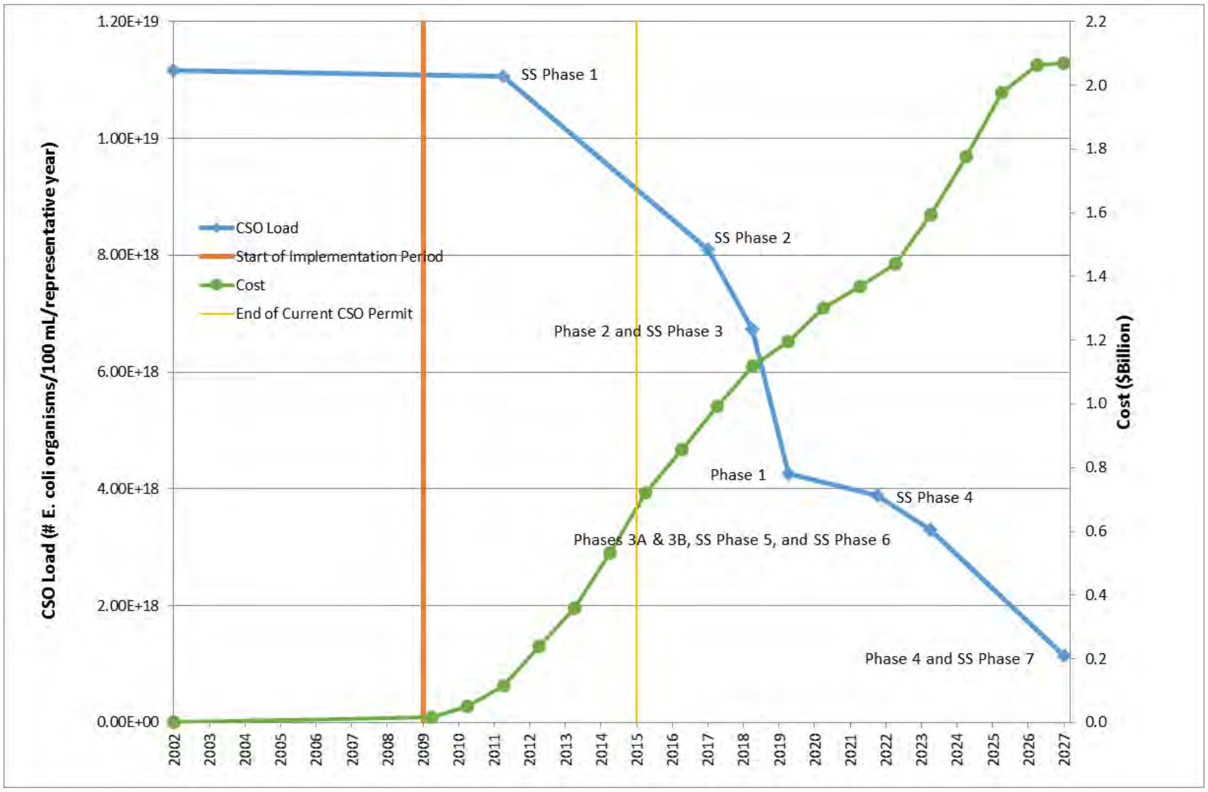


Figure ES-4 is a graphical summary of the *E. coli* loading reductions over the 18-year implementation timeframe. It shows that the largest reduction in loading from the Existing Conditions will have occurred by the end of 2018. By that time, approximately half of the total Program capital cost of $2 billion is projected to have been spent. As noted previously, this is also the time when significant affordability concerns for communities of concern will likely take place.

FIGURE ES-4
Estimated Reductions in CSO *E. coli* Load Over Time



The LTCP Update and schedule are based on current regulations and guidance and a number of assumptions. Changes to any of the regulations, guidance or assumptions may support a request for modification of the LTCP Update and implementation schedule.

ES.6 Public Participation Process

As a continuation of the public participation efforts conducted during development of the LTCP, the City has been working with the public over the last 5 years to incorporate public input into the implementation of the LTCP. In addition, the City is informing and seeking feedback on the LTCP Update. Section 6 of this report summarizes these efforts, including:

- Inclusion and involvement of stakeholders, residential ratepayers, commercial ratepayers, industrial users, and others impacted by the effects of CSOs on waterways and by construction.
- Community Enhancement efforts
- Public meetings and mailers
- Educational displays

- Printed material
- Presentations
- CSO Website
- Hotline
- Documentary for Nebraska Education Television
- Media relations
- Youth outreach
- Minority outreach

Public participation will continue to be important as the CSO Program is implemented. It will be necessary to make sure that the public is aware of how its fees are being spent, the benefits of the Program, details on the ratepayer assistance program, local job creation, what construction impacts will occur and when, public input for projects through design and construction, and general information on LTCP implementation progress.

ES.7 Post-Construction Monitoring Plan and Wet Weather Operations Strategy Update

The City has made minimal modifications to its post-construction monitoring program. The only significant change has been the contracting with USGS to obtain Missouri River samples, which has allowed the City to obtain a better understanding of river water quality. Similarly, the City has not made any significant changes to the Wet Weather Operations Plan. Between 2015 and 2018, significant facilities will be completed and placed into operation. As these facilities come online, the Wet Weather Operations Plan will be updated to reflect the facilities as constructed.

ES.8 Future Considerations and Challenges

The City continually seeks opportunities to optimize the LTCP implementation to make it more effective in meeting the goals of addressing water quality while also reducing costs. The City is facing known challenges in the future such as competing priorities with other environmental programs as well as affordability. With the affordability concerns the City is facing, it is important that the City continue to look for ways to implement projects more efficiently.

A few items the City will continue to evaluate or focus on over the next 5 years in order to continue to adapt the LTCP include the following:

- InfoWorks Model refinements
- Green Infrastructure
- Collection system optimization
- Operation of new wet weather treatment facilities
- Refinement of specific CSO Projects

ES.9 Conclusions

The City of Omaha has made significant progress over the past 5 years in implementing the LTCP. Significant knowledge has been gained through ongoing studies, designs, and construction efforts. The City has re-examined the CSO controls and has conducted numerous evaluations intended to improve the overall cost effectiveness in meeting the ultimate water quality objectives. The LTCP Update report documents this re-examination and summarizes changes to the 2009 LTCP in terms of specific projects and compliance under the Presumption Approach of the EPA CSO Control Policy (EPA, 1995). It also documents concerns over affordability that are arising, and the need to conduct discussions with NDEQ regarding these concerns. Overall, the LTCP Update effort has made a good plan even better.

1.0 Introduction

1.1 Overview of the Long Term Control Plan Update

The United States Environmental Protection Agency (EPA) has identified more than 770 communities nationwide, including the City of Omaha (City) that must address overflows from their combined sewer systems (CSS). The City, located in eastern Nebraska adjacent to the Missouri River, developed a Long Term Control Plan (LTCP) to reduce and control such overflows. The LTCP was completed and submitted to the Nebraska Department of Environmental Quality (NDEQ) in September 2009, and was approved by NDEQ in February 2010. Implementation of the combined sewer overflow (CSO) controls described in the LTCP started in summer 2009. The LTCP completed in 2009 and approved in 2010 is referred to in this current document as the 2009 LTCP (City of Omaha, 2009a). The City's CSO Permit (NPDES Permit No. NE 133680) and the Amended Compliance Order (May 30, 2012) require the LTCP to be updated by October 1, 2014.

This document (LTCP Update) describes the LTCP update process, presents evaluations that have been conducted, summarizes the outcome of the update effort, and recommends improvements in the CSO controls.

Since the start of implementation of the LTCP in June 2009, and as described in the 2009 LTCP, the City has been following an adaptive management approach. This approach ensures that controls are implemented in a manner that minimizes ratepayer impacts while accomplishing the goals of the LTCP. The LTCP Update is an extension of this adaptive management approach, and began in 2011. This document (LTCP Update) describes the LTCP update process, presents evaluations that have been conducted, summarizes the outcome of the update effort, and recommends improvements in the CSO controls. It also provides information on the current status of LTCP implementation. Since the LTCP Update builds upon the 2009 LTCP rather than replacing it, the 2009 LTCP should be consulted for additional information

This document follows the format of the 2009 LTCP but is an update, not an entirely new, stand-alone document. Tables and figures have been updated to show changes. In addition to Section 1 - Introduction, this document includes the following sections:

- **Section 2 - Current Conditions.** Provides a summary of the current implementation status of the LTCP, updated summaries of the existing stream and CSO water quality data, and modifications to the hydraulic model used to estimate CSO discharges.
- **Section 3 – Control Alternatives.** Describes the process the City undertook to evaluate potential updates to selected CSO control technologies and alternatives. It provides a detailed summary of the various controls included in the LTCP Update and, where necessary, descriptions of changes to the controls that occurred between the 2009 LTCP and the LTCP Update.

- **Section 4 – Program Financing and Financial Considerations.** Summarizes the City's updated evaluation of the affordability of the LTCP to the ratepayers and the current plan for financing LTCP implementation through 2020.
- **Section 5 – Updated CSO Controls.** Describes the current and updated controls selected for the LTCP to reduce CSO discharges and improve water quality. It includes an updated schedule for implementation of the controls. This section also shows compliance with EPA CSO Control Policy requirements and includes a discussion on the water quality benefits from the controls.
- **Section 6 – Public Participation Process.** Summarizes the City's efforts to inform and involve the public in the decisions made following approval of the LTCP. It also provides a summary of the public participation process used to inform the public of the LTCP Update and describes anticipated future efforts by the City to continue public involvement.
- **Section 7 – Post-Construction Monitoring Plan and Wet Weather Operations Update.** Summarizes the changes to the Post-Construction Monitoring Plan from that included in the 2009 LTCP. No changes have been made to the Wet Weather Operations Plan at this point in time.
- **Section 8 – Future Considerations and Challenges.** Summarizes efforts the City will undertake to continue to refine the LTCP in the future.

A number of appendixes are included in a separate volume of this LTCP Update to supplement the information presented in the sections.

Throughout this document, reference is made to two key dates: October 2014 and October 2015. The earlier date is the deadline for this LTCP Update to be submitted to NDEQ. In general terms, this is the date that is referred to as the present time, or "currently." However, for discussion about program progress-to-date and project status, October 2015 is used because it is the date when the City's current CSO Permit expires.

1.2 Regulatory Requirements

CSOs are regulated under the Clean Water Act (CWA) through the National Pollutant Discharge Elimination System (NPDES) program, which permits and regulates wastewater discharges. The NDEQ has been delegated the authority for Nebraska's NPDES program by the EPA. The City developed this LTCP Update in compliance with requirements of the EPA "CSO Control Policy" (59 *Federal Register* 18688); the August 8, 2007, Complaint and Compliance Order by Consent (Consent Order) as amended in 2012 (Amended Consent Order); and the City's NPDES permits for the combined system (CSO Permits) as discussed in the following sections.

1.2.1 EPA CSO Control Policy

In April 1994, EPA published a CSO Control Policy (*59 Federal Register 18688*) to explain how communities and states could control CSOs while meeting CWA requirements and to provide a process for addressing CSOs. The first step in the process is the development and implementation of a Nine Minimum Controls (NMC) Plan (City of Omaha, 2007), which includes controls or measures that can reduce CSOs without significant engineering studies or major construction. This step has been completed by the City, and the processes in the NMC Plan continue to be followed.

The CSO Control Policy requires the development of a LTCP using either the Demonstration Approach or the Presumption Approach to achieve compliance (EPA, 1995). Under the EPA Presumption Approach to compliance, the EPA CSO Control Policy calls for either the capture of at least 85 percent by volume of the combined sewage entering the collection system during wet weather, or no more than four to six untreated overflows on a system-wide annual average basis. Under the EPA Demonstration Approach, compliance with water quality standards must actually be demonstrated rather than presumed.

Section 5 explains that compliance under the LTCP Update, using the Presumption Approach, consists of a volume capture of greater than 85 percent, predicted compliance with water quality standards in the Missouri River, and no preclusion of water quality standards in Papillion Creek.

1.2.2 Consent Order

On August 8, 2007, the NDEQ finalized a Consent Order with the City of Omaha. It remained unchanged until 2012. The 2011 Missouri River Flood (2011 Flood) was considered a *force majeure* event under the Consent Order, and an amendment was made to the 2007 Consent Order as a result. The amendment was finalized on May 31, 2012, and provided an additional three years to the schedule to account for the construction seasons impacted by the 2011 Flood (see Appendix A - Amended Consent Order between NDEQ and the City of Omaha). The Amended Consent Order establishes the following requirements, which are paraphrased from the Consent Order:

1. The schedule shall provide for implementation of the LTCP, except post-construction monitoring, as soon as practicable and in any event by October 1, 2027.
2. Upon approval of the LTCP and schedule by NDEQ, the City shall implement the LTCP according to the schedule on or before October 1, 2027.
3. The 2009 LTCP shall be revised and submitted to NDEQ on or before October 1, 2014; the amended LTCP shall address all *force majeure*-related delays. The revision shall be subject to, and contingent upon, approval by NDEQ. Upon approval by NDEQ, the LTCP shall be performed by the City according to its terms and schedule.
4. The remainder of the Consent Order of August 8, 2007, is still in effect, and the City shall comply with the terms of the Consent Order.

1.2.3 NPDES Permit

The City has been operating under NPDES Permit No. NE0133680 issued on October 1, 2010, which authorizes the discharge from various CSO points within the City. The permit requires that prior to renewal of the permit certain submissions be made. Table 1-1 summarizes the submissions that are addressed in this document and where they can be found. The LTCP Update is being submitted in compliance with these requirements and the Amended Consent Order.

TABLE 1-1
Comparison of CSO Permit Requirements and LTCP Update Sections

CSO Permit Requirement	LTCP Update Section	Comments
Part V.C. Consideration of Sensitive Areas - By October 1, 2014, the City must submit a report to the NDEQ on reassessment of overflows to sensitive areas in those cases where elimination or relocation of the overflow is not included in the LTCP. The reassessment shall be based on consideration of new or improved techniques to eliminate or relocate overflows or changed circumstances that influence economic achievability.	Section 2.5 – Current Conditions	Section 2.5 provides a summary of the re-evaluation that was performed to update the sensitive areas.
Part V.D. Evaluation of Alternatives - Any significant changes or revisions to the controls set forth in the LTCP must be submitted to the NDEQ for review by October 1, 2014. This is also stated in Part VIII.F Revision of the Long Term Control Plan.	Section 3 – Control Alternatives	Section 3 as a whole provides a summary of how the alternatives were developed and lists the revisions.
Part V.E. Cost/Performance Consideration - By October 1, 2014, the City must submit a financial report to the NDEQ that sets forth a strategy to obtain sufficient revenue to fund the CSO program through at least the year 2020 that includes funding for the specific projects in the Implementation Schedule, Section 7 of the LTCP.	Section 4 – Program Financing and Financial Considerations	This section provides a summary of the financial plan.
Part VIII.F. Revision of the Long Term Control Plan - As stated previously, proposed significant revisions to the LTCP must be submitted by October 1, 2014 for NDEQ review and approval.	Section 5 – Updated CSO Controls	This section includes the revised controls, schedule, and compliance status of the LTCP.

1.2.4 Background

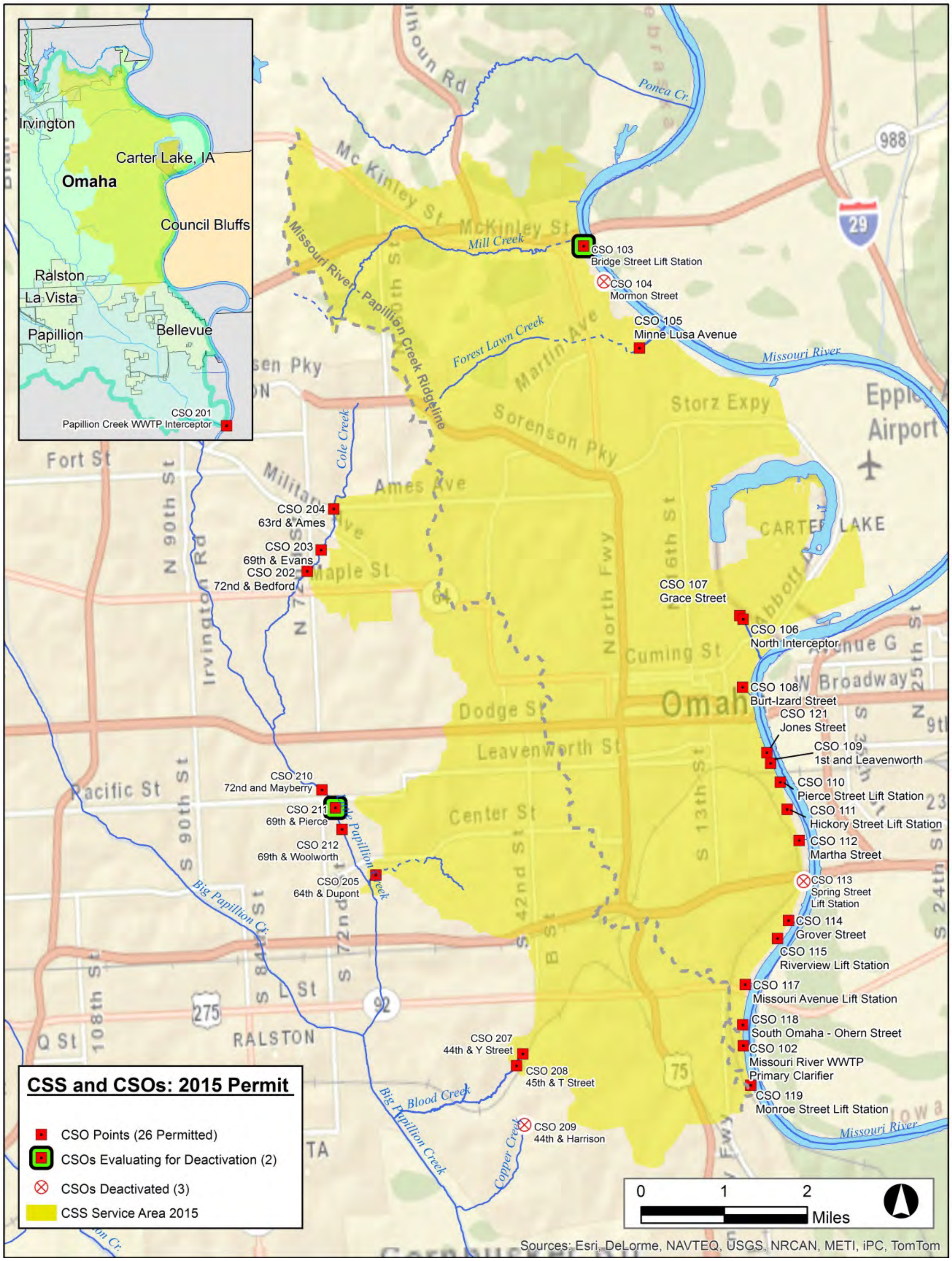
As noted in the 2009 LTCP, the Missouri River is the eastern boundary of the City, with Council Bluffs, Iowa, located across the river to the east, as shown in Figure 1-1. In Omaha's CSS, gates or weirs divert the sanitary sewage during dry weather into interceptor sewers, which convey it to wastewater treatment plants. In dry weather, the amount of sewage flow is comparatively small and can be handled without overflows.

FIGURE 1-1
City of Omaha and Surrounding Area

During wet weather, stormwater mixes with the sanitary sewage in the CSS, significantly increasing the flow rate. When the mixed flow rate increases enough, the flow will overtop a weir or pass through a gate and discharge into a river or stream at designed outfall points within the system. In 2009, 29 CSO outfalls were permitted by NDEQ to discharge during wet weather from the City's CSS: 19 to the Missouri River and 10 to tributaries of Papillion Creek. Over the last 5 years, three of these outfalls have been closed but remain in the current NPDES Permit until its renewal in 2015. Two additional outfalls are currently being evaluated and the City anticipates permanent deactivation and removal from the permit in a period shortly after the next NPDES Permit issuance. Thus, there are currently 26 active CSO locations remaining. Figure 1-2 depicts the CSO's status anticipated at the time of the next permit cycle. As summarized in Section 1.2.4.1, there are an additional 10 CSO outfall locations that are planned to be deactivated in the future.

The City's CSS service area covers approximately 45 square miles and consists of a 790-mile wastewater collection system with approximately 480 miles of combined conveyance. These values have been updated to reflect refinements in the current City GIS records. Additionally, areas served by the CSS that were outside of the City's limits or were not included in the LTCP Study Basins, are accurately reflected in this update. Notably, this includes areas near and around Eppley Airport and Carter Lake with separate storm systems and wastewater collection served by the CSS.

FIGURE 1-2
CSS Service Area and CSO Locations – 2015 Permit



The City's total wastewater service area is approximately 333 square miles in both Douglas and Sarpy Counties and provides service for a population of nearly 650,000. The City continues to treat wastewater in two major treatment facilities: the Missouri River Wastewater Treatment Plant (MRWWTP), located south of the Veterans Memorial (Highway 275) Bridge along the Missouri River, and the Papillion Creek Wastewater Treatment Plant (PCWWTP), located south of the City near Bellevue, Nebraska. A third, very small treatment facility (the Elkhorn Wastewater Treatment Plant) is located near the western boundary of the City. A portion of the collection system for the PCWWTP and all of the collection system for the MRWWTP are considered part of the CSS.

1.2.4.1 Outfall Elimination

As noted previously, when the City's first CSO Permit was issued in 2002, there were 29 permitted CSO outfalls. Shortly after issuance of the permit, work related to the development of a detailed computer model for the CSS identified three additional CSO outfalls. This resulted in a total of 32 permitted CSO outfalls. Prior to submission of the 2009 LTCP in September 2009, the City deactivated or reclassified three CSOs: 116 – Homer Street, CSO 206 – 43 and S Street, and CSO 120 – Arena and Convention Center. This brought the number of CSO outfalls back down to 29. Over the last 5 years, the City has performed projects that have deactivated these three overflows:

- **CSO 104 – Mormon Street** has been evaluated and monitored for several years after the last project and was permanently closed off July 22, 2014. The next permit will reflect that this CSO has been deactivated.
- **CSO 113 – Spring Street** has been converted to a stormwater outfall as the result a sewer separation project completed on December 6, 2011. There is no longer the ability to have an overflow at this location. The next permit will reflect this CSO has been deactivated.
- **CSO 209 – 44th and Harrison** has been evaluated and monitored for several years after the last project and permanently closed off September 27, 2012. The next permit will reflect this CSO has been deactivated.

With the above deactivations, there are currently 26 remaining CSO outfalls rather than the permitted number of 29 (see Figure 1-2). During the next permit cycle, an additional two of these 26 outfalls will have the necessary projects complete and be evaluated for permanent deactivation:

- **CSO 211 – 69th & Pierce**. The outfall will be closed following inflow reduction and monitoring. The City anticipates this CSO to remain permitted in the next permit, while undergoing evaluation for deactivation.
- **CSO 103 – Bridge Street Lift Station**. The outfall will be closed following sewer separation and monitoring. The City anticipates this CSO to remain permitted in the next permit, while undergoing evaluation for deactivation.

The following CSO outfalls are planned to be deactivated beyond the next permit cycle, but within the LTCP implementation schedule:

- **CSO 112 – Martha Street**. The outfall will be deactivated when flow is directed south as a result of project work and when monitoring is complete.
- **CSO 117 – Missouri Avenue Lift Station**. The outfall will be deactivated after sewer separation.
- **CSO 202 – 72nd & Bedford**. The outfall will be deactivated following sewer separation and monitoring.
- **CSO 203 – 69th & Evans**. The outfall will be deactivated following sewer separation and monitoring.
- **CSO 207 – 44th & Y Street**. The outfall will be deactivated following sewer separation and monitoring.
- **CSO 208 – 45th & T Street**. The outfall will be deactivated following sewer separation and monitoring.
- **CSO 210 – 72nd & Mayberry**. The outfall will be deactivated following sewer separation and monitoring.
- **CSO 212 – 69th & Woolworth.** The outfall will be deactivated following sewer separation and monitoring.

Further detail regarding the work associated with deactivating these CSO outfalls is included in Sections 2 and 3 of this LTCP Update. After these deactivations are accomplished, there will be 16 remaining CSO outfalls.

1.2.4.2 Nine Minimum Controls

As required in the 2010 CSO Permit, the City has continued to implement its NMC Plan (City of Omaha, 2007). As defined by the EPA, the NMC Plan includes nine minimum technology-based controls that can be used without extensive engineering studies or significant construction costs, prior to the implementation of long-term controls. No changes to the NMC Plan were made as a result of the LTCP Update.

1.3 Challenges in LTCP Implementation

Since the beginning of LTCP implementation in 2009, the City has made significant progress, as documented in this LTCP Update. However, numerous challenges have been encountered and dealt with along the way. A few of these challenges are documented below.

1.3.1 Flood Events

FIGURE 1-3
Flooding in 2011 near the MRWWTP (*photo courtesy of City of Omaha*)

In 2011, the Missouri River experienced an historic flooding event, with the river reaching levels more than 6 feet higher than any flood elevation seen since the construction of the mainstem dams along the river. The river was at flood stage in Omaha for 104 days (Figure 1-3), resulting in significant impacts to the design and construction schedules of projects that were a part of the original LTCP, in particular, but not limited to, those along the river. The 2011 Flood was declared a *force majeure* event, and on May 30, 2012, a 3-year extension to the LTCP implementation period was granted to the City, with the Amended Consent Order revising the completion date to October 1, 2027. The 2011 Flood continues to impact the scope, schedule, and cost of projects in the LTCP. The most recent impact is the unstable bank conditions adjacent to the MRWWTP (Figure 1-4). The design of stabilization improvements are currently ongoing. The 2011 Flood has most significantly impacted the replacement of the South Interceptor Force Main (SIFM) and MRWWTP Improvement projects. Completion of the SIFM replacement and MRWWTP improvements is part of LTCP Major Projects Phase 1 and, originally scheduled for completion by October 2015, will extend beyond this current permit cycle and into the next permit. Cost impacts are discussed in greater detail in Section 1.3.3 of this document. The City applied for modification to the CSO Permit to address these delays. At the time of writing of this document, the modification was under review by NDEQ.

FIGURE 1-4
Unstable River Bank Conditions at the MRWWTP Site
(*photo courtesy of CH2M HILL*)

In June of 2014, a flooding event much shorter and minor in duration resulted in impacts to the cost and schedule of the LTCP, in particular to the MRWWTP improvements because of the need to implement the United States Army Corps of Engineers (USACE) Emergency Action Plan.

The schedule impacts of the flood events have been incorporated into the revised schedule included in this LTCP Update.

1.3.2 Political Changes

The 2009 LTCP was developed primarily under the administration of Former Mayor Mike Fahey. In 2009, Mayor Jim Suttle took office, and in 2011, he challenged the CSO Program Management Team (PMT) to find more economical alternatives, in particular to the Deep

Tunnel. Efforts completed under the Suttle administration are discussed in Section 3. In May 2013, Major Jean Stothert was elected to office. Mayor Stothert, who gained an understanding of the CSO Program while a member of the City Council before becoming Mayor, took some time to evaluate the CSO Control Program, and in July 2014 signed a rate ordinance that extends sewer use fee increases until 2018. Each of the elected officials mentioned in this paragraph, along with members of the City Council, are placed in a difficult position where they are asked to approve items that increase the financial burden on the people who place them into office. Additionally, each election cycle results in new elected officials that must be educated on why the work required by the CSO Program and the CWA is not optional.

1.3.3 Project Cost Adjustments from the 2009 LTCP

The LTCP implementation plan called for many of the larger, more complex CSO control projects to be implemented in the first few years of the implementation period. These were key infrastructure projects that need to be constructed early in the program to allow for the future projects upstream to be constructed or developed, or had early water quality benefits. Significantly higher construction costs have been encountered on several of these projects, including:

- MRWWTP Improvements
- Minne Lusa Stormwater Conveyance Sewer and Storz Detention Basin Improvements
- Paxton Boulevard Stormwater Conveyance Sewer
- Nicholas Street Phase 2 to 23rd & Grace
- Leavenworth Lift Station Replacement
- Saddle Creek CSO 205 – 64th and Dupont Retention Treatment Basin (RTB)
- SIFM
- Martha Street Sewer Separation Phase 1
- Miller Park to Pershing Detention Basin Sewer Separation

Based on a common Engineering News Record Construction Cost Index (ENRCCI) of 9484, the total increase in construction cost represented by the above projects is $189 million. The CSO Program budget described in the LTCP included approximately $330 million in "Risk Dollars." While not all project cost increases have been specifically caused by the specific risk items used to develop the Risk Dollars, it is significant that the total increase in cost for these early, complex projects is well below the original Risk Dollars total amount.
A comparison of the 2009 LTCP cost, listed by major project type, with the 2014 LTCP Update cost is provided and described in Section 5.

Key reasons for the increases in cost for these projects are noted below:

- MRWWTP Improvements:
  - Reconfiguration of disinfection and odor control facilities as a result of the 2011 Flood to less cost effective layouts
  - Changes to the flow handling and disinfection system to handle first flush flows from the SIFM
  - Inclusion of facilities to maintain plant operation during future flood events and to protect plant assets

  - Stabilization of the river bank to protect the existing plant and new facilities from further failure of the bank that resulted from the 2011 Flood
  - Transfer of costs from other portions of the LTCP to the MRWWTP Improvement project, such as rehabilitation of the In-Plant Lift Station, grit removal for the South Omaha Industrial Area (SOIA) Lift Station, and raw sewage piping for SOIA and SIFM
  - Capital asset replacement of several pumping systems to improve reliability for the increased wet weather flows
  - Inclusion of additional piling to support large-diameter piping and shallow slabs, determined to be needed by additional geotechnical investigations
  - Inclusion of an advanced grit removal system to accommodate wide fluctuations in plant influent flow rates
  - Addition of odor control for municipal headworks and primary clarifier splitter box

- Minne Lusa Stormwater Conveyance Sewer and Storz Detention Basin Improvements:
  - Evolution from embankment modifications and a trapezoidal open channel conveyance to retain only smaller return flows to a high hazard dam and twin 8-by-8-foot outlet conveyance conduits
  - Increase in the conveyance sewer diameter to 14 feet

- Paxton Boulevard Stormwater Conveyance Sewer:
  - Complexity of construction in the Paxton Street corridor due to size of conveyance
  - Increase in sewer depth due to crossing under existing sewers, plus restricted width due to close proximity of existing sewers

- Nicholas Street Phase 2 to 23rd & Grace
  - Increase in project scope, which originally included extension of 24-inch sanitary sewer, to include extension of 108-inch storm sewer and additional sewer separation area

- Leavenworth Lift Station Replacement:
  - Increase in pumping capacity
  - Addition of bedrock blasting requirements and secant wall construction
  - Addition of a dry-weather wet well
  - Increase in size for grit removal
  - Addition of two diversion structures to accommodate construction on the existing Leavenworth Sewer (protected existing sanitary sewer and mitigated risk with stormwater flows)

- Saddle Creek CSO 205 – 64th and Dupont RTB:
  - Disposal of existing construction debris from existing on-site landfill
  - Addition of foundation enhancements for influent pipes, diversion structure, and RTB facility
  - Inclusion of office space, break room, and shop

- Inclusion of enhancements to existing CSO 205 channel to improve drainage after storm events
- Addition of gates for influent flow control, basin isolation and backwater protection
- Adjustment of facility layout for size, thus increase in the volume of the facility in the headworks and influent channel

- SIFM:
  - Changes in alignment from railroad corridor to rock tunnel through the Heartland of America Park based on utility conflicts and poor soils
  - Addition of piles for construction of portions of the SIFM due to poor soils
  - Repair of the levee road after construction is complete
  - Resolution of environmental issues associated with Heartland of America Park and Lewis & Clark Landing

- Martha Street Sewer Separation Phase 1:
  - Deteriorated condition of existing combined sewer through Lauritzen Gardens changed the concept, necessitating construction of a new collection system for both sanitary and storm flows
  - Significant regrading of the existing site to accommodate Lauritzen Gardens
  - Mitigation of construction issues and stormwater runoff in former balefill site
  - Granite boulder obstruction during trenchless pipe construction

- Miller Park to Pershing Detention Basin Sewer Separation:
  - Need for closed-face tunneling machine for tunneling operations in soils encountered
  - Extension of open cut portion of conveyance sewer to reduce risk of excavating through pond embankment

The City has been able to accommodate these increases in cost and continue to meet the LTCP implementation schedule, as extended to 2027 in the Amended Consent Order, through measures that include the following: adjusting the schedule of projects; using some CSO Program Risk Dollars; and incorporating reductions in some projects costs (such as the change in sewer separation concept in the Paxton Area and conversion of the 26th and Corby projects to Combined Sewer Renovation (RNC). Project scheduling details are included in Section 5 of this document. Affordability concerns that could potentially require further schedule changes are discussed in Section 4.

1.4 LTCP Update Approach

Since 2006, the City has contracted with CH2M HILL, Inc. in association with HDR Engineering, Inc. (HDR), and Lamp Rynearson & Associates (LRA), to serve as the Program Manager for the development and implementation of the LTCP. These firms collectively make up the PMT. The City has also retained the services of Lovgren Marketing Group, a professional public participation firm, to assist in the development and implementation of a program to ensure the public's involvement in development and implementation of the LTCP.

1.4.1 Work Plan

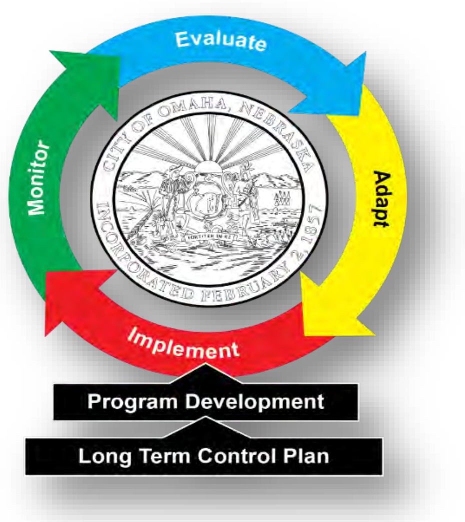
To complete the LTCP Update, which is required by the City's CSO Permit, the PMT developed a workplan to evaluate the plan for possible changes. The update process incorporated additional evaluations requested by current and former mayors. In 2011, the former Mayor Suttle asked the PMT to consider elimination of the Deep Tunnel from LTCP and to investigate other changes that could reduce the cost of the CSO Program. This request resulted in an increased effort to update the LTCP. Current Mayor Stothert has challenged the PMT to work on project designs and evaluate technological solutions that are cost effective and have direct impact to lower overall Program costs. More detail on the LTCP update process is included in Section 3. The LTCP Update presents the results of this process, but does not mark the end of the City's efforts to continue adaptive management of the LTCP.

1.4.2 Adaptive Management of the Long Term Control Plan

The LTCP is a plan, not a design document, and many of the factors that affect this plan change over time. For this reason, the City uses an adaptive management strategy for implementing the LTCP. Adaptive management, as defined by the EPA, is "the process by which new information about the health of a watershed is incorporated into the watershed management plan." The City has applied this process to the LTCP and implementation of individual controls within the LTCP by following these simple steps (Figure 1-5):

Step 1 – Implement
Step 2 – Monitor
Step 3 – Evaluate
Step 4 – Adapt

FIGURE 1-5
Adaptive Management Strategy for Implementing the LTCP



2.0 Current Conditions

2.1 Introduction

This section summarizes the current status of projects included in the 2009 LTCP. It provides an overview of the projects currently being designed or under construction, and those that are expected to be completed by October 2015 (the end of the City's current CSO Permit). The section also summarizes the significant efforts that the City has undertaken to refine the CSS model, and to characterize the Missouri River and Papillion Creek watersheds. Section 2.5 meets the requirement of Part V. C. Consideration of Sensitive Areas in the CSO Permit. As noted in Table 1-1, the requirement states that "By October 1, 2014, the City shall submit a report to the NDEQ on reassessment of overflows to sensitive areas in those cases where elimination or relocation of the overflow is not included in the LTCP. The reassessment shall be based on consideration of new or improved techniques to eliminate or relocate overflows or changed circumstances that influence economic achievability."

As explained in the 2009 LTCP, projects in this LTCP Update are categorized as either Major Projects or Sewer Separation Projects. Major Projects consist of projects that are associated with four major elements of the LTCP: maximizing flow to the MRWWTP, the Saddle Creek RTB, the Stormwater Conveyance Sewer in the Minne Lusa Basin, and the CSO Deep Tunnel. Based on this definition, there are four Sewer Separation Projects that are defined as Major Projects. The rest of the projects in the LTCP are defined as Sewer Separation Projects.

Projects are referred to primarily by the LTCP project names, which were given in the 2009 LTCP. In some instances, as projects are implemented by the City, they have been given a different City project name to divide a project into multiple contracts, clarify the LTCP project name, or define a geographical area for a Sewer Separation Project. In the following discussion, where necessary for clarification, the 2009 LTCP project name may be used as well as the individual City project name to address specific phases or contracts related to the larger project.

Through July 2014, the City had spent $126 million on construction for implementation of the CSO Program, and anticipates spending another $371 million on construction by October 2015.

2.2 Implementation Status

The CSO controls in the 2009 LTCP include:

- Improvements to the MRWWTP to treat a relatively continuous flow of 150 million gallons per day (mgd) during wet weather, and to separately treat high-strength industrial wastewater through primary treatment. Up to 64 mgd is planned in the 2009 LTCP to be treated through full secondary treatment, with the remainder being disinfected prior to discharge to the Missouri River. In addition to improvements at the MRWWTP, the 2009 LTCP describes several new or updated facilities to convey flow, including: the SIFM; Leavenworth Lift Station; Riverview Lift Station; Burt-Izard Lift Station; Monroe Street Lift Station; and the Ohern/Monroe Industrial Lift Station, Force Main, and Gravity Sewer.
- Extensive sewer separation through the CSS service area.
- Stormwater Collector Sewer and associated facilities in the Minne Lusa Basin.
- A CSO Deep Tunnel, 5.4 miles long and 17 feet in diameter.

- Two high-rate treatment (HRT) units, referred to as RTBs.
- Two storage tanks.

In addition, the 2009 LTCP stated that the City's Green Solutions (referred to in the LTCP Update as Green Infrastructure) Program would be expanded to better define how to incorporate Green Solutions into the CSO Program.

The cost estimate for the controls described in the 2009 LTCP was approximately $1.66 billion in April 2009 dollars. Following implementation of the LTCP controls, it was estimated that approximately 94 percent of the average annual volume of combined sewage would be controlled, not more than four CSO events would occur in each watershed during Representative Year precipitation, and water quality standards for *E. coli* would be met in the Missouri River. Out of the 29 CSO outfalls permitted at the time of the 2009 LTCP, nine were planned to be deactivated.

The schedule presented in the 2009 LTCP demonstrated the City's intent to complete the CSO controls within the 15-year implementation period. The LTCP schedule was based on information available at that time, and anticipated that the City would identify and resolve uncertainties and adjust the schedule accordingly. It was also stated in the 2009 LTCP that, over the 15-year implementation period, there would likely be unanticipated situations that would affect the City's ability to meet the schedule. Schedule milestone dates were established in the 2009 LTCP for inclusion in the City's CSO permits with NDEQ using a phased approach.

The City started implementation of the LTCP in June 2009, prior to approval of the LTCP. Through July 2014, the City had spent $126 million on construction for implementation of the CSO Program, and anticipates spending another $371 million on construction by October 2015. This covers construction of major projects, sewer separation, and other miscellaneous projects. By October 1, 2015, it is anticipated that 16 projects will be completed, 11 will be under construction, and 17 will be under design.

2.2.1 Compliance with Permit Dates

The City's CSO Permit includes compliance dates for the different project phases for Major Projects and Sewer Separation Projects. These compliance dates are based on the various phases that were provided in Section 7 of the 2009 LTCP. Table 2-1 provides a summary of the phases from the LTCP and CSO Permit and their anticipated compliance status for Major Projects through October 2015. Table 2-1 demonstrates the overall success of LTCP implementation to date. Requirements incorporated in the CSO Permit as compliance schedule dates are in **bold**.

TABLE 2-1
LTCP and CSO Permit Compliance Status for Major Projects

Milestone (Permit Reference)	Compliance Date	Date Achieved	LTCP Project That Achieved Compliance Date	Comment
Phase 1 Major Projects in the LTCP, Begin Construction	December 31, 2010	June 8, 2010	Ohern/Monroe Industrial Flow Area Sewer Separation Project	
Phase 1 Major Projects in the LTCP, Begin Final Design	December 31, 2009	September 1, 2009	Ohern/Monroe Industrial Flow Area Sewer Separation	

TABLE 2-1
LTCP and CSO Permit Compliance Status for Major Projects

Milestone (Permit Reference)	Compliance Date	Date Achieved	LTCP Project That Achieved Compliance Date	Comment
Phase 1, Major Projects, All Projects Operational (Part VI.A)	**September 30, 2015**			**All projects will be complete by the date except MRWWTP (Schedules B1 and B2) and SIFM Anticipated completion at the end of 2019**
Phase 2, Major Projects in the LTCP Begin Final Design	December 31, 2010	September 30, 2010	Aksarben Village Phases A and B	
Phase 2 Major Projects in the LTCP, Begin Construction (Part VI.B)	**December 31, 2011**	**September 29, 2011**	**Aksarben Village Phases A and B**	
Phase 3, Major Projects in the LTCP, Begin Final Design	**December 31, 2011**	December 27, 2011	Minne Lusa Stormwater Conveyance Sewer	
Phase 3 Major Projects in the LTCP, Begin Construction (Part VI.C)	**December 31, 2013**	**July 8, 2013**	**Miller Park to Pershing Detention Basin Sewer Separation**	

Table 2-2 provides a summary of the phases from the LTCP and CSO Permit and their anticipated compliance status for Sewer Separation Projects through October 2015. Requirements that were incorporated in the CSO Permit as compliance schedule dates are in **bold**. As with Table 2-1, Table 2-2 demonstrates that the CSO Permit requirements have been achieved with the exception of the MRWWTP Improvements and SIFM. The dates for these projects will be modified as part of the next CSO Permit.

TABLE 2-2
LTCP and Permit Compliance Status for Sewer Separation Projects

Milestone (Permit Reference)	Compliance Date	Date Achieved	LTCP Project That Achieved Compliance Date	Comment
Phase 1, Sewer Separation in the LTCP, Begin Bidding	December 31, 2009	January 1, 2009	Webster Street Sewer Separation Phase 2	

TABLE 2-2
LTCP and Permit Compliance Status for Sewer Separation Projects

Milestone (Permit Reference)	Compliance Date	Date Achieved	LTCP Project That Achieved Compliance Date	Comment
Phase 1, Sewer Separation Projects in the LTCP, Complete Construction (Part VI.D)	**December 30, 2011**	**January 10, 2011**	**24th Street & Ogden Street Sewer Separation; Webster Street Sewer Separation Phase 2; 42nd Street and X Street Sewer Separation**	
Phase 2, Sewer Separation in the LTCP, Begin Bidding	December 31, 2011	January 26, 2011	Spring Street Sewer Separation	
Phase 2, Sewer Separation in the LTCP, Complete Construction (Part VI.E)	**September 30, 2015**			**Nicholas and Webster Sewer Separation Phase 1 - construction on critical path and is due to be complete June 1, 2015**
Phase 3, Sewer Separation in the LTCP, Begin Bidding (Part VI.F)	**December 31, 2014**	**January 8, 2014**	**Missouri Avenue Sewer Separation Phase 1 and Phase 2**	

2.2.2 Major Projects

This section summarizes the Major Projects that are expected to be completed by October 1, 2015, and those expected to be under construction as of October 2015.

2.2.2.1 Major Projects Completed

Following are descriptions of Major Projects completed or expected to be completed as of October 1, 2015.

Ohern/Monroe Industrial Flow Area Sewer Separation

The Ohern/Monroe Industrial Flow Area Sewer Separation project removed industrial discharges from the existing CSS within the Ohern/Monroe Basin and delivered flows to the existing 22nd and Washington Joint Use Facility site where the Industrial Lift Station was subsequently built. This area is now known as the SOIA. This project, also known by its City project name of South Omaha Industrial Area Sewer Separation (SOIASS), involved sanitary and storm sewer separation as well as cleaning existing sewer lines. Construction of the SOIASS project started on June 8, 2010, and was substantially complete on November 3, 2010.

Ohern/Monroe Industrial Lift Station, Force Main, and Gravity Sewer

The Ohern/Monroe Industrial Lift Station, Force Main, and Gravity Sewer project was bid in two separate construction packages due to the differences in the types of construction required for the two projects. The following packages are listed by their City project names:

a) SOIA Lift Station (OPW 51596)(Contract 1)
b) SOIA Force Main and Gravity Sewer (OPW 51597)(Contract 2)

The SOIA Lift Station (Figure 2-1) project provided pumping of the separated high-strength flows, from the SOIA Lift Station directly to the MRWWTP through the SOIA Force Main, which includes both dual force main and a gravity sewer leading to the MRWWTP. The force mains extend from the lift station to a high point along 13th Street where it converts to the gravity sewer that conveys flow to the MRWWTP. The City's original schedule in the LTCP required construction to commence by June 20, 2012. Construction of the lift station (OPW 51956) actually began on October 3, 2011, and was substantially complete on May 16, 2014. Construction of the force main and gravity sewer actually began on August 31, 2011 and was substantially complete on February 26, 2014.

FIGURE 2-1
SOIA Lift Station *(photo courtesy of Wade Trim)*

The design storm noted in the 2009 LTCP for this facility was revised following additional analysis. The design storm in the 2009 LTCP was a 25-year, 24-hour storm event; this was changed to a 10-year, 24-hour event. This change decreased the facility conveyance design flows (Lift Station, Gravity Sewer, and Force Main) slightly from 18.3 mgd to 17.4 mgd, but still ensures that the industrial wastewater will be conveyed to the MRWWTP for full treatment. This modification does not result in a change of the level of control described in the 2009 LTCP.

Grit removal pretreatment was relocated to the MRWWTP industrial treatment facilities. This change was made because of the odor associated with pretreatment of this waste. It was determined that it would be easier and more acceptable to the public for operations and maintenance (O&M) to handle these materials directly at the MRWWTP.

MRWWTP Improvements

As noted in the 2009 LTCP, the MRWWTP Improvements project will result in immediate, significant reductions in the size and number of untreated overflows and the *E. coli* loading to the Missouri River. The MRWWTP Improvements project is now being delivered under three major construction contracts, listed here by either their City project names or common names: MRWWTP Improvements - Schedule A (OPW 52200), MRWWTP Improvements - Schedule B1 (OPW 51875), and MRWWTP Improvements - Schedule B2 (OPW 52648). (Common names are names that are used on some projects based on how they are often referred to day to day by City staff, the PMT and others). Two smaller but necessary construction contracts have also been added: MRWWTP – SIFM Wetlands Mitigation (OPW 52570) and MRWWTP Improvements – River Bank Stabilization (OPW 52494). Wetlands mitigation is required as part of the 404 Permit from the USACE for Schedules B1 and B2 and the SIFM project. River bank stabilization is required to allow construction of the disinfection facilities under Schedule B2. (Additional information regarding the river bank stability issue at the MRWWTP is included in Sections 1 and 3.) Both of these smaller contracts are anticipated to be completed by October 2015. As described later, Schedules B1 and B2 are expected to be under construction in October 2015. Schedule B1 is currently under construction.

Schedule A (Figure 2-2) includes separate primary treatment of the high-strength waste from the SOIA, modifications to the Transfer Lift Station so that the high-strength waste can go directly to the secondary treatment system, and a non-potable plant water system. The capacity of the transfer lift pumps was also increased to enable the ability to convey 64 mgd of primary effluent to the secondary treatment system. The end result of the project is that the waste no longer will be part of the CSO 102, 118, and 119 discharges; instead, it will go directly to secondary treatment.

FIGURE 2-2
SOIA Treatment System *(photo courtesy of CH2M HILL)*

A grit storage pad was originally included in the MRWWTP Improvements project as part of the 2009 LTCP. The grit pad has been deemed to be unnecessary at this time and deferred until later in the LTCP. Deferral of the construction of the grit storage pad will not adversely affect plant or collection system operations because the bulk of the new grit accumulations anticipated as part of the program improvements will not occur until the CSO Deep Tunnel is online at the end of the implementation period.

A significant change order was added to Schedule A to replace the two force mains leading from the Transfer Lift Station to the Secondary Complex. This replacement was necessary when the poor condition of these force mains was discovered during the early months of construction. The change order included the installation of bypass pumping that remained in place for 7 months and an overall cost of over $3 million. It was paid for by the City using non-CSO funds.

The MRWWTP Improvements - Schedule A started construction on March 26, 2012. Substantial completion is expected by November 30, 2014.

MRWWTP Improvements Schedules B1 and B2 will allow the plant to treat a peak-hour flow rate of up to 150 mgd during wet weather and will provide disinfection of flow in excess of the plant's secondary treatment capacity. Further detail on these projects are provided later in this section.

Leavenworth Lift Station Replacement

The Leavenworth Lift Station Replacement project was divided into two contract packages to facilitate the relocation of an Omaha Public Power District (OPPD) power line. OPPD needed to complete this work prior to peak demand in the summer months. Leavenworth Lift Station Contract 1 – Site Preparation (OPW 52199) consisted of preliminary site work required to prepare the site for OPPD's relocation of high voltage power lines. Construction for Contract No. 1 started on January 13, 2012, and was substantially complete on June 20, 2012.

Leavenworth Lift Station Contract 2 – Lift Station (OPW 51874) included the new lift station (Figure 2-3) and the diversion structures at the existing Leavenworth Sewer site. The Leavenworth Lift Station Replacement project allows for the conveyance of additional wet weather flow to the MRWWTP for treatment. In addition to handling flows that has historically gone to the existing

Leavenworth Lift Station, the new Leavenworth Lift Station handles dry weather flows and a portion of the wet weather flows from the Pierce Street Lift Station and Hickory Street Lift Station, both of which will be abandoned.

The new lift station has two wet wells (one for wet weather and one for dry weather). The dry weather wet well includes two 7.5-mgd submersible pumps (one duty, one stand by). The wet weather wet well includes four 15-mgd submersible pumps (three duty, one standby) for a total pumping firm capacity of 45 mgd during wet weather. Additional information on this lift station is included in Section 3.4.2.1.

FIGURE 2-3
Leavenworth Lift Station *(photo courtesy of HDR)*

Construction for Contract No. 2 started on August 1, 2012. The project is anticipated to be substantially complete slightly after the submittal of the LTCP Update to the NDEQ in October, 2014. The Leavenworth Lift Station will not be able to deliver the full 45 mgd to the MRWWTP until the MRWWTP Improvement project (Schedule B1) and the Central and South Segments of SIFM are complete.

Aksarben Village Phases A and B

The Aksarben Village project, also known by its City Project Name: Aksarben Village Neighborhood Sewer Separation project (OPW 51151), included the construction of new storm sewers north and east from the 63rd and Shirley intersection to approximately 56th and Marcy Streets. The project removes stormwater from the Saddle Creek Basin, and reduces the volume of combined flows to the future Saddle Creek RTB. The existing combined sewers in the project area were converted to sanitary sewers to convey the sanitary flows downstream and remain connected to the downstream CSS.

The 2009 LTCP defined the work for the Aksarben Village to be completed in two separate projects:

- Phase A, consisting of primarily new construction
- Phase B consisting mainly of the rehabilitation of existing sewers that were to remain in place

During the design of the project it was noted that the need for rehabilitation was not as extensive as anticipated and could be more cost effectively addressed along with the Phase A project. Therefore, Phase B work was accomplished as part of Phase A.

A cost saving measure that helped reduce community disturbance and added a community feature to an underutilized area of Elmwood Park was another important part of the project. Storm sewers were constructed to carry stormwater northwest to Elmwood Park where it flows through a series of weirs and detention ponds referred to as the Elmwood Diversion. These ponds provide a cost effective, and Green Infrastructure by:

- Slowing stormwater runoff
- Allowing the ground to absorb more stormwater
- Reducing the amount of stormwater released into the creek

- Improving the quality of water entering the creek
- Reducing overall project cost

Construction for the Aksarben Village Phase A and B project started on September 24, 2011 and was substantially complete on September 22, 2013.

Bohemian Cemetery Sewer Separation

The Bohemian Cemetery Sewer Separation project in the LTCP is also referred to by its City project name: Saddle Creek Area – 55th to 64th Street Sewer Separation project (OPW 51777). The project removed an unnamed creek from the CSS, and removed stormwater from the CSS from an area bounded on the north by Center Street, on the east by 45th Street, on the south by Grover Street, and on the west by 60th Street. The project reduced combined sewer flow to the Papillion Creek CSS, treatment of stormwater flow at the PCWWTP, and the volume of combined sewer flows to the proposed Saddle Creek RTB.

The project contains two green infrastructure features (Figure 2-4). A detention basin and wetland system constructed in the Westlawn Cemetery was designed to reduce the peak flow rates from the creek, reducing the required downstream pipe size. A second feature, constructed at the west end of the project between approximately 62nd and 64th Streets, is an open channel, where the flows were day-lighted to produce a more natural feature. Funding of the work in the cemetery was provided in part by a \$807,000 grant from the Nebraska Environmental Trust (NET). Funding for the open channel was provided in part by an \$810,000 grant from the Papio-Missouri River Natural Resources District (PMRNRD).

FIGURE 2-4
Green Infrastructure Projects at Bohemian Cemetery *(photos courtesy of City of Omaha and CH2MHILL)*

The 2009 LTCP identified a 78-inch storm sewer for the project. The actual constructed sizes for the project ranged from 78 to 84 inches in diameter at the upstream end to a twin 8- by 7-foot box culvert at the outlet to the Little Papillion Creek. The increase in pipe size was due in part to account for the potential flows that could be added in the future if deemed necessary from the separated areas north of Center Street at 55th and 58th Streets, as well as to accommodate separated flows south of Arbor Street and west of Westbrook Avenue, which were planned for in the 2009 LTCP.

Construction for Saddle Creek Area – 55th to 64th Street Sewer Separation project started on December 17, 2012, and was substantially complete on May 22, 2014. A significant delay in the project and cost increase occurred when a tunnel bore under 60th Street encountered flowing soils, and the specified machine could not complete the work. A custom built tunnel boring machine was required to be furnished by the contractor to complete the work.

Miller Park to Pershing Detention Basin Sewer Separation

The Miller Park to Pershing Detention Basin Sewer Separation project (OPW 51941), located in the easterly portion of the Minne Lusa Basin, diverts separated stormwater that was previously discharged into the downstream CSS, to the Pershing Detention Basin from Miller Park. More specifically, it diverts stormwater overflows from the Miller Park Pond, which is a wet detention pond, to a larger downstream detention area where water quality will be improved prior to flows reaching the Missouri River. Project work included construction of approximately 2,300 feet of 60-inch stormwater conveyance sewer between the basins. Due to topography and utility conflicts, approximately 1,260 feet was installed by microtunneling. Modifications to the existing Miller Park Pond outlet structure, and construction of a new inlet into the Pershing Detention Basin were also included in the project. This project reduces flows in the CSS and reduces the size of required downstream controls.

Construction for the Miller Park to Pershing Detention Basin Sewer Separation project started on July 8, 2013 and was substantially complete on June 8, 2014.

2.2.2.2 Major Projects under Construction

The following are descriptions of Major Projects scheduled to be under construction by October 2015.

FIGURE 2-5
Construction of Schedule B1 at the MRWWTP *(photo courtesy of CH2M HILL)*

South Interceptor Force Main

The existing SIFM was constructed in the early 1960s and has remained in continuous operation for more than 50 years. The current condition of the existing SIFM makes it unreliable for continued long-term use. Replacement is necessary to reliably convey both dry and increased wet weather flows to the MRWWTP. The new SIFM will provide the needed reliability and increased flow capacity.

A single SIFM project was envisioned in the LTCP, but the SIFM project (Figure 2-5) was designed presuming three construction projects: SIFM-North Segment (OPW 52223), SIFM-Central Segment (OPW 52222), and SIFM-South Segment (OPW 51873). The SIFM-South Segment and SIFM-Central Segment projects were bid under one construction contract. Together, these two projects include approximately 18,400 feet of 64-inch diameter pipe from the newly constructed Leavenworth Lift Station south to the MRWWTP, and various other structures and sewers, such as the South Gravity Sewer, that convey flow from the Hickory Street and Pierce Street Sewers to the Leavenworth Lift Station.

The SIFM-South Segment and SIFM-Central Segment projects began construction on January 9, 2014. The projects are expected to be substantially complete by approximately July 2015.

The SIFM-North Segment consists of approximately 4,360 feet of 48-inch diameter pipe from the north connection, located south of the I-480 Bridge, to the new Leavenworth Lift Station. The project also includes the North Gravity Sewer that will convey flow from the existing Leavenworth

Sewer to the Leavenworth Lift Station. The project includes several tunnels, with the majority of the SIFM alignment in bedrock.

The SIFM-North Segment project was bid in May 2014. Construction is scheduled to begin in late 2014, with substantial completion expected in late 2016.

MRWWTP Improvements

As noted previously, the MRWWTP Improvements project has been divided into multiple projects. Schedule A was described earlier in this section. The Schedule B1 project (OPW 51875) (Figure 2-6) will modify the plant to enable it to receive 150 mgd and to provide secondary treatment of 64 mgd. Schedule B1 includes adding a new headworks and modifying the municipal preliminary and primary treatment facilities to accept a sustained peak-hour flow of 150 mgd. This project was modified to include allowances for temporary flood protection for river stages greater than the 100-year flood.

FIGURE 2-6
Construction of the SIFM South Segment *(photo courtesy of HDR)*

The MRWWTP Improvements – Schedule B1 project started construction on April 1, 2014, and is expected to be substantially complete in the second half of 2016.

The MRWWTP Improvements – Schedule B2 project (OPW 52648) will provide disinfection of wet weather flows for CSO 102[1]. Schedule B2 includes the chlorination and dechlorination of the primary clarifier effluent prior to discharge through CSO 102 to the river during wet weather events. The MRWWTP Improvements project was modified to provide for a separate construction package to provide ground stabilization to protect the MRWWTP from the bank failure. This project is necessary to allow for construction of the chlorine contact basin and odor control facilities included in MRWWTP Schedule B2.

It is anticipated that construction of Schedule B2 will start in early 2016, following completion of the MRWWTP Improvements – River Bank Stabilization project described previously. Substantial completion is anticipated by December 2019.

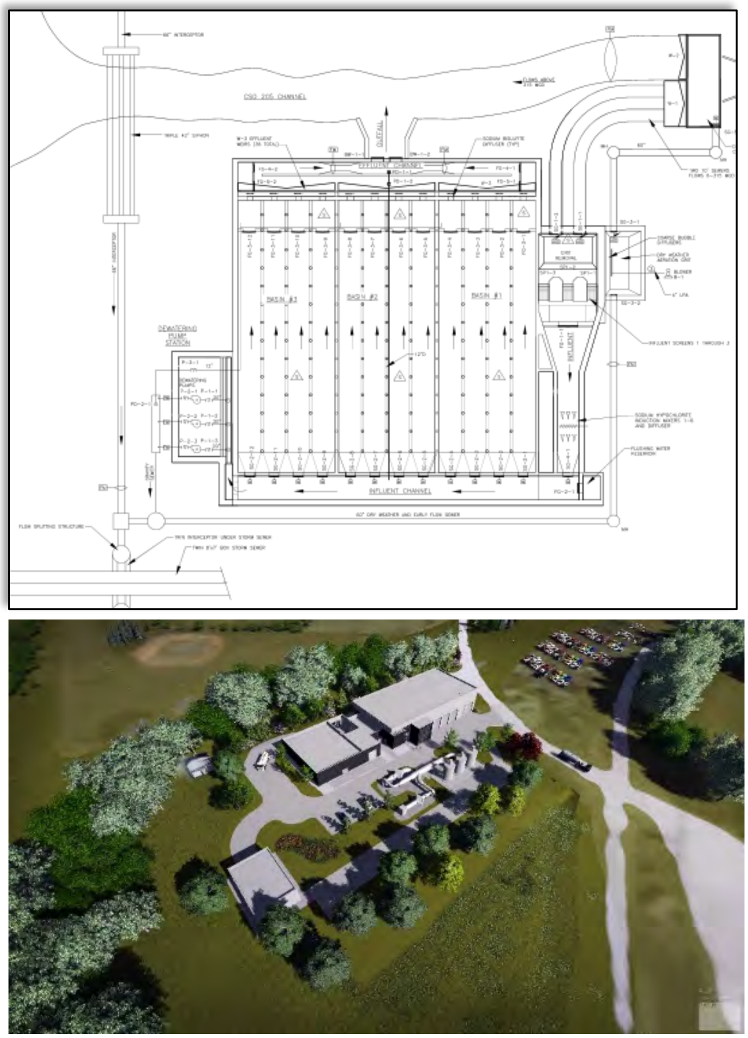
Saddle Creek CSO 205— 64th and Dupont RTB

The Saddle Creek RTB will be located at 64th Avenue and Dupont Street, and will provide treatment and disinfection of combined sewage prior to discharge to Little Papillion Creek (Figure 2-7). The

[1] Note CSO 102 is an authorized bypass of the secondary treatment system at the MRWWTP, approved by the CSO NPDES Permit.

RTB will provide an underground structure where combined sewage is stored during wet weather events and treated (grit and screenings removal, settling, chlorination, and dechlorination) before discharge. The existing grit removal facility at 64th and Dupont will be demolished and new grit facility incorporated into the RTB structure. The design will allow wet weather flow to be maximized to the Little Papillion Interceptor for conveyance to the PCWWTP where it will receive further treatment; however, gates and controls will be included to allow the flow to the interceptor to be controlled according to interceptor capacity. Maximizing flow to the interceptor will potentially reduce the hours the RTB is used and increase the percentage of capture during wet weather. Dewatering flow from the RTB will be pumped into the Little Papillion Interceptor following wet weather events. Flushing gates will be incorporated in the RTB to facilitate cleaning between wet weather events. Above-ground improvements include a building to house controls, equipment, and chemicals, and a pump station building housing dewatering pumps, and associated controls. A carbon odor control system is included to eliminate or minimize the risk of odors being released to the surrounding area.

FIGURE 2-7
Saddle Creek RTB Layout and Site *(rendering courtesy of Wade Trim)*



The RTB is being designed to accept a peak-hour flow rate of 315 mgd. While targeting a maximum flow of 315 mgd using a modulated gate, equipment and reaction time will likely allow flows of greater than 315 mgd to enter the basin for short periods of time. The sizing of the RTB will accommodate these higher flows to meet expected effluent disinfection limits. The completion of this facility will result in a significant reduction in the volume of partially treated CSO, total suspended solids (TSS), and *E. coli* bacteria entering Little Papillion Creek. Flows in excess of the facility capacity will be routed around the RTB and discharged into Little Papillion Creek.

The project is scheduled to begin construction in mid-2015 and be completed by December 31, 2018.

Minne Lusa Stormwater Conveyance Sewer and Minne Lusa Storz Detention Basin Improvements

The Minne Lusa Stormwater Conveyance Sewer and Minne Lusa Storz Detention Basin Improvements project (OPW 52004) is scheduled to be under construction by October 2015. This project includes a large-diameter (14-foot) stormwater conveyance sewer northwest from Paxton Boulevard at 30th Street east beneath the Highway 75 and Sorensen interchange, and then paralleling the north side of the Storz Expressway to the Storz/Pershing Detention Basins east of Florence Boulevard. Improvements to the Storz/Pershing Detention Basin include a concrete forebay at the tunnel outlet, an embankment around the detention basin constructed to an elevation of 1,000 feet mean sea level (msl), and twin 8- by 8-foot conduits to convey basin outflow to the Minne Lusa Channel from the north end of the basin. The conveyance sewer is designed to accommodate a peak flow rate of 2,000 cubic feet per second (cfs). Substantial completion is anticipated to occur in mid-2019.

In addition to stormwater flows from the stormwater conveyance sewer, the detention basin will receive stormwater flow from the Sorensen Sewer, Crown Point Sewer, and Miller Park to Pershing Detention Basin Conveyance Sewer. Upstream sewer control gates will be constructed in lieu of an auxiliary spillway on the embankment. A total of four gate structures will be installed for the Paxton Sewer, John A. Creighton Boulevard (JCB) Sewer, Crown Point Sewer, and Miller Park to Pershing Detention Basin Sewer. The existing Sorensen Sewer provides stormwater drainage for the Nebraska Department of Roads (NDOR) Storz Expressway right-of-way and will not be gated. A basin pool action level has been established to allow time for gate closure while maintaining sufficient basin storage to accommodate additional flows from the Sorenson sewer and direct runoff to the basin. Gate closure will be required only under very rare combinations of river levels and storm events. The basin is expected to be classified as a High-Hazard Dam. The concept for this system has been deemed approvable by the Nebraska Department of Natural Resources (NDNR).

2.2.3 Sewer Separation Projects

The following sections present Sewer Separation Projects expected to be completed by October 1, 2015, and those expected to be under construction by October 2015.

2.2.3.1 Sewer Separation Projects Completed

Following are descriptions of Sewer Separation Projects expected to be completed as of October 1, 2015.

Webster Street Sewer Separation Phase 2

The Webster Street Sewer Separation Phase 2 project (OPW 51503) involved the construction of a new trunk sewer, referred to as the Webster Street Sewer, to relieve the two existing main trunk combined sewers in the Burt-Izard Basin and to collect runoff from the local areas around the CenturyLink Center Omaha (formerly the Qwest Center) area. In addition, a new parallel 30-inch sanitary sewer was constructed to serve the Burt-Izard Basin for potential future combined sewer separation.

In 2003, the City designed and constructed an extension to the Webster Street Sewer that extended the trunk and sanitary sewers to 16th Street. During the design, a hydrology and hydraulics report was completed that identified the need to relieve flows from the southern and western portions of the Burt-Izard Watershed. As a result, it was determined that this extension would provide additional relief to the existing sewer systems in the upper extents of the basin and would reduce street flooding in the area. In addition, extension of the sanitary sewers would allow for potential future sewer separation in the basin.

The Webster Street Sewer Separation project was committed to by the City in advance of work on the 2009 LTCP due to redevelopment activity in the project area and to provide capacity for additional upstream sewer separation. It reached substantial completion on July 31, 2010.

42nd Street and X Street Sewer Separation

The purpose of the 42nd Street and X Street Sewer Separation project (OPW 50986) was to separate combined sewer flow in a portion of the Papillion Creek South Basin to reduce overall flow to the downstream CSS at CSO 209 located near 44th and Harrison Streets. Over 3,800 feet of storm sewer ranging from 15 to 60 inches in diameter were constructed to separate the area bounded by W Street on the north, approximately 41st Street on the east, Y Street on the south, and 42nd Street on the west. A new outfall storm sewer was constructed from the 42nd and X Street intersection west to Blood Creek just east of 48th Street. Existing combined sewers were rehabilitated where necessary, allowing the previously combined system to remain in place as sanitary sewers. As noted in Section 1, CSO 209 has been closed.

A permanent detention basin and vegetated filter strip were also constructed as part of the CSO Program's Green Infrastructure Program. Construction of this federal-stimulus-supported project reached substantial completion on October 13, 2010.

24th Street and Ogden Street Sewer Separation

The 24th Street and Ogden Street Sewer Separation Project (OPW 51497) is located in the easterly portion of the Minne Lusa Basin. The project provided sewer separation to this sub-basin area, and directed separated stormwater flows to the Pershing detention basin, thereby reducing peak combined flow rates and volume in the remaining combined system to CSO 105. The separated area is bounded on the north by Kansas Avenue, on the east by Florence Boulevard, on the south by Fort Street, and on the west by 25th Avenue. Substantial completion was reached on January 10, 2011.

Spring Street Sewer Separation

The Spring Street Sewer Separation Project (OPW 51784) provided sewer separation to this small sub-basin of the South Interceptor Basin. Sanitary flows were directed to the Spring Street Lift Station through the construction of a sanitary sewer. CSO 113 was converted to a stormwater discharge to the Missouri River and deactivated. Substantial completion was reached on April 13, 2011.

36th Street Sewer Separation

The purpose of the 36th Street Sewer Separation Project (OPW 51698) is to separate the existing combined sewer on 36th Street between State and McKinley Streets. The existing combined sewer on 36th Street collects both sanitary flow and stormwater flow from adjacent residential properties and from ditches adjacent to the roadway. For this project, a new 24-inch diameter storm sewer is planned to be constructed parallel to the existing combined sewer in 36th Street. Existing stormwater inlets will be disconnected from the existing combined sewer and connected to the new storm sewer. The existing combined sewer will remain in place and serve as a sanitary sewer for the area. The project reduces peak flows and volume to the Bridge Street Lift Station. Substantial completion is expected to be reached by December 2014.

Nicholas Street Phase 1 (10th Street to 16th Street)

In the Nicholas Street Phase 1 (10th Street to 16th Street) project (OPW 51892), storm and sanitary sewers were extended to provide additional sewer capacity north and west of the CenturyLink

Center Omaha, north of Nicholas Street, and to provide sewer separation for the area north from Nicholas Street on 11th Street to Clark Street. Three 9-foot-diameter storm sewers and one 24-inch-diameter sanitary sewer were extended west from Abbott Drive at approximately 10th Street to 16th Street, following an alignment approximately one-half-block north of Nicholas Street (Figure 2-8).

Both storm and sanitary sewers along 11th Street between Clark and Nicholas Streets were replaced to provide separation to this area.

FIGURE 2-8
Economy Products Building Before and During Demolition *(photos courtesy of Lamp, Rynearson & Associates, Inc.)*

As part of the project, the abandoned four-story building (Economy Products Building) near 11th and Nicholas Streets was demolished (Figure 2-9) and 11th Street was repaved. In addition to demolishing a local eyesore, contaminated soils were excavated and disposed of in accordance with all applicable rules and regulations.

Substantial completion on this project was reached on May 31, 2013.

Martha Street Sewer Separation Phase 1

This LTCP project was delivered in three construction contracts, described below by both their City project names and common names:

- Martha Street Area Residential Combined Sewer Separation (OPW 51880)
- Lauritzen Gardens Sanitary and Storm Sewer Separation (OPW 52187)
- Lauritzen Gardens Storm Sewer Grading and CSO Abandonment (OPW 52188)

FIGURE 2-9
Pipe Installation during the Nicholas Street Phase 1 Project *(photo courtesy of Lamp, Rynearson & Associates, Inc.)*

The purpose of the overall Martha Street Sewer Separation Phase 1 project was to separate combined sewer flow in the CSO 112 portion of the South Interceptor Basin and reduce overflows to CSO 112. Approximately 240 acres of the South Interceptor Basin bounded by Hickory Street on the north, the Missouri River levee on the east, Bancroft Street on the south, and South 9th Street on the west were separated as part of the project. The project was divided into two distinct areas for evaluation: the residential area and Lauritzen Botanical Gardens. Lauritzen Botanical Gardens work was completed through two contracts—Lauritzen Gardens Sanitary and Storm Sewer Separation and Lauritzen Gardens Storm Sewer Grading and CSS Abandonment, noted above.

Sanitary flows from the Martha Street Sub-basin will be routed in the future to the south through the Martha to Riverview Phase 1 and Phase 2 sanitary sewer and pumped by the (new) Riverview Lift Station into the SIFM. Flow monitoring at CSO 112 will occur until it is determined whether it can be deactivated.

The Martha Street to Riverview Lift Station Phase 1 project was constructed concurrently with the three Martha Street projects due to the close proximity of the projects and to accommodate sanitary flows from Martha Street to the Spring Street Lift Station if required. The Martha Street to Riverview Lift Station Phase 2 project will be completed in the future as part of the Riverview Lift Station Replacement project. As explained in Section 3, the sanitary flow from the Martha Street Project was originally planned to go to the new Leavenworth Lift Station; however, the discovery of an abandoned dump changed the concept and this flow will now be conveyed south to the Riverview Lift Station.

Substantial completions for the three Martha Street projects were reached on August 31, 2012; October 11, 2013; and November 20, 2013, respectively.

Nicholas and Webster Sewer Separation Phase 1

The Nicholas and Webster Sewer Separation Phase 1 project (OPW 51962) builds upon sewer separation already completed as part of the CSO Program and will be accomplished in two parts. The first part involves the construction of storm and sanitary sewer on Nicholas Street between 16th and 20th Streets (Figure 2-10). The project starts with a connection to the west end of the storm and sanitary sewers constructed as part of the Nicholas Street Phase 1 (10th Street to 16th Street) project. The second part of the project includes construction of one block of sanitary sewer tunneled in place on 15th Street from Mike Fahey Boulevard to California Street.

FIGURE 2-10
Construction of the Nicholas and Webster Phase 1 Project *(photo courtesy of City of Omaha)*

The project will divert a substantial stormwater flow to the Missouri River via the Nicholas Street Phase 1 storm sewers and reduce CSO peak flow rates and volume to the existing combined system. Sanitary flows are directed to the sanitary sewer constructed as part of the storm sewers constructed as part of the Nicholas Street Phase 1 (10th Street to 16th Street) project. Substantial completion is expected by July 2015.

CSO 211 Sewer Separation

The CSO 211 sewer separation project (OPW 51686) is also known by its City project name "Pacific Street 63rd to 66th Sewer Separation". This project included construction of a storm sewer along Pacific Street between 63rd and 66th Streets. The project provides sewer separation for a small portion of the Papillion Creek North Basin to reduce combined sewer flows to the CSO diversion structure at South 66th and Pacific Streets. Additional investigation, study and monitoring will need to be completed before CSO 211 can be deactivated. Substantial completion of the CSO 211 Sewer Separation project was reached on September 6, 2013.

Cole Creek CSO 204 Sewer Separation Phase 1

The Cole Creek CSO 204 Sewer Separation project (OPW 51995) is a multi-phase project located in the Cole Creek Basin. The project covers a 522-acre area bordered on the north by Brown Street, on the east by 52nd Street, on the south by Northwest Radial Highway and on the west by Cole Creek. This sewer separation project is the first phase of construction within the Cole Creek CSO 204 Basin and includes construction of new sanitary sewers along 63rd Street between Taylor and Spaulding Streets, and in Benson Park north of the baseball fields. Construction is expected to start in early 2015, and substantial completion is expected to be reached by September 2015. A description of the phases is included in Section 3.

2.2.3.2 Sewer Separation Projects under Construction

The following are descriptions of the Sewer Separation Projects anticipated to be under construction as of October 2015.

Missouri Avenue Sewer Separation Phase 1

The Missouri Avenue Sewer Separation Phase 1 project (OPW 51997) is also known by its City project name of Missouri Avenue/Spring Lake Sewer Separation. This overall Phase 1 and Phase 2 project will provide sewer separation to the entire 416-acre Missouri Avenue sub-basin through a combination of new storm and new sanitary sewers. Sanitary flows will be directed to the existing Missouri Avenue Lift Station while storm flows will be conveyed to the Missouri River through the existing combined sewer which will eventually be converted to a storm-only sewer following completion of the Missouri Avenue Phase 2 Sewer Separation project. This Phase 1 project includes construction of a multi-use pond within Spring Lake Park to provide detention of stormwater runoff to reduce downstream stormwater flows and to allow the continued use of the combined sewer as a storm sewer following completion of the sewer separation.

The Phase 1 project is located in the South Interceptor Basin. Substantial completion is expected to be reached by May 2016.

Nicholas Street Phase 2 (to 23rd & Grace)

The Nicholas Street Phase 2 (to 23rd & Grace) (OPW 52297) project includes the extension of one of the 9–foot-diameter storm sewers from 16th and Nicholas Streets to 16th and Clark Streets and includes local sewer separation in Charles Street from 16th Street to 20th Street. The project also includes the extension of a 24-inch sanitary sewer from 16th Street north of Nicholas Street to the 23rd & Grace Lift Station. The 23rd & Grace Lift Station will then be abandoned. It will provide separation to a significant combined sewer area thereby reducing stormwater flow rates and volume to the existing combined sewers. Substantial completion is expected to be reached by July 2016.

Gilmore Avenue Sewer Separation Phase 1 and Phase 2

The Gilmore Avenue Sewer Separation Phase 1 project (OPW 52184) was modified to also include the Gilmore Avenue Sewer Separation Phase 2 project (OPW 52184) identified in the 2009 LTCP. The combined project will provide sewer separation to an approximately 226-acre area in the Ohern/Monroe Basin and will consist of abandonment of some existing pipes, rehabilitation, and construction of new storm and sanitary sewers. The newly constructed and rehabilitated sewers will convey stormwater flow to the South Barrel and sanitary flows to the North Barrel. This separation will direct the overland creek flow entering the sewer system from Sarpy County to the South Barrel, which will convey stormwater to the Missouri River. The project incorporates green infrastructure (detention basin) that decreases the size of necessary downstream storm sewers and offers benefits to neighborhood residents. Construction is anticipated to start in spring 2015, and substantial completion is expected to be reached by September 2016.

Minne Lusa – 105-1 JCB & Miami Phase 1 and Phase 2

The Minne Lusa – 105-1 JCB & Miami Phase 1 project (OPW 52165) is also known by its City project name: JCB & Miami Street Sewer Separation. The project includes the Minne Lusa – 105-1 JCB & Miami Phase 2 project (OPW 52165) identified in the 2009 LTCP. The combined projects will separate a substantial area in the Minne Lusa Basin and direct the separated stormwater into a new wetland and dry detention basin in Adams Park (Figures 2-11 and 2-12). The project includes construction of a storm sewer to allow for conversion of the existing combined sewer to sanitary sewer within the sewer separation area. The project is bounded on the north by Maple Street, on the east by 32nd Street, on the south by Hamilton Street, and on the west by 40th Street. It will reduce the CSO flow rate and volume in the downstream combined sewer. Stormwater will eventually be diverted to the Minne Lusa Conveyance Sewer and be discharged directly to the Missouri River.

FIGURE 2-11
Adams Park as it Looks Today *(photo courtesy of CDM Smith and Vireo)*

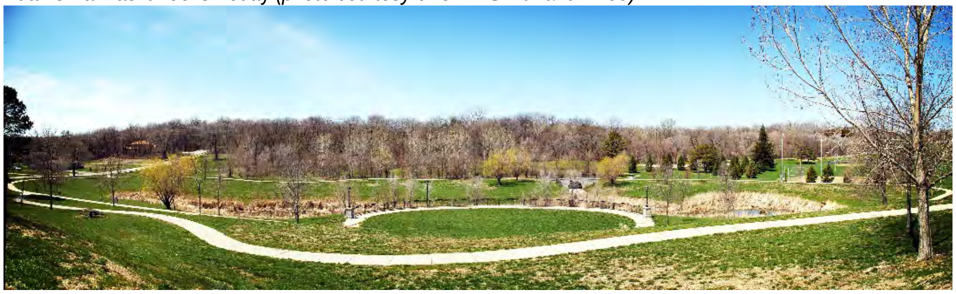


FIGURE 2-12
Rendering of Adams Park After Construction *(rendering courtesy of CDM Smith and Vireo)*

Construction started in September 2014, and substantial completion is expected by November 2016.

2.2.4 Green Infrastructure Program

The EPA defines green infrastructure as the following:

> "Green infrastructure uses natural systems and or engineered systems designed to mimic natural processes to more effectively manage urban stormwater and reduce receiving water impacts. These systems are often soil or vegetation-based and include planning approaches such as tree preservation and impervious cover reduction, as well as structural interventions such as rain gardens and permeable pavements. By maintaining or restoring the hydrologic function of urban areas, green infrastructure treats precipitation as a resource rather than waste, and can play a critical role in achieving community development as well as water quality goals."

These systems were referred to as "Stormwater Management" in the technology screening process of the 2009 LTCP. They were expanded to include a wider breadth of alternatives during the refinement period, as discussed in Section 3.4.1 of the LTCP. The terminology is used to represent an approach to stormwater management that is cost-effective, sustainable, and environmentally friendly.

These techniques include, but are not limited to, the following:

- Upland storage of stormwater in the form of detention or retention ponds, vegetated filter strips, grass swales, etc. These upland storage areas control peak rates and volumes of runoff into the combined sewers and can be constructed to reduce pollutant loads and divert stormwater away from the CSS entirely.
- Rooftop runoff management that can reduce stormwater runoff from roofs through vegetation and ponding areas.
- Porous pavement, which is a highly pervious media that can be used in place of standard impervious/paved areas to increase infiltration of stormwater into the ground, thereby reducing inflow to sewers.

These green infrastructure technologies are most efficient and economical when they target small, frequent storm events, but they are less likely to provide a noticeable reduction in CSO volume during the larger storm events that dictate the sizing of CSO controls.

The City's Green Infrastructure Program, established in 2007, is an important element of the LTCP. As part of the implementation of the CSO Program, the City developed guidance that requires that all CSO project teams evaluate green infrastructure elements as part of the design of the project. Where cost effective, these elements are incorporated into the design for construction (Appendix B).

The primary goal of the City's CSO green infrastructure effort is to reduce the flow rate and volume of stormwater entering the CSS through the use of best management practices. This volume and flow rate reduction can then reduce the size and cost of downstream infrastructure. Thus far, the CSO Program, working primarily with City of Omaha Parks, Recreation and Public Property (PRPP), has been successful in creating large-scale centralized stormwater management practices that will save Omaha ratepayers more than $30 million in gray infrastructure for CSO control. Figure 2-13 shows this regional system of centralized stormwater management that is a part of the CSO program.

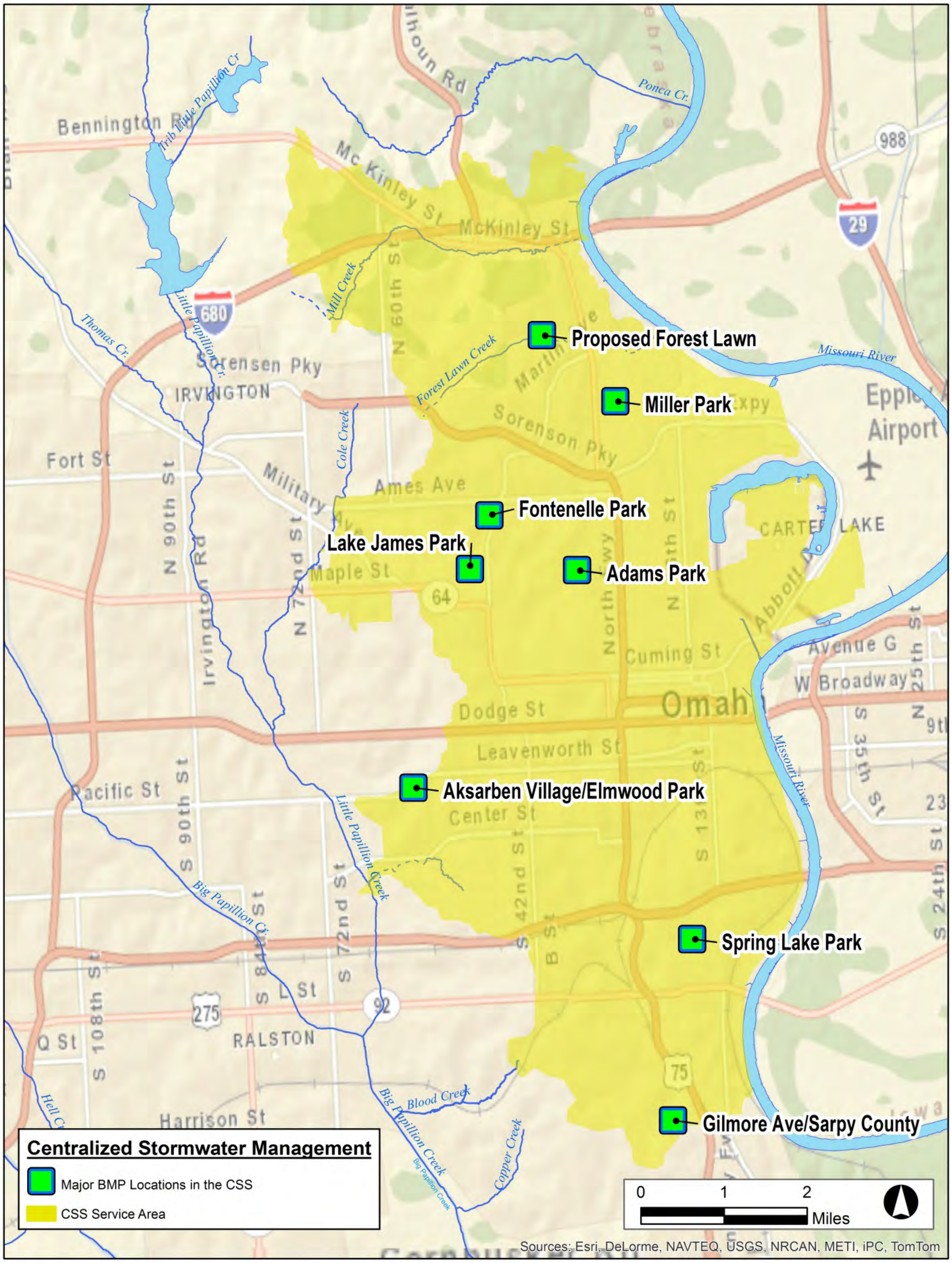
Other important activities that have occurred and continue to take place to ensure that the LTCP continues to adapt its Green Infrastructure Program include the following:

- **Coordination with EPA -** The City was selected by the EPA in 2012 to receive $70,000 for technical assistance in developing tools and guidance to identify opportunities for cost-effective green infrastructure and to ensure that it is built properly.
- **Office of Research and Development (ORD) -** The City worked directly with the EPA ORD and EPA Region 7 to study the soils in various areas of the CSS. This partnership ultimately lead to the construction of an EPA-sponsored demonstration facility at the City Sewer Maintenance Facility. The construction of the facility was funded by the Omaha Stormwater Program, with $100,000 paid for by EPA toward 3 years of data collection and monitoring by the United States Geological Survey (USGS)
- **Analysis of Additional Green Infrastructure Opportunities –** A consulting firm was selected in June 2013 to identify and evaluate potential green infrastructure projects in select areas in the CSS area that could reduce the volume of stormwater entering the CSS. A final list of potential projects to implement has been developed. These projects and possible locations are discussed in more detail in Section 3.
- **Collaboration with the City's Municipal Separate Stormwater Sewer System (MS4) Program –** A primary objective of the City's MS4 Program is to reduce the amount of pollutants entering the storm sewer system or receiving streams through contaminated

stormwater flows. Work completed by and lessons learned from the MS4 Program are crucial to the success of the CSO Program.

- **Updates to the Computer Support Tools –** The CSS model and the City's geographic information system continue to be updated to improve stormwater and green infrastructure modeling accuracy to better predict and implement improvements to the system. This is described further in Section 2.3.

FIGURE 2-13
Regional System of Centralized Stormwater Management Controls



2.3 CSS Model Update

2.3.1 Description of Model and Updates

A computer model representing the hydrologic and hydraulic elements of Omaha's combined and sanitary sewer system was created to support the development of the 2009 LTCP using InfoWorks software. Since the original model was completed in 2004 (prior to the official start of the LTCP development effort), several cycles of updating, calibrating, and extending the model have been undertaken to update the model with sewer system changes, improvements to the model's representation of the sewer system (for example, by adding detail or replacing assumptions with new data), and to prepare it to be used for a wider range of evaluations to aid effective implementation of the LTCP. Interim models are developed, such as the one mentioned in Section 3, to evaluate progress at specific points in time. The LTCP provides more detail about the development of the model. This section provides a brief overview of the model but primarily summarizes updates to the model subsequent to the LTCP submittal (*Omaha CSO InfoWorks CS Model 2010 Calibration and Model Update Technical Memorandum* [Omaha CSO Program Management Team, 2013]).

The comprehensive CSS model is organized into three model elements.

- A **hydrologic runoff** model to simulate wet-weather flows (storm runoff that enters the sewer system) in the combined and separate sanitary systems.
- A **dry-weather flow** model to simulate sanitary inflows from residential, commercial, and industrial users and groundwater infiltration.
- A **hydraulic collection system** model to simulate the separate and CSSs, and route the runoff and inflow from the previous two model elements.

The first two of these elements address the three inflow components of the model: base sanitary flow, groundwater infiltration, and runoff.

Approximately 330 square miles of land area are included in the model. About 40 square miles are modeled as combined sewer area (as of 2014), while the rest is modeled as separate sanitary sewer area. The service area is modeled in over 1,000 subareas called subcatchments, with a median size of about 30 acres. This fine level of detail facilitates distinguishing between areas with different runoff characteristics. The most challenging aspect of modeling Omaha's hydrology is that the sewer system ranges from separate sanitary to combined, and thus the amount of runoff entering the sewer system differs significantly among areas. This facet of the sewer system was captured through the use of a contributing area value. During calibration, flow monitoring data were used to help determine how much of the land area in each subcatchment is actually contributing runoff into the sewer.

Because updates have occurred in many cycles, reference to the model versions can be confusing. In general, there are three main versions of the model: one representing the sewer system in 2002 coinciding with the City's first CSO Permit (called *Existing Conditions Model*), one approximately representing the current sewer system (necessary for some evaluations and for use with new flow monitoring data) (*Current Model*), and one representing the future sewer system after implementation of the LTCP (*LTCP Model;* the name sometimes includes a future date to distinguish between the LTCP Model used for the 2009 LTCP submittal [*2024 Model*] and the LTCP Model used for this LTCP Update [*2027 Model*]). When a project is constructed, its details go into the Current and LTCP Models. When an assumption is replaced by a field measurement, the change may be needed in all of the models. If the text refers simply to "the model," it is in a context in which it is not necessary to be specific as to which database was used.

Adding Detail in Papillion Creek Watershed Separate Sanitary Sewer System

The City recently input to its geographic information system (GIS) the as-built drawings for all sewers that are 24-inch diameter and larger in the Papillion Creek Watershed, including the major interceptors in Sarpy County. The model was updated to include this detailed 24-inch diameter and larger pipe network including over 2,000 pipes, 40 siphons, and 2 sanitary lift stations: Standing Bear Lift Station, southwest of 114th and Saddlebrook Drive (on a tributary in the Big Papillion Creek Watershed) and Ridges Lift Station, southeast of 180th and West Center Road (on the Box Elder Branch of the West Papillion Creek Watershed).

Updating Population to 2010 Census Data

The original model was developed beginning in late 2003 (prior to the start of LTCP development), using 2000 census data (U.S. Census Bureau, 2000). Since that time, population shifts have occurred, and it was necessary to update the model with revised population numbers to more accurately reflect the current sanitary dry weather flow discharged to the sewer system. The model was therefore updated with 2010 census data. This change more accurately represents the current sanitary dry weather flow; however, the Existing Conditions Model is still based on 2000 census data.

The update to 2010 census population data resulted in a net increase of 42,312 people system-wide (Missouri River and Papillion Creek Watersheds) (U.S. Census Bureau, 2010). In the Papillion Creek Watershed, there was an increase of 52,739 people and a decrease of 10,427 people in Missouri River Watershed (see Table 2-3).

As part of the population update, per-capita sanitary flow rates and industrial flow contributions were reviewed and updated.

TABLE 2-3
Population Update

Basin	2000 Census	2010 Census	Change from 2000 to 2010
Little Papillion Creek Basin	39,589	42,333	2,745
Cole Creek Basin	28,167	25,750	(2,417)
Saddle Creek Basin	34,199	31,610	(2,588)
Papillion Creek North Basin	15,435	16,216	782
Papillion Creek South Basin	14,436	14,117	(319)
Big Papillion Creek Basin	128,698	139,312	10,614
West Papillion Creek Basin	124,466	158,126	33,660
South Papillion Creek Basin	34,266	49,252	14,986
Papillion Creek Basin	42,236	37,513	(4,722)
Papillion Creek Watershed	**461,491**	**514,230**	**52,739**
Bridge Street Basin	3,722	3,047	(675)
Minne Lusa Basin	51,246	42,872	(8,374)
Burt Izard Basin	28,259	25,484	(2,775)

TABLE 2-3
Population Update

Basin	2000 Census	2010 Census	Change from 2000 to 2010
Leavenworth Basin	20,389	21,423	1,035
Ohern/Monroe Basin	30,743	31,115	373
South Interceptor Basin	8,328	8,318	(10)
Missouri River Watershed	**142,686**	**132,259**	**(10,427)**
Both Watersheds	**604,177**	**646,489**	**42,312**

Updating to Reflect Recent Sewer System Changes and Increase Accuracy

In several locations recent field changes have occurred with sewer separation and other projects that required updates to the model. In addition, other updates were made to increase the model's accuracy in specific locations. The following is a summary of the projects and changes that were made.

- RNC 5209 – 50th St, Saddle Creek Road to Howard Street (1994).
- RNC 5277 – 56th and Francis Street (1996).
- SP91-19 – Saddle Creek Road from Dodge Street to Cuming Street (1997).
- RNC 5462 – Leavenworth St, 38th to Saddle Creek (1999).
- RNC 5561 – 55th St, Center Street to Mason Street (1999).
- RNC 5735 – 50th Street Phase II (Dodge to Pacific) 44th and Wakeley (2000).
- RNC 5788B – Country Club Phase 1 (2002).
- Sanitary sewer line that parallels open stream channel on Westlawn-Hillcrest Cemetery property.
- The Saddle Creek trunk sewer pipe and box culvert dimensions were updated with as-built drawings and measurements in the field. This included modeling the North and South Barrels of the Saddle Creek trunk sewers in more detail to reflect that the barrels are isolated from one another after they split from one to two barrels.
- A new diversion near 63rd and Castelar Street was added to the model network. This diversion allowed minimal flow to by-pass the CSO 205 diversion and flow directly to the Little Papillion Interceptor. The City closed this diversion in August 2010. Therefore, this diversion is included in the 2010 network of the Current Model (meters used for calibration were in place from April to August 2010), but it was removed from the 2027 network.
- The Big Papillion Interceptor Sewer Improvements West Dodge Road to Blondo Street Near 117th Street project (OPW 51586) near Miracle Hills Golf Course was not constructed when the 2010 meters were in place. Therefore, the model was calibrated based on the pipe network that was in the ground when the meters were in place. OPW 51586 was constructed in 2011 and 2012, so the 2010 pipe network in this area no longer exists. The 2027 Model network includes the new pipe configuration, including the new siphon across the Big Papillion Creek north of Blondo Street.

- RNC 5686 – 35th and Leavenworth Street, Phase 1 (portions in Leavenworth Park added to model) (2001).
- RNC 5992 – 18th and Browne (only included reconfiguration of the North Interceptor where it is crossed by a stormwater pipe) (2003).
- RNC 6061 – Webster St, 14th – 16th Street (2003).
- OPW 50762 – 26th and Grant, 20th to 27th, Lake Street to Grace Street (2007).
- OPW 51339 – Webster Street Phase 1, 16th and Webster Street to 20th and Cuming Street (2008).
- OPW 51503 – Webster Street Phase 2, (2009).

Performing Further Calibration with 2010 Data

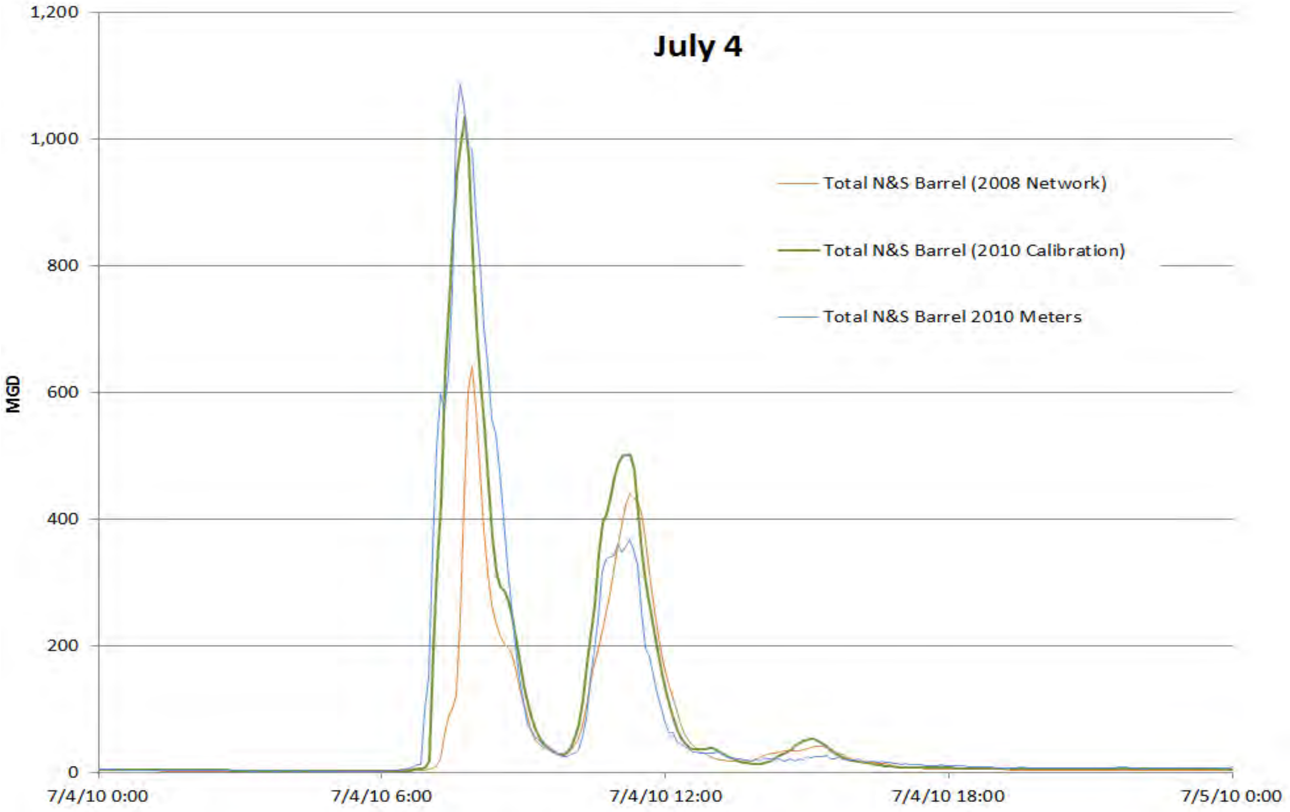
New flow monitoring data were acquired in 2010 to provide information to further calibrate the Saddle Creek Basin and Papillion Creek Watershed portions of the model. The Saddle Creek Basin had been previously monitored several times with inconsistent results, so the City elected to perform further monitoring to support calibrating to greater accuracy in this basin, where the major CSO control is a HRT facility at the downstream end of the basin and further calibration was needed to accurately size this facility. Figure 2-14 shows hydrographs of the sum of the Saddle Creek North and South Barrel flows for one of the calibration events with the 2008 network (used for 2009 LTCP) and the recalibrated 2010 network (used for the 2014 LTCP Update), along with the 2010 meter data.

At the beginning of the monitoring period (in May 2010), the model over-predicts wet weather flow. However, as the monitoring period progressed, the model corresponded to the meters better, matching or under-predicting the meters in the wet months of June and July as antecedent moisture conditions grew wetter. The 2010 calibration effort for Saddle Creek targeted the middle of this wet period and the 2010 network is therefore calibrated to slightly higher flows than were available with the 2007 meter data used for the 2008 network calibration efforts. The overall result of the revised calibration in Saddle Creek was to increase the Representative Year volume and peak rates of flows to CSO 205.

In addition, many pipes were added to the separate sanitary sewer network in the Papillion Creek Watershed, and data acquired in 2010 supported further calibration of the more detailed network. Many more locations within the Papillion Creek Watershed could be compared between the model and meter data because of the extensive monitoring effort in 2010 and the greater detail added to the model. The overall result of the revised calibration in the Papillion Creek watershed was to reduce the estimated Representative Year CSO volume at CSO 201, which is located near the PCWWTP.

Details of the recalibration effort, including many graphs are provided in *Omaha CSO InfoWorks CS Model 2010 Calibration and Model Update Technical Memorandum* (Omaha CSO Program Management Team, 2013).

FIGURE 2-14
Hydrographs of Total Saddle Creek Trunk Sewer Upstream of CSO 205 Diversion, July 4, 2010, Storm



Updating Modeled Real-Time Controls

Several lift stations along the SIFM have had variable frequency drive (VFD) motors installed for the pumps in recent years. The model was updated to reflect these changes, as well as to model VFDs at the MRWWTP lift stations that have been present for a longer period of time. The lift stations where VFD RTC logic was included are:

- Burt Izard Lift Station
- Riverview Park Lift Station
- Missouri Avenue Lift Station
- MRWWTP In-Plant Lift Station
- MRWWTP Transfer Lift Station

Portions of the model for the MRWWTP were removed from the Current and LTCP Models because they are modeled in more detail in the MRWWTP and SIFM Replica™ model created for the MRWWTP Schedules A, B1, B2, and the new SIFM designs. To promote use of the more detailed model for evaluations at the MRWWTP, the lower-resolution representation was eliminated.

Updating the LTCP Model

Multiple model databases are maintained, due to the fact that multiple time horizons need to be modeled. Most of the information about the model discussed in the previous sections refers to the current model, which reflects approximately current conditions in the sewer system. In addition, as noted previously, there is an Existing Conditions Model that represents sewer conditions in 2002, and a LTCP model that represents the anticipated sewer network at the end of LTCP implementation. Numerous changes were made to the LTCP model to reflect recent information for projects that were constructed or designed to a level of 90 percent complete. In some cases, designs that were in earlier stages of completion were added because of their importance to the overall system hydraulics. This model will continually be updated as LTCP implementation progresses. For details on the model changes for this section, consult *Omaha CSO InfoWorks CS Model 2010 Calibration and Model Update Technical Memorandum* (Omaha CSO Program Management Team, 2013).

Summary of Updated Model

Table 2-4 provides a comparison of the number of modeled elements between the 2024 Model and the 2027 Model.

TABLE 2-4
Summary of Data for InfoWorks Model Data

2009 Number	2014 Number	Model Element	Notes
5,681	8,131	Nodes	Includes manholes, blind connections, wet wells, and other chambers
6,479	9,019	Pipes	Was 416 miles of pipe, now 449 miles of pipe, primarily 24 inches in diameter and greater
1,010	1,181	Subcatchments	
40	37	Weirs	
20	26	Orifices	
45	75	Sluice Gates	20 had real-time control, now 48 have real-time control
30	37	Pumps	1 had real-time control, now 22 have real-time control (21 have variable frequency drives modeled)
11	16	Bar Screens	
22	28	Flap Gates	Prevent river intrusion into sewer system
4	41	Siphons	Siphons are primarily in the separate sanitary network

Note: Data from 2024 (v34) and 2027 (v5) InfoWorks Models.

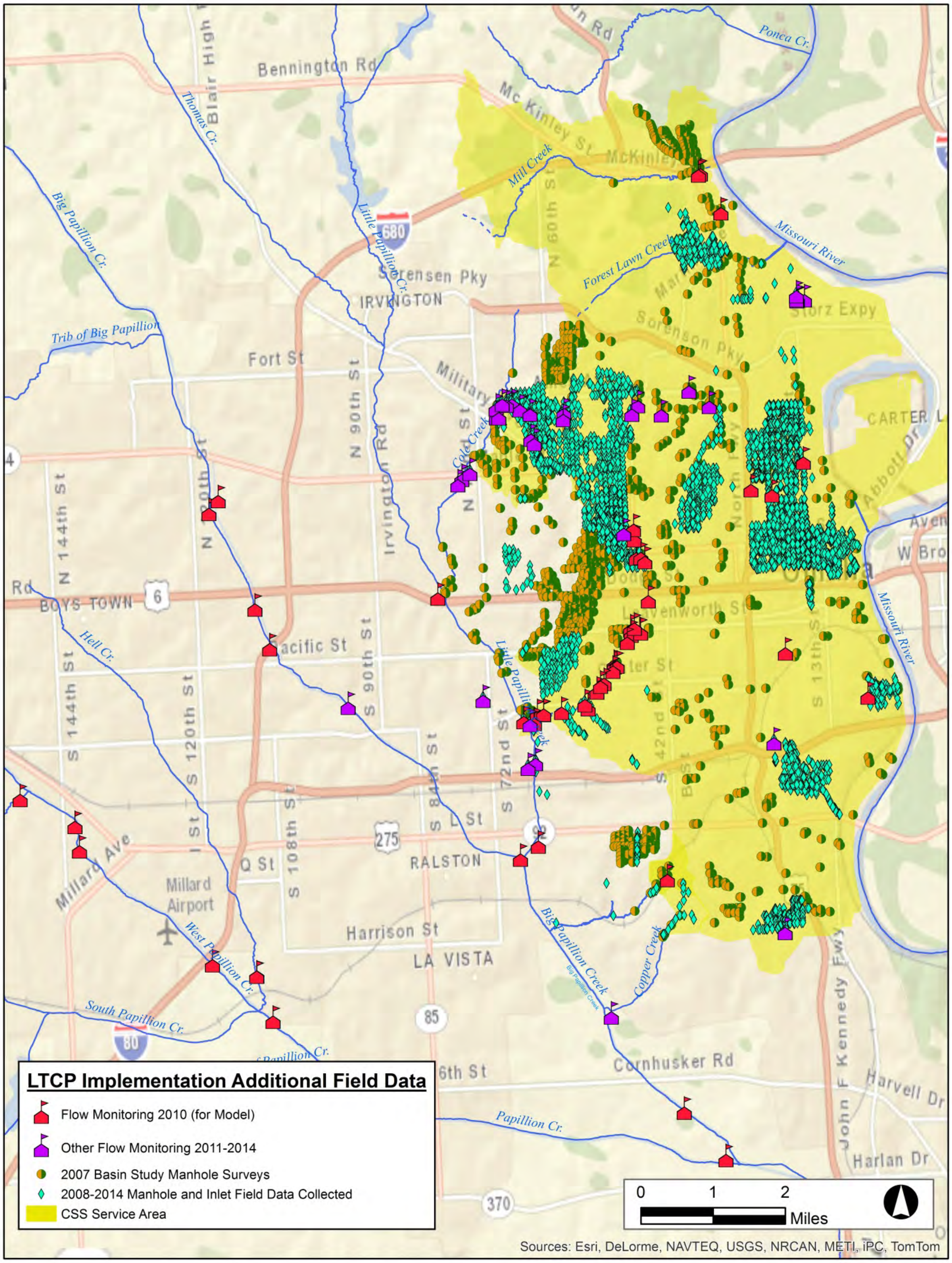
2.3.1.1 Model Calibration and Flow Monitoring

Data are collected to assess and calibrate the model. This section describes field data collection, flow and rainfall monitoring, and the storm events that were selected to use in model calibration.

Field Data Collection and Inclusion in the Model

As part of the ongoing effort to update and expand the model, field data are acquired. These data include information from field investigations such as inspections of manholes and inlets as well as flow monitoring data. Figure 2-15 displays the locations of field data that have been acquired since 2007 during planning and implementation of the LTCP. Some of these data are gathered to support project designs rather than specifically to support modeling; however, the data are available to be used to answer questions or support more detailed modeling in the future. Detailed inlet data are currently being gathered to support expansion of the modeling to include major storm sewer networks. This effort is a future enhancement discussed further in Section 8.

FIGURE 2-15
Field Data Collected During LTCP Planning and Implementation



Flow and Rain Monitoring

The City has invested more than $2 million dollars in flow and rain monitoring since the start of development of the CSS model in 2003. This has included the installation of over 150 flow meters as a part of both temporary and permanent efforts to characterize the flows in the system. Early efforts included temporary programs to characterize the system at the CSO outfalls and diversion structures and at complex interconnection points within the system, and a collaboration effort with the USGS on a water quality study to support the development of the LTCP. During development of the LTCP, additional monitoring programs were conducted within the study basins and again at outfalls, diversion structures, and complex areas of the system where additional information was needed. Radar/rainfall information has been utilized since the beginning of development of the model, in particular to provide detailed rain information for the calibration storms described in the following section.

Recent efforts include flow monitoring to support the design of projects included in the LTCP and post-construction validation of the effectiveness of completed projects. In addition, a large effort in 2010 included the installation of 35 temporary meters within the Saddle Creek Basin, collection of radar/rainfall information, installation of a permanent flow monitoring system throughout the Papillion Creek interceptor system, and establishment of a permanent rain gauge system to provide coverage throughout the CSS.

Calibration Storms

The calibration storm events were selected to provide a wide range of storm events—with low and high volumes, low and high intensities, short and long durations—because the model is used to simulate multiple years of precipitation data and it is essential that it be able to reproduce results from very different types of storm events. The 2010 monitoring season was wetter than normal (by about 40 percent in rainfall depth) and it was necessary to model periods of time that included multiple storm events. From the 5 years of monitoring, 28 calibration events were selected. More information about each of these storms is provided in Table 2-5.

TABLE 2-5
Summary of Storm Events for Calibration of InfoWorks Model

Date	Total Rainfall (inches [in])	Average Intensity (in/hour [hr])	Peak Intensity (in/hr)	Return Period (year)
4/24/2004	0.87	0.08	0.24	< 1
5/22/2004	2.67	0.45	1.79	3
5/24/2004	2.28	1.14	1.60	4
5/11/2005	2.30	0.13	0.51	< 1
5/31/2005	1.33	0.12	0.32	< 1
6/4/2005	0.62	0.21	0.52	< 1
6/24/2006	0.36	0.07	0.24	< 1
7/13/2006	0.87	0.17	0.61	< 1
7/21/2006	0.73	0.15	0.35	< 1
8/6-8/8/2006	4.48	0.19	0.34	4
5/23/2007	1.39	0.09	0.35	< 1
5/26/2007	0.99	0.20	0.60	< 1
7/18/2007	1.12	0.16	0.38	< 1

TABLE 2-5
Summary of Storm Events for Calibration of InfoWorks Model

Date	Total Rainfall (inches [in])	Average Intensity (in/hour [hr])	Peak Intensity (in/hr)	Return Period (year)
7/26/2007	2.25	0.56	1.23	2
5/10/2010	0.59	0.07	0.20	< 1
5/12/2010	0.97	0.16	0.56	< 1
6/1/2010	0.93	0.23	0.78	< 1
6/3/2010	0.11	0.06	0.07	< 1
6/5/2010	1.42	0.28	0.85	< 1
6/8/2010	1.21	0.40	0.99	< 1
6/10/2010	1.20	0.40	1.08	< 1
6/11/2010	0.27	0.14	0.25	< 1
6/12/2010	0.24	0.06	0.19	< 1
6/13/2010	0.54	0.14	0.31	< 1
6/17/2010	0.24	0.06	0.17	< 1
6/20/2010	0.90	0.06	0.20	< 1
6/22/2010	1.94	0.32	0.91	< 1
7/4/2010	2.74	0.30	1.41	2
Minimum	**0.11**	**0.06**	**0.07**	**< 1**
Maximum	**4.48**	**1.14**	**1.79**	**4**

The variation in storms is illustrated in Figure 2-16, which presents both average and peak rainfall intensities against total depth of rainfall for each calibration storm.

FIGURE 2-16
Depths and Intensities of Calibration Storms for InfoWorks Model

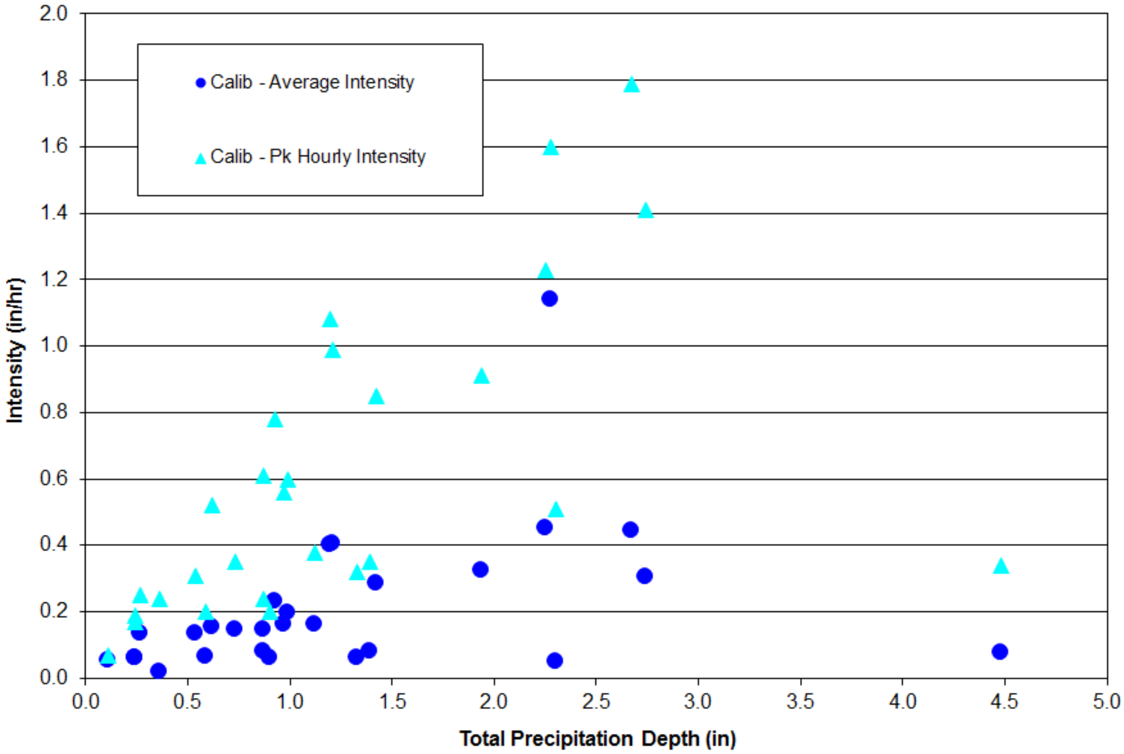
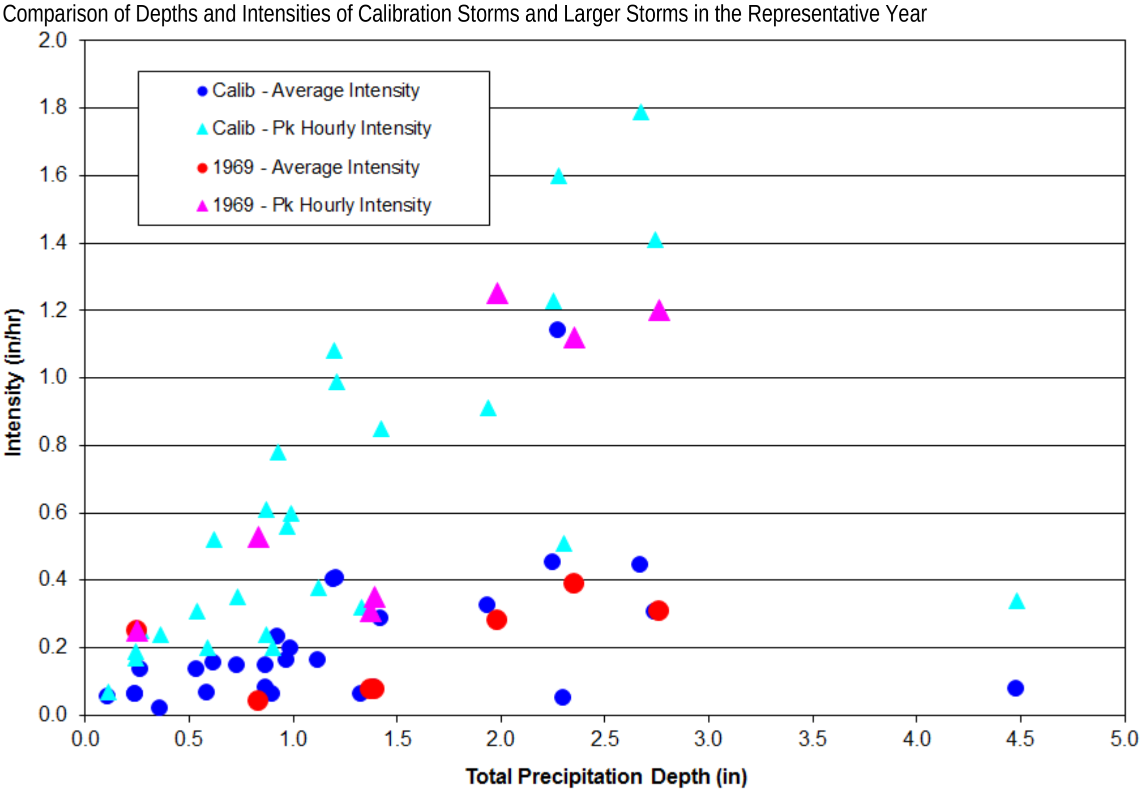


Figure 2-17 shows the same information as Figure 2-16, but plotted with similar data from the largest storms in the Representative Year of 1969 (discussed in greater detail below). The figure shows that the range of larger storms within the Representative Year matches well with the range of calibration storms, indicating that the model is calibrated for the correct scale of rainfall.

FIGURE 2-17
Comparison of Depths and Intensities of Calibration Storms and Larger Storms in the Representative Year



2.3.1.2 Outfall Summary – Frequency, Duration and Magnitude for the Representative Year Precipitation with Existing (2002) Conditions

Table 2-6 presents a summary of the frequency, magnitude, and peak flow rate of CSOs associated with each outfall under sewer system conditions as of the year 2002, which for the purposes of the LTCP is considered "Existing Conditions," because it corresponds with the date of the City's first CSO Permit. The frequency ranges from 3 to 86 CSO occurrences in the Missouri River Watershed and from 0 to 70 CSO occurrences in the Papillion Creek Watershed. The total CSO volume for the Representative Year under existing conditions was estimated to be 2,761.6 million gallons (MG) for the Missouri River Watershed and 824.1 MG for the Papillion Creek Watershed.

TABLE 2-6
Estimated CSO Frequencies, Volumes, and Peak Flow Rates for the Representative Year Precipitation under Existing Conditions[2]

Location	CSO Outfall Number	CSO Frequency (number per year)	Annual CSO Volume (MG)	CSO Peak Rate (mgd)
MRWWTP Primary Clarifier[4]	102	61	202.4	76.0
Bridge Street Lift Station	103	3	<0.1	0.4
Mormon Street	104	3	0.6	4.5
Minne Lusa Avenue	105	77	286.6	461.0
North Interceptor	106	68	514.3	148.6
Grace Street	107	63	281.6	281.9
Burt-Izard Street	108	84	485.9	661.2
1st and Leavenworth	109	55	623.7	544.2
Pierce Street Lift Station	110	24	5.1	13.6
Hickory Street Lift Station	111	3	0.2	2.8
Martha Street	112	19	3.8	13.0
Spring Street Lift Station	113	3	<0.1	<0.1
Grover Street	114	31	6.1	12.4
Riverview Lift Station	115	38	48.0	88.4
Homer Street	116	42	19.0	32.3
Missouri Avenue	117	44	44.7	71.1
South Omaha/Ohern Street	118	31	102.3	226.0
Monroe Street Lift Station	119	86	279.9[3]	410.8[3]
Jones Street	121	31	59.9	228.2
Total for Missouri River Watershed		**86**	**2,964.0**[4]	-
PCWWTP Interceptor	201	7	46.2	62.2
72nd and Bedford	202	33	10.2	17.5
69th and Evans	203	34	7.5	11.9
63rd and Ames	204	70	62.0	98.4
64th and Dupont	205	62	672.6	920.9
43rd and S Street[1]	206	0[5]	0.0	0.0
44th and Y Street	207	19	5.4	17.0
45th and T Street	208	19	0.7	1.8

TABLE 2-6
Estimated CSO Frequencies, Volumes, and Peak Flow Rates for the Representative Year Precipitation under Existing Conditions[2]

Location	CSO Outfall Number	CSO Frequency (number per year)	Annual CSO Volume (MG)	CSO Peak Rate (mgd)
44th and Harrison	209	3	0.3	2.1
72nd and Mayberry	210	35	18.9	29.0
69th and Pierce	211	3	0.1	0.9
69th and Woolworth	212	2	<0.1	0.1
Total for Papillion Creek Watershed		**70**	**824.1**	**-**

Notes:
[1] No flow from this outfall is predicted for the Representative Year under 2002 Existing Conditions.
[2] Data from 2002 Existing Conditions (v19/v20) InfoWorks Models.
[3] Total for North and South Barrels.
[4] CSO 102 – MRWWTP Primary Clarifier is a bypass rather than a CSO; however, it is included in this table because it is listed in the City's CSO Permit.
[5] CSO 206 was separated prior to 2002.

2.4 Modeling of Updated Proposed CSO Controls

The general approach to modeling the proposed CSO controls did not change from the 2009 LTCP. While the InfoWorks Model for LTCP conditions included a representation of controls such as sewer separation or the addition of diversion gates, some of the controls were evaluated using a suite of spreadsheet models that was developed to assess the performance of different types of offline facilities. This approach greatly simplifies the effort of modeling large storage facilities (which can cause instabilities in dynamic hydraulic models), reduces simulation times, and provides a realistic portrayal of the performance of the facilities. These facilities function as offline facilities, with treatment or storage occurring during a storm event and dewatering back to the wastewater treatment plant after the storm event has subsided. The spreadsheet models include versions for storage, RTBs and the CSO Deep Tunnel. InfoWorks Model hydrographs in 15-minute timesteps are input to the spreadsheets.

The operation of a storage facility is modeled as follows:

- Flow enters the facility and is stored if capacity is available; otherwise, it bypasses the facility and exits the CSS as a CSO. This element is the same for the operation of the CSO Deep Tunnel, which is an equalization storage/conveyance facility.
- When there is no longer any inflow to the facility and capacity is available at the wastewater treatment plant, the storage tank is dewatered to the existing CSS. This element is not the same for the CSO Deep Tunnel, which conveys flow to the Missouri River RTB during wet weather events, as described below.

The operation of the Missouri River RTB is modeled as follows:

- Flow enters the facility (from the tunnel) and is initially stored in the RTB.
- Once the basin is filled, the facility treats inflow up to its maximum treatment rate.
- Inflow in excess of the maximum treatment rate is stored in the tunnel if capacity is available.

- Flow that exceeds both the treatment and storage capacities is diverted around the facility as a CSO.
- When treatment capacity is available in the RTB, flows stored in the tunnel are treated and discharged. All of the flow stored in the tunnel eventually is treated through the RTB.
- The flow remaining in the RTB after the storm event has subsided is dewatered to the wastewater treatment plant when capacity is available.

The spreadsheet model for the Saddle Creek RTB was modified slightly to reflect the design of the facility. The general approach is the same as for the Missouri River RTB, but flows in excess of the RTB treatment capacity are shunted off prior to entering the facility. There is no equalization storage for the Saddle Creek RTB.

2.5 Water Quality Update

The 2009 LTCP, Sections 2.2.3 through 2.2.5, should be consulted for information relative to the Missouri River and Papillion Creek drainage basin characteristics. Section 2.3 of the 2009 LTCP provides a summary of water quality information, including the classification and water quality of streams that receive or may be impacted by CSOs. This section updates the relevant information.

2.5.1 Changes to Designated Uses and Standards of the Receiving Streams

In the 2009 LTCP, it was noted that there were five streams in the Omaha area that receive CSO discharges during wet weather events. With the deactivation of CSO 209, Copper Creek no longer receives CSO flows. This has reduced the number of streams impacted by CSOs to four. The Missouri River receives direct runoff from the portion of the City defined within the Missouri River Watershed (generally the area east of the gray dashed ridgeline noted in Figure 2-18). The other streams are within the Papillion Creek Watershed, and are tributaries to Papillion Creek, and the streams receive runoff directly from that portion of the City tributary to the specific stream. As noted previously, runoff from the Papillion Creek Watershed eventually enters the Missouri River by way of Papillion Creek.

The following are the four streams, listed below by watershed, that receive CSOs:

Missouri River Watershed

- Missouri River (currently 19 CSOs)

Papillion Creek Watershed

- Cole Creek (currently 3 CSOs)
- Little Papillion Creek (currently 4 CSOs)
- Blood Creek (currently 2 CSOs)

Figure 2-18 shows the locations of these streams in relation to the CSOs and the CSS service area. The NDEQ's designated water quality uses for these water bodies are presented in Table 2-7. The classifications have not changed since development of the LTCP.

FIGURE 2-18
Locations of Receiving and Affected Streams and CSO Deactivation Status as of October 2015

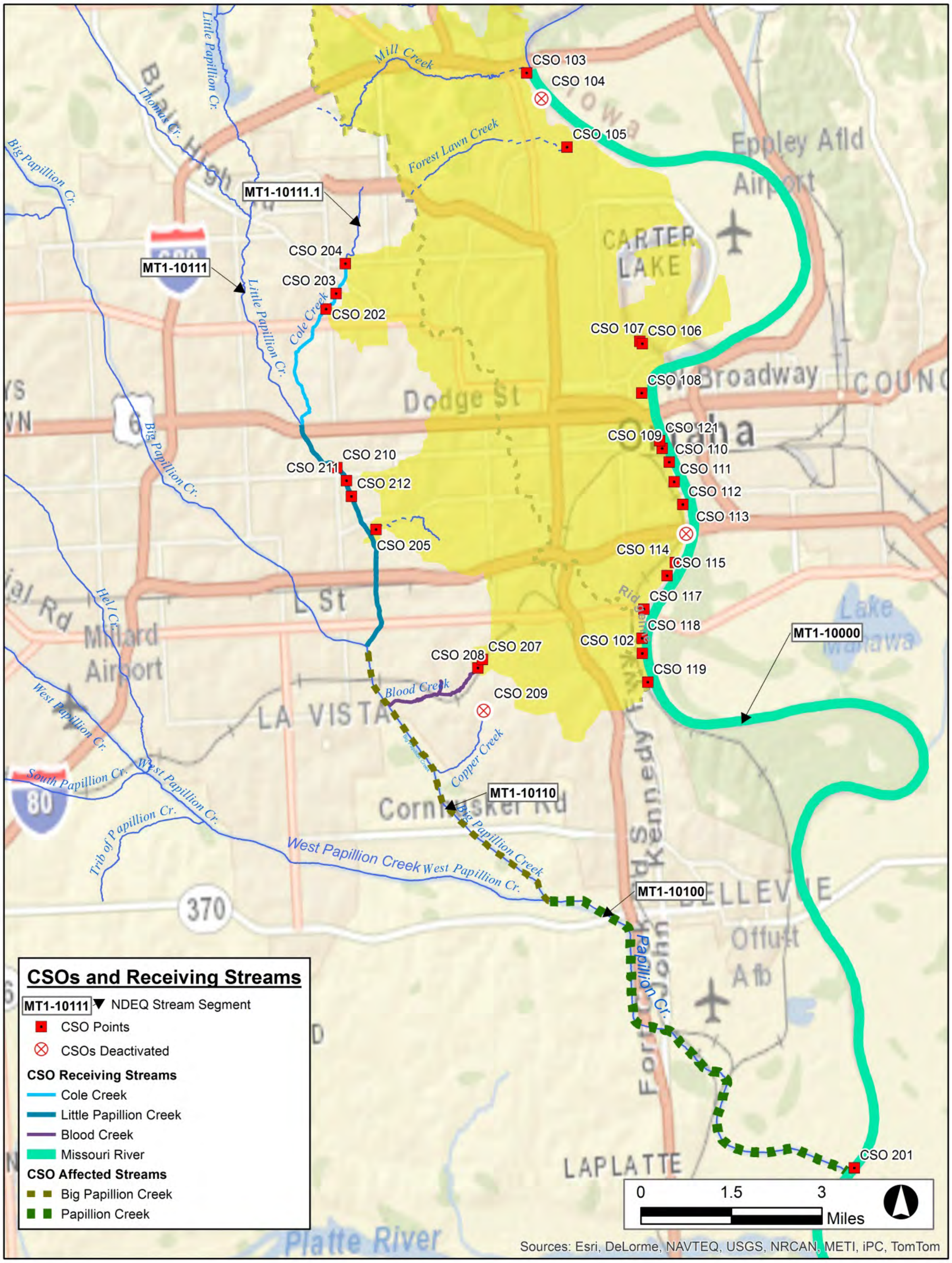


TABLE 2-7
Beneficial Use Classifications for Streams Adopted by NDEQ

Segment Name	Segment Number	Segment Description	NDEQ Beneficial Uses
Missouri River	MT1-10000	Missouri River – Big Sioux River to Platte River	Recreation Warmwater Aquatic Life Class A Public Drinking Water Agricultural Class A Industrial Aesthetics
Big Papillion Creek	MT1-10110	Big Papillion Creek – Little Papillion Creek to Papillion Creek	Recreation Warmwater Aquatic Life Class A Agricultural Class A Aesthetics
Little Papillion Creek	MT1-10111	Little Papillion Creek – Thomas Creek to Big Papillion Creek	Recreation Warmwater Aquatic Life Class B Agricultural Class A Aesthetics
Cole Creek	MT1-10111.1	Entire length	Recreation Warmwater Aquatic Life Class B Agricultural Class A Aesthetics
Blood Creek	Not designated	Not designated	Aesthetics Warmwater Aquatic Life Class B (Acute only)

The standards that protect the uses listed in Table 2-7 are included in Nebraska Administrative Code, NDEQ, Title 117 – Nebraska Surface Water Quality Standards, Chapter 4 (Title 117).

Title 117 also has established several "Key Species." These species are those identified as endangered, threatened, sensitive, or recreationally important aquatic species. They are associated with the various water bodies and their aquatic life use classes. Title 117 provides some protection for these species such as the establishment of standards for ammonia. The following are the "Key Species" in the Missouri River:

- Endangered Species:
  - Pallid sturgeon
  - *Topeka shiner*
  - Sturgeon chub
  - *Blacknose shiner*
  - *Scaleshell mussel*
- Threatened Species:
  - Lake sturgeon
  - *Northern redbelly dace*
  - *Finescale dace*

- Other:
  - Paddlefish (declining population)
  - Blue Catfish
  - Channel Catfish
  - Flathead Catfish

Species added to the list since the 2009 LTCP was developed are noted in italics. No key species have been identified for Papillion Creek or its tributaries.

2.5.2 Description of the Monitoring Programs

In the 2009 LTCP, the City of Omaha planned to collect data on the water quality of both the Missouri River and the impacted streams of the Papillion Creek watershed to evaluate trends as the LTCP was implemented. This plan has since been modified to include USGS collecting data on the Missouri River. This section summarizes the changes and the data that have been gathered. Figure 2-19 shows these monitoring points along with those CSOs that the City monitors.

2.5.2.1 United States Geological Survey

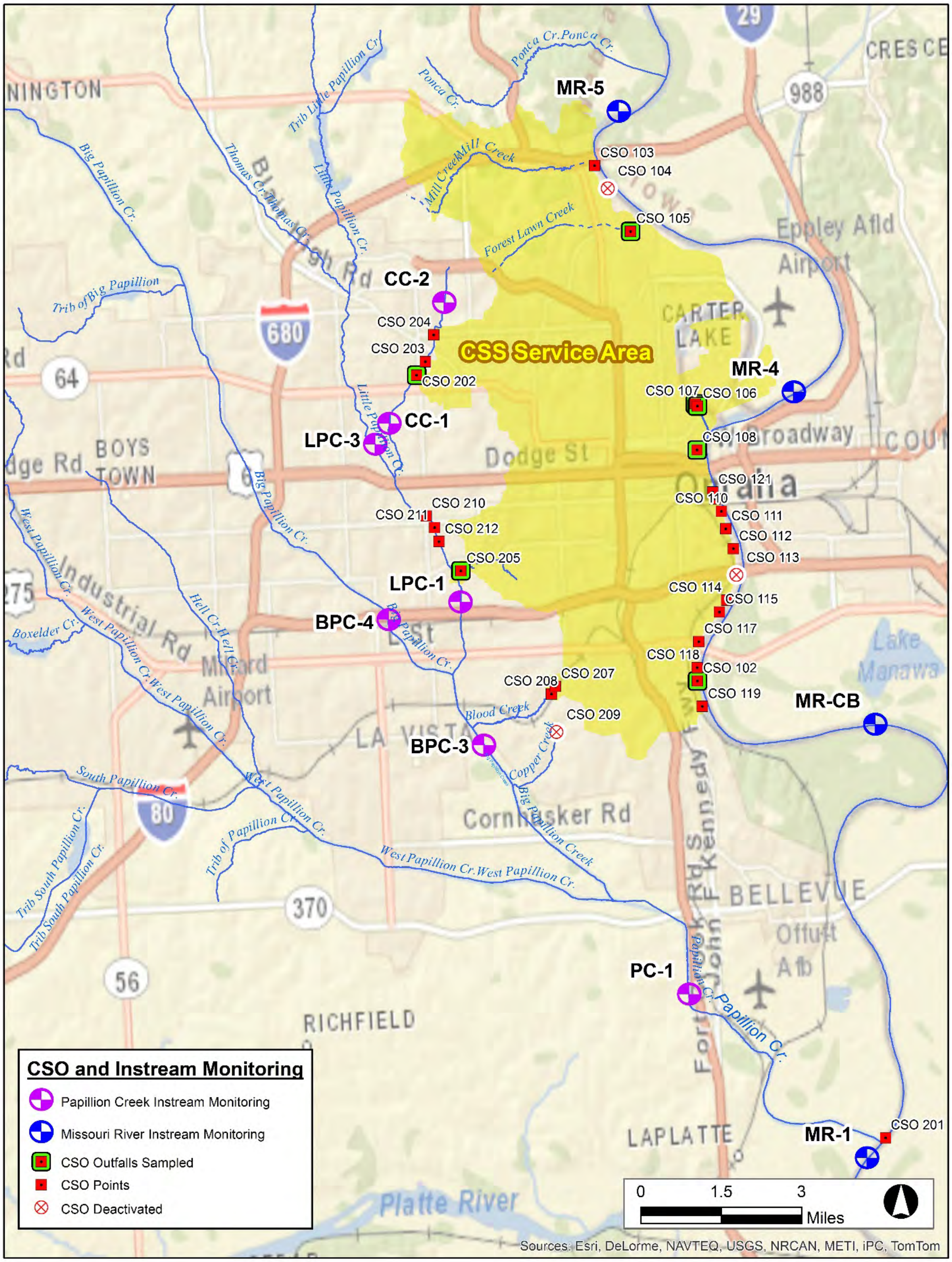
The City in 2012 requested that the USGS Nebraska Water Science Center implement a Missouri River water-quality monitoring program at selected points in the Missouri River. The following are the goals of the monitoring program:

1. Provide continuous stage and discharge records for the Missouri River at locations important to the pursuit of understanding the water quality in the river.
2. Provide continuous monitoring of selected water-quality parameters at such locations.
3. Provide monthly discrete water-quality sampling of selected compounds at such locations.

The USGS work started in 2012 operating continuous monitoring water-quality probes at four sites along the Missouri River. These sites are as follows, from upstream to downstream:

- MR-5: USGS Site Number: 412126095565201 - Missouri River at NP Dodge Park (above the City)
- MR-4: USGS Site Number: 411636095535401- Missouri River at Freedom Park (below the Airport)
- MR-CB: USGS Site Number: 06610505- Missouri River near Council Bluffs, IA (below MRWWTP and above the confluence with Papillion Creek, North/East side of the river)
- MR-1: USGS Site Number: 410333095530101 - Missouri River near La Platte (downstream of the PCWWTP and below the confluence with Papillion Creek but above the Platte River.)

FIGURE 2-19
CSO and Stream Monitoring Points



The USGS has also provided a two-person crew for monthly sampling events beginning in July 2012 at the four Missouri River sites (Figure 2-20). Field parameters obtained during monthly sampling include the following:

- Discharge
- pH
- Temperature
- Dissolved oxygen
- Specific conductance
- Turbidity

FIGURE 2-20
USGS Collecting Samples along the Missouri River (*photo courtesy of the USGS*)

Sampled parameters include:

- *E. coli* and Total Coliforms
- TSS
- Total phosphorous (colorimetric)
- Biochemical Oxygen Demand (BOD) 5-day
- Total Kjeldahl Nitrogen (TKN)
- Nitrogen, Nitrate
- Nitrogen-ammonia (liquid)
- Floating debris

These data are provided to the City on a monthly basis, and are also available on the USGS Website.

City Sampling Data

The City of Omaha is required by its NPDES CSO Permit to routinely sample six CSO outfalls, including:

- CSO 105 – Minne Lusa Avenue
- CSO 106 – North Interceptor
- CSO 107 – Grace Street
- CSO 108 – Burt-Izard Street
- CSO 202 – 72nd and Bedford
- CSO 205 – 64th and Dupont

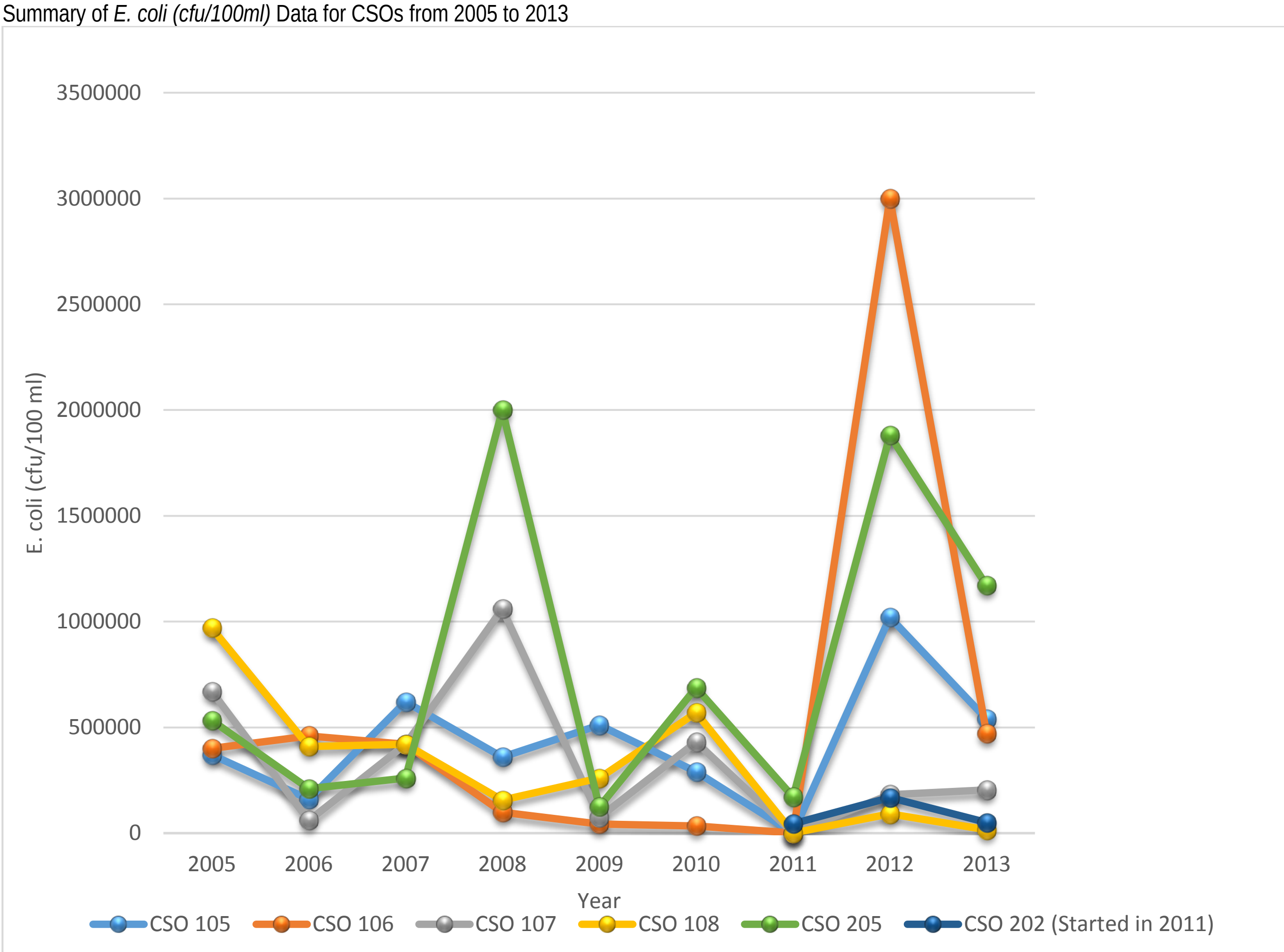
Each CSO has been sampled once each year since 2003. The permit requires that grab samples be collected. Sampling protocol requires samples to be collected within 30 minutes of the start of an overflow in an attempt to sample the initial flows from the CSO, which are thought to have the highest concentrations of pollutants. The CSO Permit also requires that the City collect CSO water quality samples to be analyzed for the following parameters:

- Flow
- Duration of discharge
- TSS
- Chemical Oxygen Demand (COD)

- BOD
- TKN
- Total phosphorus
- Chloride
- *E. coli*
- pH
- Floating solids or visible foam

Figure 2-21 provides a summary of the *E. coli* data for the CSOs since 2005. This data shows that the *E. coli* data is highly variable and further conclusions cannot be drawn at this time.

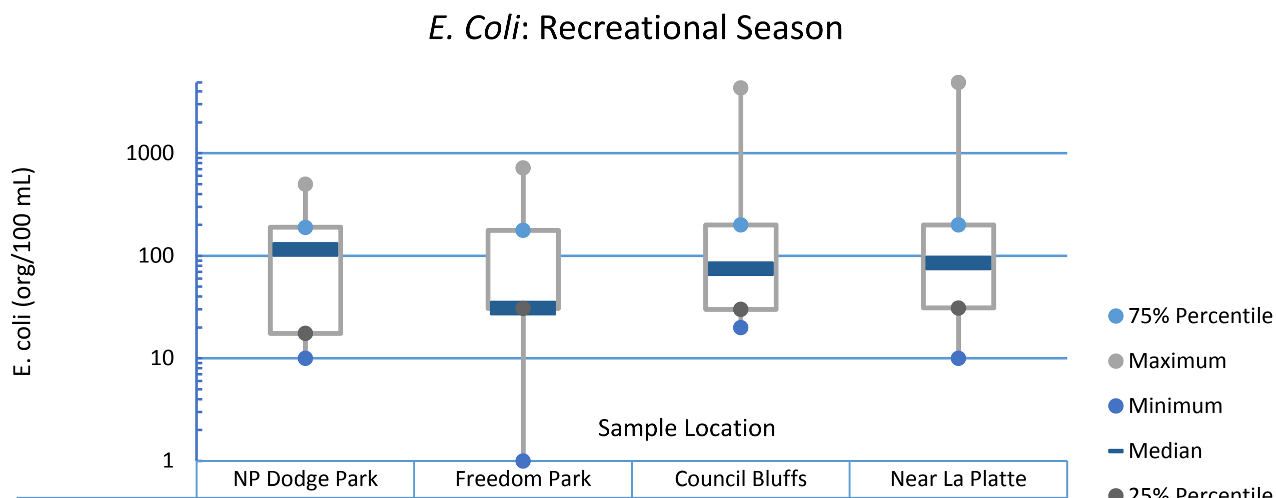
FIGURE 2-21
Summary of *E. coli (cfu/100ml)* Data for CSOs from 2005 to 2013



2.5.2.2 Missouri River Data

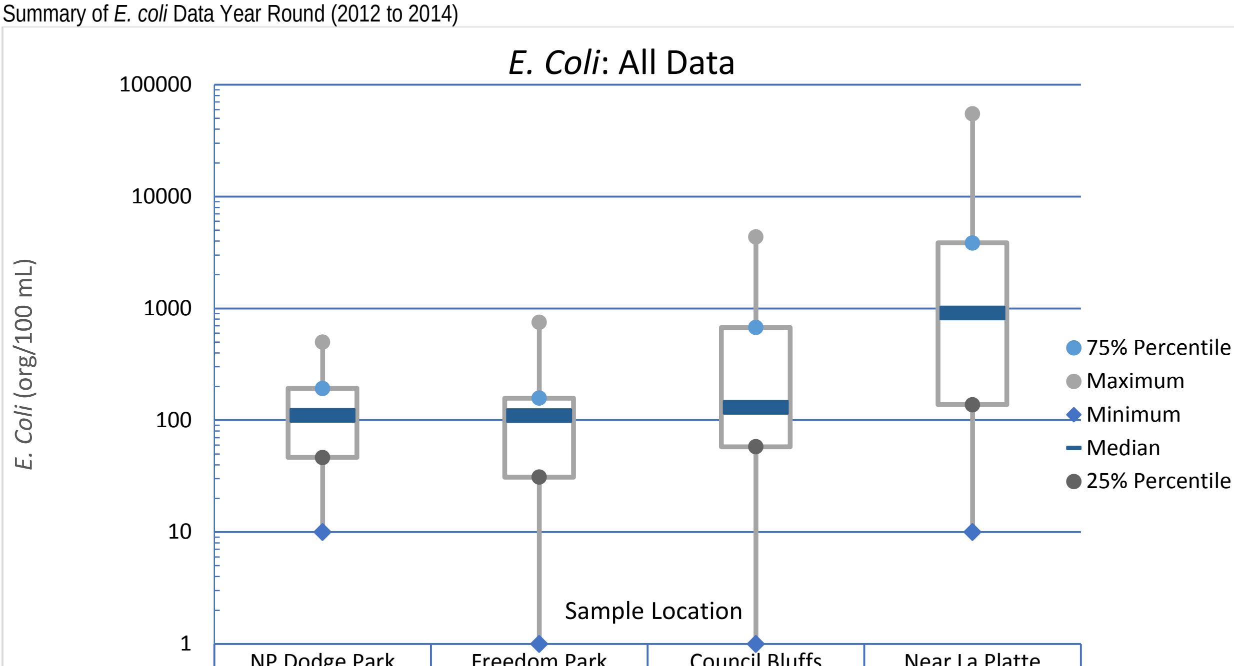
As noted previously, the City contracted with the USGS to monitor the Missouri River at four locations. The results of the data collection through March 2014 are summarized and shown in Figure 2-22 and Figure 2-23. The list of the monitoring sites is in section 2.5.2.1 above.

FIGURE 2-22
Summary of *E. coli* Data for the Recreation Season (2012 to 2014)



	NP Dodge Park	Freedom Park	Council Bluffs	Near La Platte
75% Percentile	190	177.5	200	200
Maximum	500	720	4352	4900
Minimum	10	1	20	10
Median	115	31	75	85
25% Percentile	18	31	30	31

FIGURE 2-23
Summary of *E. coli* Data Year Round (2012 to 2014)



	NP Dodge Park	Freedom Park	Council Bluffs	Near La Platte
75% Percentile	193	158	675	3850
Maximum	500	750	4352	55000
Minimum	10	1	1	10
Median	110	110	130	910
25% Percentile	47	31	58	138

Using the data collected by the USGS, the geometric mean at NP Dodge Park (Site Number: 412126095565201), which is upstream of all CSOs, was determined to be 70 org/100 mL for the recreation season and 85 org/100 milliliter (mL) for all data. (Note the geometric mean is not shown on Figures 2-22 and 2-23.) This geometric mean for all of the data will be used in the water quality model for upstream ambient data, as it is more conservative.

In addition, two conclusions can be drawn:

1. In general, *E. coli* levels upstream of the City are of good quality and meet the water quality standard for *E. coli* during the recreation season. Downstream of the City, the values in general increase.
2. The *E. coli* data can vary significantly depending on wet weather in the upper portions of the Missouri River drainage basin.
3. Increases in *E. coli* levels at Council Bluffs and La Platte reflect the discharges of the WWTPs during non-recreation season when disinfection is not practiced.

2.5.3 Missouri River Drainage Basin Water Quality Standards

The NDEQ divides the Missouri River into four segments in Nebraska called NI1-10000, MT2-10000, MT1-10000, and NE1-10000. These segments are described as follows and are shown in Figure 2-24:

- **NI1-10000: Missouri River:** Nebraska-South Dakota border (Sec 21-35N-10W) to Niobrara River
- **MT2-10000: Missouri River:** Niobrara River to Big Sioux River
- **MT1-10000: Missouri River:** Big Sioux River to Platte River (this segment flows past the City of Omaha)
- **NE1-10000 Missouri River:** Platte River to Nebraska-Kansas border (Sec 32-1N-19E)

Every 2 years, NDEQ evaluates the streams in Nebraska and makes a determination as to whether they are exceeding the state's water quality standards. A list of the segments in violation of the standards is then developed. This list is known as the 303(d) List, referencing the section of the CWA that requires the list to be developed. A 303(d) List has been developed by NDEQ every 2 years since 1998, with the most recent in 2014. These lists are included in a *Water Quality Integrated Report*. Table 2-8 lists the Missouri River segments described above and whether they were listed in the *2008 Water Quality Integrated Report* (NDEQ, 2008) which would have been reflected in the 2009 LTCP and whether they are listed in the *2014 Water Quality Integrated Report* (NDEQ, 2014). The NDEQ's listing criteria uses all data available through its sampling as well as sampling performed by others and does not differentiate between samples collected during wet weather (when there is precipitation) and dry weather.

TABLE 2-8
Missouri River Segments and 303(d) List Status

Segment	Description	Listed in 2008 NDEQ Report?	Listed in 2014 NDEQ Report?	Parameters of Concern for LTCP Update
NI1 – 10000	Missouri River – Nebraska-South Dakota border (Sec 21-35N-10W) to Niobrara River	No	No	
MT2 – 10000	Missouri River – Niobrara River to Big Sioux River	No	No	

TABLE 2-8
Missouri River Segments and 303(d) List Status

Segment	Description	Listed in 2008 NDEQ Report?	Listed in 2014 NDEQ Report?	Parameters of Concern for LTCP Update
MT1 – 10000	Missouri River – Big Sioux River to Platte River (this segment flows past the City of Omaha)	Yes	No	Listed in the 2012 Report for both Cancer Risk and Hazard Index Compounds. A new Fish Consumption assessment determined full support for the aquatic life use.
NE1 – 10000	Missouri River – Platte River to Nebraska-Kansas border (Sec 32-1N-19E)	Yes	Yes	Segment is listed for *E. coli*

The two segments upstream of the City, NI1-10000 and MT2-10000, were not listed in 2008 or 2014. This suggests that the Missouri River above the City continues to meet the water quality standards and has for some time. The Missouri River does carry a large suspended solids load, which the public often assumes is suggestive of a "dirty river"; however, the NDEQ has not established water quality standards for solids. Figure 2-25 is a photo of the Missouri River near the MRWWTP. Data collected by the USGS also suggested that individual samples may have exceeded the standard; however, actual compliance with water quality standards is determined by the preponderance of data, and compliance with the bacteria standard is determined by calculation of the geometric mean of all available data.

Historic NDEQ water quality data from sampling locations upstream of the City suggest that the Missouri River is in compliance with the standards as it comes into the City.

MT1-10000 is the segment of the Missouri River into which the City's CSOs discharge either directly or indirectly through the Papillion Creek Drainage, as shown in Figure 2-18. Segment MT1-10000 of the Missouri River was listed for dieldrin and polychlorinated biphenyl (PCB) contamination as well as for *E. coli* in 2008. *E. coli* was removed in the 2012 report, but he segment was still listed for dieldrin and PCBs. The 2014 report shows that the segment is now in compliance with all water quality standards, including *E. coli*.

FIGURE 2-25
Missouri River at the MRWWTP *(photo courtesy of CH2M HILL)*

In addition to the various streams receiving CSO discharges, several lakes in the CSS have been or will be impacted by CSO projects as a result of green infrastructure. These lakes are included in Table 2-9 along with whether they are listed.

FIGURE 2-24
Missouri River Stream Segments Established by NDEQ

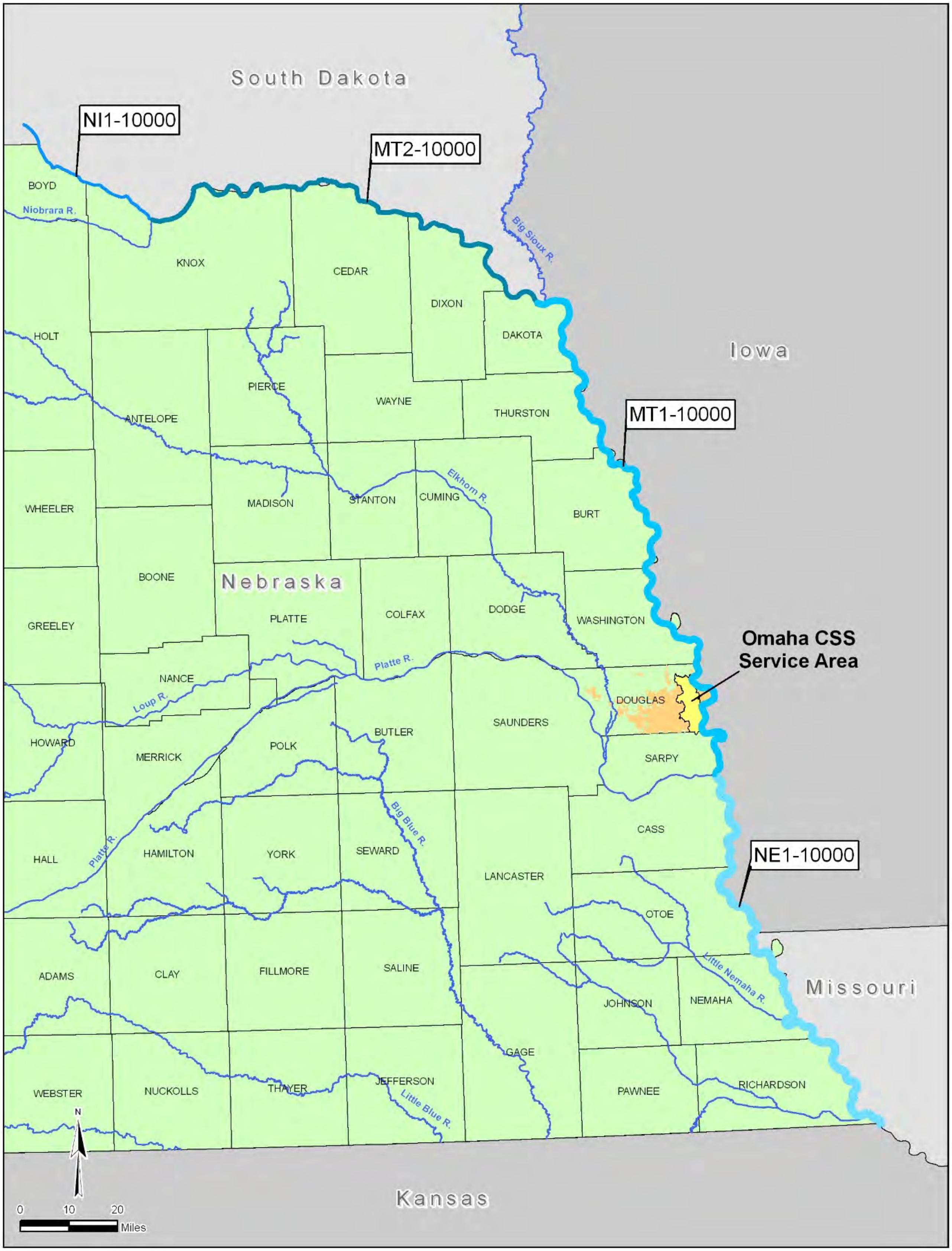


TABLE 2-9
Lakes and 303(d) List Status

Lake	Segment	Listed in 2008 NDEQ Report?	Listed in 2014 NDEQ Report?	Parameters of Concern for LTCP Update
Hitchcock Park Lake	MT1-L0040	No - Not evaluated by NDEQ	Yes	Aquatic Life – pH; Pollutants of concern unknown, Total Phosphorus and Total Nitrogen not assessed
Hanscom Park Lake	MT1-L0060	No - Not evaluated by NDEQ	No	
Fontenelle Park Lake	MT1-L0070	No - Not evaluated by NDEQ	No	
Miller Park Lake	MT1-L0110	No - Not evaluated by NDEQ	Yes	Aquatic Life – pH; Pollutants of concern unknown, Total Phosphorus and Total Nitrogen not assessed
Benson Park Lake	MT-L0080	Not on the NDEQ list	No	

2.5.3.1 Papillion Creek Drainage Basin

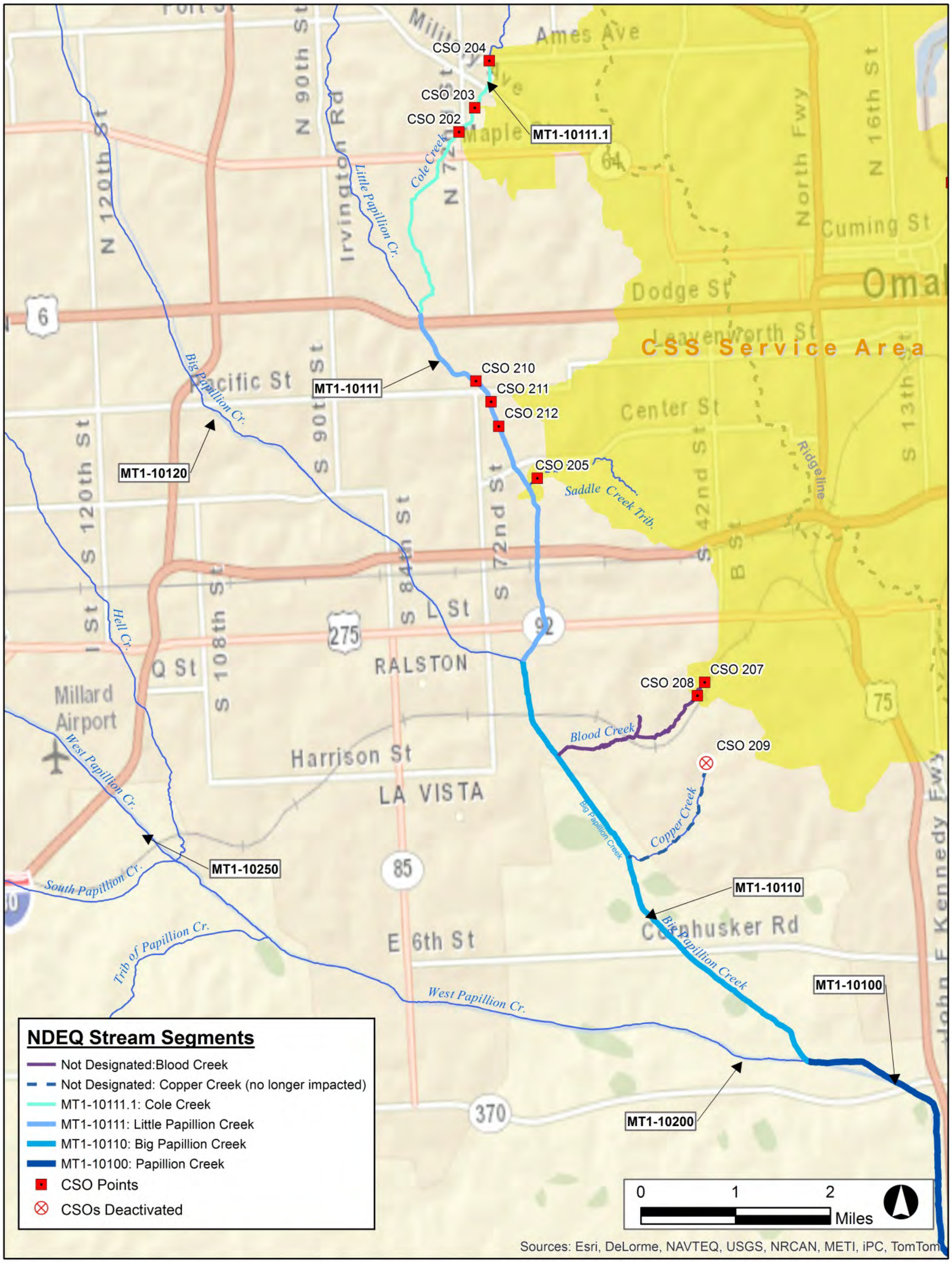
As noted previously, the NDEQ periodically reviews the water quality of the receiving waters, and segments not meeting the water quality standards are included on the 303(d) List. Table 2-10 lists the stream segments, whether they are included on the 303(d) List, and for which parameters of concern (pollutants) they are listed for the Papillion Creek Watershed. The stream segments are shown in Figure 2-26.

TABLE 2-10
Papillion Creek Drainage Basin Segments and 303(d) List Status

Stream	Segment	Listed in 2008 NDEQ Report?	Listed in 2014 NDEQ Report?	Parameters of Concern for LTCP Update
Papillion Creek	MT1-10100	Yes	Yes	*E. coli*, selenium
Big Papillion Creek	MT1-10110	Yes	Yes	*E. coli*
Blood Creek	Not designated	NA	NA	None
Copper Creek	Not designated	NA	NA	None
Little Papillion Creek	MT1-10111	Yes	Yes	*E. coli*
Cole Creek	MT1-10111.1	Yes	Yes	*E. coli*, dissolved oxygen

As noted in Table 2-10, nearly all of the tributaries to Papillion Creek are listed for impairment of water quality standards due to elevated *E. coli* bacteria counts. It should be noted that these segments are part of a Total Maximum Daily Load (TMDL) that was developed by NDEQ in 2008. The TMDL notes that the City's implementation of the LTCP meets the requirements of the TMDL.

FIGURE 2-26
Stream Segments for Papillion Creek as Established by NDEQ



2.5.3.2 Papillion Creek Tributaries Data

The City performs sampling of the Papillion Creek tributaries at various points. This data is provided in the CSO annual reports provided to NDEQ to summarize the CSO program for each year. Table 2-11 provides a summary of the E. coli data that was collected from 2011 to 2013. As can be noted in the table, the tributaries are above the water quality standard of 126 organisms (org)/100 mL for *E. coli*.

TABLE 2-11
Papillion Creek Tributary Data (2011 to 2013)

Monitoring Point	Description	Median	Geometric Mean	Minimum	Maximum
CC-1 (Cole Creek)	Upstream of CSO discharge points	4,352	3,349	171	58,326
CC-2 (Cole Creek)	Downstream of CSO discharge points	5,599	4,074	105	241,960
LPC-1 (Little Papillion Creek)	Downstream of CSO discharges and upstream of confluence with Big Papillion Creek	875	976	155	10,811
LPC-3 (Little Papillion Creek)	Upstream on confluence with Cole Creek (upstream of CSOs)	2,247	1,502	11	58,372
BPC-3 (Big Papillion Creek)	Downstream of confluence with Little Papillion Creek and respective CSOs	3,714	3,568	231	38,730
BPC-4 (Big Papillion Creek)	Upstream of the confluence with Little Papillion Creek (upstream of CSOs)	2,419	2,287	150	86,640
PC-1 (Papillion Creek)	Downstream of the confluence with Big Papillion Creek and all respective CSOs	669	895	112	198,630

2.5.4 Missouri River

Table 2-12 lists the low flows for the Missouri River upstream of the MRWWTP. This data are updated from what was presented in the 2009 LTCP, and were used in the water quality evaluation described in Section 3.0 and is from the NDEQ evaluations done as part of the renewal of the Missouri River Wastewater Treatment Plant NPDES Permit.

TABLE 2-12
Low Flows in the Missouri River, as defined by the NDEQ

Statistical Low Flow	Spring Flow (March 1 to May 31) (cfs)	Summer Flow (June 1 to October 31) (cfs)	Winter Flow (November 1 to February 29) (cfs)
1Q10[1]	11,983	15,564	11,103
7Q10[2]	13,241	16,168	13,432
30Q5[3]	20,893	24,348	15,568

[1]The 1Q10 is the lowest 1-day average flow that occurs (on average) once every 10 years.
[2]The 7Q10 is the lowest 7-day average flow that occurs (on average) once every 10 years.
[3]The 30Q5 is the lowest 30-day average flow that occurs (on average) once every 5 years.

2.5.5 Papillion Creek Drainage Basin

2.5.5.1 Hydrology and Physical Characteristics

Table 2-13 shows the 7Q10 low flows that were calculated by the City under the 2009 LTCP for the streams in the area that are impacted by CSOs. Several of the streams have little or no flow in low flow conditions. These flow values are not updated from the 2009 LTCP.

TABLE 2-13
Low Flows in the Papillion Creek Watershed, as Calculated by the City

Stream	7Q10 Low Flow (cfs)[1]
Cole Creek	0
Little Papillion Creek	0.9
Big Papillion Creek	33
Blood Creek	0
Copper Creek	0
West Papillion Creek	127

[1]The 7Q10 is the lowest 7-day average flow that occurs (on average) once every 10 years.

2.6 Sensitive Areas Description

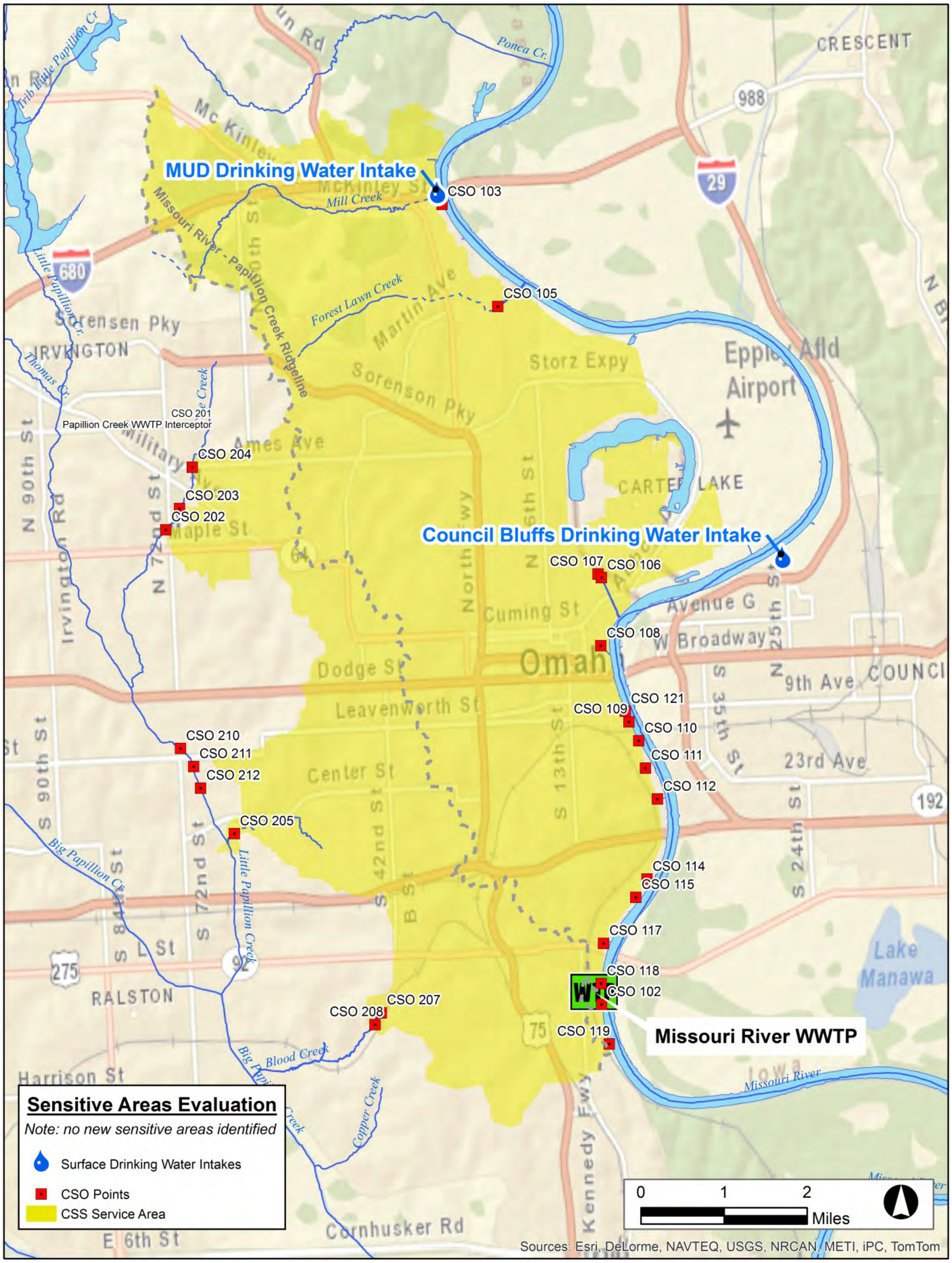
The City has updated the original evaluation regarding the presence of sensitive areas, as defined by the EPA CSO Control Policy, within the vicinity and downstream of CSO discharges (Figure 2-27). Copies of Sensitive Area Letters to and from Agencies are included in Appendix I. This was done to comply with Part V. C. - Consideration of Sensitive Areas as required in the CSO Permit. The requirement states that “By October 1, 2014, the City must submit a report to the NDEQ on reassessment of overflows to sensitive areas in those cases where elimination or relocation of the overflow is not included in the 2009 LTCP. The reassessment shall be based on consideration of new or improved techniques to eliminate or relocate overflows or changed circumstances that influence economic achievability.”

The LTCP Update revisited the analysis of sensitive areas within the receiving streams, based on the criteria in the EPA CSO Policy and other EPA guidance, sensitive use areas which includes the following:

- Public drinking water intakes
- Swimming beaches, designated as such by the appropriate state or local health department or other agency
- Waters with existence of threatened or endangered species, or their designated critical habitat, specifically the pallid sturgeon

The EPA CSO Control Policy also requires the identification of Outstanding National Resource Waters, National Marine Sanctuaries, and shellfish beds. At the time of the LTCP Update, as found at the time of the LTCP, none of these three types of waters is found in the Omaha area. Further detail is provided below.

FIGURE 2-27
Location of Drinking Water Intakes



2.6.1 Public Drinking Water Intakes Update

Based on contacts made with the appropriate Nebraska and Iowa agencies, no new drinking water intakes in the vicinity or downstream of Omaha's CSOs were identified. As part of updating the LTCP sensitive areas analysis, follow up correspondence was sent to the Nebraska Department of Health and Human Services to confirm there are no new surface water intakes on the Nebraska side of the Missouri River downstream of the Metropolitan Utilities District (MUD) Florence Water Treatment Plant. The MUD Florence Water Treatment Plant is on the Missouri River upstream of the CSO points as shown in Figure 2-27. There are still no drinking water intakes on Papillion Creek or its tributaries.

According to the Iowa Department of Environmental Quality, the City of Council Bluffs has a surface water intake in the Missouri River located near the Council Bluffs Water Treatment Plant, on the north side of Council Bluffs and south of Eppley Airfield along the east side of the River as shown in Figure 2-27. At the time of updating the LTCP and sensitive areas analysis, follow-up correspondence was sent to the Iowa Department of Public Health to confirm there are no new public drinking water intakes on the Iowa side of the Missouri River.

CSO 105 – Minne Lusa Avenue is the only CSO outfall that regularly discharges on the Missouri River above the Council Bluffs intake.

In addition to domestic surface water supplies, an evaluation was done to determine if there are drinking water wells under the influence of surface water in Nebraska. It was determined that there are a number of groundwater wells south of the City along the Missouri River, but these wells are for industrial or irrigation uses and not for a domestic supply. Therefore, their use should not be affected by the CSO discharges.

At the time of development of the 2009 LTCP, Nebraska City had a groundwater well that was influenced by the Missouri River, but it was not a direct intake from the river. As part of updating the LTCP and sensitive areas analysis, the locations and types of registered groundwater wells in the Omaha area were reviewed using the NDNR online geospatial interface, to confirm there are no new active domestic wells in areas impacted by CSOs.

Two of the CSOs above the intake (CSO 103 – Bridge Street Lift Station and CSO 104 – Mormon Street) do not regularly discharge. Although the Council Bluffs intake is located downstream of the remaining CSO discharge (CSO 105 – Minne Lusa Avenue), an impact to the Council Bluffs Water Treatment Plant intake water quality is unlikely. It is probable as a result of the large Missouri River flow velocity, low CSO discharge velocity, and relatively small CSO volume (as compared to Missouri River flows) that the CSO impacts do not extend across the Missouri River and impact the drinking water intake.

As noted in the 2009 LTCP, the belief was similarly stated that the flow from the remaining CSO above this location, CSO 105 – Minne Lusa Avenue, does not have sufficient outfall velocity to overcome the velocity of the Missouri River to the extent that there would impact along the Missouri River's eastern shoreline. Initially the City had planned on the construction of the first phase of a storage tank for CSO 105 early in the Program. However, through additional study of the Minne Lusa Basin it became uncertain whether a tank would be the most cost effective solution for addressing the discharges from this CSO. As such, the construction of the tank has been moved to late in the implementation schedule. However, several projects are planned for the next several years which will result in a significant reduction in the overflow volumes from CSO 105. These include the following:

JCB & Miami Sewer Separation Phase 1 and 2/Adams Park - This project is under construction. Originally this project was not scheduled to start construction until 2017. Sewer separation will result in a reduction in the volume of CSOs. In addition, modifications at Adams Park will result in the reduction of peak flows into the sewer system, also resulting in a reduction in the volume of CSOs.

Minne Lusa Stormwater Conveyance Sewer – This project is under final design. It will remove stormwater from the Minne Lusa Basin resulting in fewer overflows from CSO 105. Connections to the tunnel from the JCB and Paxton areas are also currently under design.

Paxton Conveyance Sewer – The first phase of this multiphase project is currently under design. This project will result in the removal of stormwater from the system. This will result in reduction in peak flows, therefore reducing the volume of overflows from CSO 105 – Minne Lusa Avenue.

Forest Lawn – This project is currently under design. The purpose of this project is to remove a creek from the CSS, which will reduce the volume and frequency of the CSOs.

2.6.2 Recreational Uses Update

At the time of development of the 2009 LTCP, no designated swimming beaches along the Missouri River or Papillion Creek and its tributaries existed. This is primarily the result of barge traffic on the Missouri River that is not conducive to supporting designated swimming beaches during the summer season. Beaches are not encouraged on rivers that are open for navigation since the large commercial vessels would endanger swimmers.

As part of updating the LTCP and sensitive areas analysis, updated aerial photographs of these recreation areas were evaluated to confirm that there were no new swimming beach areas. Based on this review, it was concluded that there are no swimming beaches located within the vicinity or downstream of the CSO outfalls. There are no designated swimming beaches within the Papillion Creek Drainages.

2.6.3 Threatened or Endangered Species

To re-confirm the existence of federal or state listed threatened or endangered species that would be impacted by CSO discharges, as part of the LTCP Update, the Nebraska Game and Parks Commission and the United States Fish and Wildlife Service were contacted. Table 2-14 lists the species of concern. Since the time of development of the LTCP, the pallid sturgeon's spawning timeframe has been refined to be March 1 through June 30. No other changes in species occurred since 2009.

TABLE 2-14
Species of Concern Identified by the Nebraska Game and Parks Commission

Species Name	Location	Type of Listing
Pallid Sturgeon	Missouri and Platte Rivers	Federal and state endangered
Lake Sturgeon	Missouri River	State threatened
Sturgeon Chub	Missouri River	State endangered
Blue Sucker	Missouri River	Tier 1 species

The pallid sturgeon is the only federally-listed endangered fish species whose habitat is the Missouri River. Pallid sturgeon are known to concentrate at the confluence of the Missouri River and the Platte River but are found uniformly along the river, occupying the edge between deep and shallow, and rocky and sandy. The lake sturgeon, sturgeon chub, and blue sucker are found in similar locations in the Missouri River.

2.6.4 Summary of Sensitive Area Analysis

As a result of this analysis, it was determined that no new sensitive areas exist that could be impacted by the CSOs. This is based on the following:

As a result of this analysis, it was determined that no new sensitive areas exist that could be impacted by the CSOs.

1. At this time, no additional actions are needed in the LTCP Update to address endangered species impacts. Recovery of the pallid sturgeon or other species noted is not solely related to the mitigation of CSO discharges. While the City understands that environmental pollution may play a role, addressing this is beyond the scope of this LTCP Update.
2. It is believed that the Council Bluffs Water Treatment Plant intake is not impacted by the CSO discharges upstream of its intake. While the construction of the first phase of the storage tank has been delayed, the City is implementing other projects that will result in the reduction of the frequency and volume of the CSOs at CSO 105. In addition, two other upstream CSOs will soon be deactivated.

2.7 2011 Flood Impacts to Implementation

This section describes the events that led to the 2011 Flood, the magnitude and duration of the flooding in the Omaha area, the impacts to the CSS, the City's ability to deliver flows to the WWTPs, and reactionary measures taken by the City to maintain the system to the extent possible while attempting to protect the citizens of the City of Omaha and public and private property. Following is an abbreviated description of events related to the 2011 Flood. This information has been provided in greater detail in the City's CSO Annual Reports of 2011 and 2012 to the NDEQ.

2.7.1 2011 Missouri River Flood

The 2011 Flood was the result of a greater than normal snowfall late in the season in the Northern Rocky Mountains, followed by excessive amounts of rain in May and June in the Upper Missouri River Basin states of Montana and North and South Dakota. The resulting runoff exceeded the capacity of the five reservoirs managed by the USACE. With no available capacity to store the inflows into the system, the USACE had to release the water downstream, resulting in excessive and prolonged flooding in the Omaha area. The flooding greatly impacted the City's ability to maintain portions of the CSS and at times impacted the City's ability to deliver flow from the CSS to the treatment plants.

The USACE manages five mainstem reservoirs in the upper Missouri River basin. The primary purpose of these reservoirs is flood control. The USACE has been maintaining monthly records of runoff, measured in millions of acre-feet (MAF) since 1898. In 2011, the late season snowmelt coupled with the excessive amounts of rain produced three of the five highest monthly totals of runoff ever recorded, with May runoff at 10.5 MAF, June runoff at 13.8 MAF, and July runoff at 10.0 MAF. The combined total runoff from May through July of 34.3 MAF exceeded the normal yearly runoff to the system by nearly 40 percent. The total runoff for 2011 of 61 MAF was approximately 240 percent of normal, and nearly 25 percent greater than the previous record annual runoff of 49 MAF, which occurred in 1997.

Runoff from the basin coupled with water already in the reservoirs exceeded the 72.8 MAF of storage capacity, causing the USACE to increase flows released from Gavins Point, the downstream-most reservoir in the system, to a rate of 150,000 cfs, nearly double the previous record release rate. (Additional rains in South Dakota that occurred in June resulted in the flows to be increased to 160,000 cfs.) The USACE informed the City of Omaha that flooding resulting from these flows would be significant, and would be sustained for a long duration. The City of Omaha utilizes a gauge at the I-480 Bridge as the official gauge for recording river elevation and flow rate. Flood stage at this gauge is 29 feet. The City was notified to prepare for elevations of 34 to 36 feet, in excess of the 100-year event. On May 31, 2011, the gauge registered an elevation of 29 feet, and the City of Omaha declared that a flood event was occurring. On June 21, 2011, the 100-year flood flow of 174,900 cfs was exceeded, at an elevation of 34.7 feet. The 100-year flood lasted until August 8, 2011, a total of 47 days. Two intermediate crests of 36.29 feet on July 2, and 36.1 feet on July 24 occurred during this time. On September 10, 2011, the river finally fell below 29 feet. This resulted in a total flood event duration of 114 days as defined by the 29-foot elevation.

Following is a summary of major items impacted within the CSS as a result of the 2011 Flood, either immediately or during and after restorations:

- Because the southern portion of the MRWWTP is not protected by the City's flood control levee, a temporary earthen levee approximately 2,100 feet in length was constructed to protect this infrastructure. This allowed the City to continue primary and secondary treatment of flows conveyed to the plant. This embankment remained in place until removal in 2013.
- Due to flooding of the Monroe Street Lift Station, the City of Omaha closed the isolation gates at the diversion structure on June 3, 2011, and returned to regular service on October 1, 2011.
- As the river rose, the bulkhead gates were closed to prevent river intrusion, dry weather overflows, and flooding of the river back through the levee and internally into the City. Because the bulkhead gates were closed off, the CSS and many of the CSOs could no longer flow by gravity. Temporary pumping stations were set up to pump combined sewer overflows over the levee at CSO 106/107–North Interceptor/Grace, CSO 108–Burt Izard, CSO 121–Jones St, CSO 110–Pierce, CSO 111–Hickory, CSO 115–Riverview, and CSO 117–Missouri Ave. Ninety-six pumps were installed throughout the City and its treatment plants during the 2011 Flood, with the majority of these installed to help convey and evacuate combined flows (Figure 2-28).
- The August 22, 2011, rain event exceeded the 100-year frequency, with measured rainfall totals of 5 to 7 inches falling in a 3- to 4-hour period over the eastern third of the City. The temporary pumping systems along the levee were greatly overwhelmed, and substantial flooding occurred in low areas adjacent to the levee. Substantial damage and total loss of electrical systems and equipment at the Hickory, Pierce, and Riverview stations rendered these stations inoperable for an extended period of time. These stations underwent a redesign and reconstruction and were restored to full operation by January 2012. The joint probability of this event and river stage exceeded the 10,000-year event.

- The CSO screening stations at the CSO 106/107 outfall channel and at CSO 108 were removed from operation in June 2011 due to the 2011 Flood. The screen at CSO 108 was restored to service in November 2011. The screen at CSO 106/107 required significant repairs to the screen connections, with manufactured parts requiring long lead times. Work to reinstall the screen was not able to start until late 2012. The screen was placed back in service on January 31, 2013, and has been functioning properly.

The City communicated with NDEQ early, on a frequent basis, and later as situations arose on the impacts to the CSS and the WWTPs. The flooding resulted in a prolonged upset condition to the City of Omaha's treatment and collection system, with conditions varying throughout the flood due to many factors, including rainfall, river levels, and elevated groundwater tables.

FIGURE 2-28
Temporary Pumping System and Flume near the US Park Service Building (CSO 108) *(photo courtesy of City of Omaha)*

2.7.2 Project Delays and Consent Order Amendment

The 2011 Flood constituted a *force majeure* event which impeded the City's efforts at design and construction of CSO projects. On May 8, 2012, the City submitted to NDEQ a request for a 3-year extension to the final implementation date of the LTCP of October 1, 2024. Following is an excerpt from the request to the NDEQ explaining the basis for the change in schedule:

1. Impacts of the 2011 Flood on the implementation of the near-term projects. Most important is the anticipation that construction of the MRWWTP Schedule B Improvements has been significantly delayed from the originally scheduled completion date.
2. Significant impacts of the 2011 Flood on the ability of the USACE to review and approve permit applications for data gathering near the flood control levee and to review and approve projects requiring Section 208 approvals. Also, based on experience with the 2011 Flood, the USACE has increased the amount of review, discussion, and scrutiny that needs to occur as part of project approvals.
3. City manpower and fund availability. As a result of the 2011 Flood, funds and manpower have been focused elsewhere. This has resulted in delays and funding shortfalls that can likely be overcome in the long run with additional time. So far, the City has spent more than $36 million on work associated with the 2011 Flood. A significant portion of this expenditure is not expected to be recovered from either FEMA or private insurance.

The request was approved by NDEQ on May 30, 2012. The Amended Consent Order changes the completion date to October 1, 2027, and requires an update to the LTCP to be submitted to NDEQ by October 1, 2014.

The overall status of the LTCP phases in the year following the 2011 Flood, reflected that much of the Program was slightly ahead of schedule with the exception of Major Controls Phase 1, due primarily to MRWWTP Schedule B and SIFM projects. Delays to the SIFM and MRWWTP Improvements projects resulted from high river levels of the Missouri River during the 2011 flood. In addition, the NDEQ was notified of a significant bank failure along the Missouri River in the vicinity of the proposed chlorination and de-chlorination system for the project. Due primarily to events related to the flood, a CSO Permit Modification Letter was submitted to NDEQ on August 16, 2013.

2.7.3 Changes as the Result of 2011 Flood

The 2011 Flood continued to affect the City of Omaha's CSS and the CSO Program well beyond its initial impact. Following is a description of a few of the major impacts that followed the 2011 Flood:

- **Transfer Lift Station Force Main Failure and Required Repairs.** In the fall of 2012, a leak was discovered in one of the dual force mains, known as the Transfer Lift Force Mains, at the MRWWTP. Further investigation revealed that both of the force mains were damaged beyond repair and would require replacement. A change order was issued to the Contractor on site under contract for the MRWWTP Schedule A Improvements, and a temporary bypass pumping operation was installed, allowing for the abandonment and replacement of the force mains. The initial contract value for this work was approximately $3.0 million.
- **Temporary Levee Removal.** In the spring of 2013, a contract was issued to remove the temporary levee that was installed during the 2011 Flood to protect the south half of the plant. An assessment of damages to the main plant road and drainage structures that were covered by the levee was conducted, with work to complete these repairs included in the MRWWTP Schedule B1 Improvements.
- **Missouri River Bank Failure Adjacent to Proposed Schedule B Construction.** In the spring of 2013, a significant failure of the Missouri River bank adjacent to the MRWWTP, in close proximity to proposed upgrades to the MRWWTP required as a part of the LTCP, was discovered by plant staff. Included with this was a failure of the structure at CSO 102. The failure was a result of the large amount of silts and sand that were deposited over very poor soils in this area, in conjunction with an inability of the area to drain by gravity to the river. The additional overburden on the very poor soils in the area has resulted in large shifts in the topography. Coordination with the USACE and discussion with former plant staff revealed significant prior concerns with the stability of the river bank adjacent to the river. Soil stabilization improvements are under design at the time of the writing of this document and are described in more detail in Section 3.
- **Flood Protection for the MRWWTP**. Flood protection has been included in the proposed MRWWTP Improvements projects due to experience from the 2011 Flood. A cutoff wall will be installed along the main roadway and elevations and drainage plans have been modified to protect the primary treatment portion of the facility against 100-year flood elevations. Additionally, the cutoff wall will allow for installation of greater levels of protection while maintaining access to all areas of the facility and the Monroe Street Lift Station.

2.8 Summary and Conclusions

This section described the current status of the implementation of the CSO Program and the current effect on water quality. The City has been implementing the Program and has made significant progress, as documented in this section. In addition, there have been a number of challenges that have been successfully dealt with thus far in the implementation of the controls, most notably the 2011 Flood. As of October 2015, 16 of the projects that were specified in the LTCP will be completed, 11 will be under construction, and 17 will be under design. Through July 2014, the City had spent $126 million on construction implementing the CSO Program. It is anticipated that another $371 million will be spent on construction by October 2015.

3.0 Control Alternatives

3.1 Introduction

This section provides an update on the status of implementing CSO controls in the context of key evaluations and the resulting proposed changes in the LTCP Update. In addition to meeting regulatory requirements and obtaining community acceptance, one of the key goals of the CSO Program is to minimize cost impacts to ratepayers. This is one of the primary focuses of the CSO Program Adaptive Management Process – to continually evaluate existing plans, identify new potential controls, and determine the most cost-effective way to achieve water quality objectives. Since beginning implementation, more has been learned about the CSS and the CSS model has been updated and improved. Lessons have been learned from implemented projects. With this new information, the City conducted several evaluations as part of the LTCP Update to seek more cost effective approaches.

This section provides an update on the status of implementing CSO controls in the context of key evaluations and the resulting proposed changes in the LTCP Update.

As noted in Section 2, projects in the LTCP Update are referred to primarily by their LTCP project names–the names they were given in the 2009 LTCP. In most instances, as projects have been implemented by the City, they have been given different City project names to divide a project into multiple contracts, clarify the LTCP project name, and/or define a geographical area for a Sewer Separation Project. As in Section 2, when necessary for clarification, in the following discussion, both the 2009 LTCP project name and the individual City project names may be used to address specific phases or contracts related to the larger project.

3.2 Background

The 2009 LTCP included the following six major control elements, developed through CSS modeling and extensive evaluations of alternatives:

- Targeted sewer separation projects
- Two HRT facilities
- One deep tunnel
- Improvements to the MRWWTP delivery and treatment system
- Two underground storage tanks
- One large stormwater sewer

In 2011, after attending the United States Conference of Mayors Meeting in Washington D.C., former Mayor Jim Suttle challenged the PMT to find more economic alternatives to the CSO Deep Tunnel, which is the single most costly of all identified control elements. In response to this challenge, members of the PMT met on several occasions with the former mayor and other City officials to discuss ways to reduce CSO Program costs. Through these meetings, various goals or enhancement elements were identified. Current Mayor Jean

Stothert has continued to ask the PMT to find ways to meet the objectives of the CSO Program in the most cost effective manner possible for the ratepayers. Several potential ways to do this were identified through the CSO Program Adaptive Management Process and pursued as part of the LTCP Update. Examples of this are briefly summarized below and discussed in more detail in this section. Selected controls are summarized in Section 5.0.

- **Gather More Water Quality Data** - Entered into a contract with the USGS for long-term water quality monitoring of the Missouri River to better understand the City's impact on the Missouri River. Refer to Section 2.0 for more information.
- **Update InfoWorks Model** – Developed an Interim InfoWorks Model of the CSS to quantify initial Program progress. The Interim Model was developed to reflect the CSS following implementation of projects in design, under construction, or "otherwise committed to" (i.e., not being evaluated for potential change as part of the LTCP Update). Data collected through various field investigations were used to create a new 2027 InfoWorks Model. Refer to Section 2.0 for more information.
- **Evaluate Various Systemwide Controls:**
  - **Investigate New Disinfection and Treatment Technologies** - Ensured that the latest technologies in wet weather treatment and CSO control were identified and evaluated for potential long-term cost savings. Alternative disinfectants were researched and piloted and vertical treatment shafts (VTS) were evaluated as an alternative to RTBs.
  - **Identify Potential Research Partners and Grant Opportunities** - Identified potential research partners focused on new and emerging technologies and research. In addition, continued to identify federal, state, and local grants for CSO projects to reduce the portion of the CSO Program cost that must be borne by ratepayers.
  - **Explore Green Infrastructure** - Evaluated where and when it makes sense to utilize green infrastructure on projects as a cost effective replacement or enhancement to traditional or grey infrastructure. The City worked in partnership with the EPA ORD to further pursue green infrastructure in Omaha, including a soil characterization study. The City contracted with a consultant for a Green Infrastructure Analysis project to identify up to five pilot projects.
  - **Update Cost Performance Analysis Tools and Processes** – Reevaluated project costs from the 2009 LTCP and updated project costs as study and design efforts progressed.
- **Evaluate Alternative Approaches and Controls in the Papillion Creek and Missouri River Watersheds:**
  - **Investigate the Demonstration Approach** - With additional water quality data from the USGS, this approach was investigated and compared with the Presumption Approach (EPA, 1995) to determine which was the more cost-effective, implementable approach. (The Presumption and Demonstration Approaches are defined in the EPA CSO Control Policy. Under the Presumption Approach, water quality standards are presumed to be met if certain

performance criteria are met. Under the Demonstration Approach, compliance with water quality standards must actually be demonstrated.)

- **Evaluate Elimination of the CSO Deep Tunnel** – Reevaluated the CSO Deep Tunnel cost estimate with updated information. Various alternative approaches to the Deep Tunnel were evaluated including the following:
  - Multiple HRT facilities at priority CSO locations in lieu of the Deep Tunnel.
  - Combined HRT and storage facilities at priority CSO locations in lieu of the Deep Tunnel.
  - Diameter and length variations of the CSO Deep Tunnel.
- **Identify a Revised Regulatory Strategy under the Presumption Approach** – Used output from the 2027 InfoWorks Model to determine that a LTCP-equivalent level of control can be met with the following criteria:
- Minimum of 85 percent volume capture at each outfall, which is more conservative than the 85 percent volume capture for the whole combined system. The output from the Model was also used to determine compliance with water quality standards.

• **Conduct Basin-by-Basin Analysis Looking for New Alternatives** – Reevaluated basin controls in the LTCP to determine if more cost-effective approaches could be realized.

3.3 Systemwide Control Evaluations

Systemwide controls are controls that affect the entire CSS. For example, conclusions from a bench-scale test conducted in one location of the CSS would apply to other areas of the CSS. Disinfection alternatives, green infrastructure, and cost performance analysis updates were evaluated during the LTCP Update process as summarized in this section.

3.3.1 Evaluation of Disinfection Alternatives

In the 2009 LTCP, chlorine was the chosen disinfectant for the Saddle Creek RTB, CSO 102 at the MRWWTP, and the RTB associated with the CSO Deep Tunnel. Due to safety issues associated with gaseous chlorine, liquid sodium hypochlorite was envisioned as the form of chlorine to use. During the LTCP Update process, similarly to what was done in the 2009 LTCP, alternative disinfection technologies were reviewed, evaluated, and tested. Specifically, current and emerging disinfection technologies were evaluated through a desktop analysis, three disinfection systems were tested at the bench-scale level, and potential research partnership opportunities were explored.

3.3.1.1 Current and Emerging Disinfection Technologies

As part of preliminary design activities for the Saddle Creek RTB, the current state of disinfection technologies for wet weather facilities was evaluated again. This evaluation applies to disinfection beyond the Saddle Creek RTB, and therefore is referred to as a systemwide evaluation. Chlorine has long been the disinfectant of choice for most wastewater disinfection systems. It offers reliable reduction of pathogenic microorganisms at reasonable operating costs. However, due to complications dealing with total residual chlorine, the effects of the presence of ammonia on disinfection efficiency, and the need to dechlorinate with a separate chemical (sodium bisulfite), alternate disinfectants were considered and compared against sodium hypochlorite. The following disinfectants were included:

- Chlorine dioxide (with sodium bisulfite for dechlorination of residuals)
- Ultraviolet radiation (UV)
- Bromochlorodimethylhydantoin (BCDMH)
- Ozone
- Peracetic acid

An overview of this desktop analysis including advantages and disadvantages associated with each disinfectant and evaluation criterion is summarized in the *Saddle Creek RTB Disinfection Findings Technical Memorandum* (City of Omaha, 2009c). Overall comparison results are summarized in Table 3-1.

TABLE 3-1
Comparison of Disinfection Technologies

Criteria	Sodium Hypochlorite[1]	Chlorine Dioxide[1]	UV	Ozone	BCDMH	Peracetic Acid
Effectiveness	High	Moderate	Moderate-High	Moderate	Moderate-High	Moderate-High
Occupational Safety Requirements	Moderate	High	Low	Moderate-High	Low-Moderate	Moderate
Applicability to CSOs	High	Moderate	Moderate	Moderate	Moderate-High	High
Full Scale CSO Installations	High	None Known	Low	None Known	Low	None Known
Ease of Operation	Simple	Simple-Moderate	Simple	Moderate-Complex	Simple-Moderate	Simple
Generation Equipment Required	No	Yes	Yes	Yes	No	No
Persistent Residuals	Low	Low	No	No	Yes	No
Power Requirement	Low	Low	Moderate-High	High	Low	Low

[1] Includes dechlorination with sodium bisulfite.

The desktop analysis showed peracetic acid to be to be the most viable alternative to conventional sodium hypochlorite due to its ease of operation, long shelf life, low dosages, and lack of harmful disinfection by-products. Although some jar and pilot testing has been conducted and some full-scale testing has been planned, a full-scale application at a CSO RTB facility has not been initiated in the United States. There is also a lack of regulatory precedence for use of this chemical in CSO treatment. This desktop evaluation was followed by bench-scale testing.

3.3.1.2 Alternative Disinfection Bench-Scale Testing

Two rounds of bench-scale testing were conducted during the LTCP Update period. The first round, based on the previously mentioned Saddle Creek RTB desktop evaluation, occurred in 2011. The second round, in which a new disinfection technology (Viriditec) was evaluated, occurred in 2012. Both are discussed in the following sections.

2011 Bench-Scale Study of Sodium Hypochlorite and Peracetic Acid

Disinfection bench-scale tests, as well as other tests, were conducted on six overflow events and one dry weather event from May to August 2011 to provide information on the applicability and effectiveness of sodium hypochlorite and peracetic acid over a range of wet weather events. The testing was performed by Wade Trim and Brown & Caldwell, members of the Saddle Creek RTB project team.

The testing results indicated that both sodium hypochlorite and peracetic acid are effective disinfectants and required similar dosages. Under bench-scale testing conditions, a 20 milligrams per Liter (mg/L) dosage of sodium hypochlorite was required compared to a 30 mg/L dosage of peracetic acid. Table 3-2 provides a basic comparison of the two disinfectants based on the bench-scale study.

Although testing results from other facilities have shown that peracetic acid requires a lower or equal dosage when compared to sodium hypochlorite, the bench-scale testing results presented in Table 3-2 indicate that the dosage may be higher. Additionally, the cost per gallon of peracetic acid is substantially higher than the cost for sodium hypochlorite. Even with the cost of dechlorination factored in, the chemical costs for a sodium hypochlorite/sodium bisulfite system are less than those for a peracetic acid system. Finally, the unknown regulatory requirements and approvals associated with peracetic acid, combined with the fact that there are no full-scale CSO applications for peracetic acid, are major disadvantages. As a result, sodium hypochlorite, followed by dechlorination with sodium bisulfite, was again recommended for use as the preferred disinfection system for the Saddle Creek RTB facility. However, the need for the chosen disinfection system to be adaptable to alternate disinfection chemicals such as peracetic acid in the future was considered during the design process.

TABLE 3-2
Comparison of Sodium Hypochlorite and Peracetic Acid

	Sodium Hypochlorite	**Peracetic Acid**
Typical Solution Strength	10-15%	12-15%
Typical Shelf Life of Solution	~ 7 months for 10% solution[1]	~ 12 to 18 months
Current Cost per Gallon of Chemical	\$0.72/gallon for Sodium Hypochlorite[2] \$1.32/gallon for Sodium Bisulfite[3]	\$9.82/gallon[4]
Required Dosage Based on Bench-scale Testing Results	~ 20 mg/L for Sodium Hypochlorite ~ 33 mg/L for Sodium Bisulfite[5]	~ 30 mg/L
Delivery Lead Time	3-5 days	1-2 weeks
Primary Advantages	- Widely used CSO disinfectant - Much lower cost per gallon - Operator familiarity	- Longer shelf life - Does not appear to require dechlorination - No toxic by-products appear to be produced

TABLE 3-2
Comparison of Sodium Hypochlorite and Peracetic Acid

	Sodium Hypochlorite	Peracetic Acid
Primary Disadvantages	- Requires dechlorination step - Degrades over time, dilution water system may be necessary to extend shelf life by lowering stored concentration and reducing degradation rate	- No full-scale CSO applications - Regulatory requirements and approval unknown at this time - Increased organic content of effluent - Much higher cost per gallon - Chemical compatibility with various materials is not completely known

[1] Based on half-life method at 77 degrees Fahrenheit.
[2] Cost per gallon according to an invoice from DPC Industries dated June 13, 2011 to the City of Omaha.
[3] Cost per gallon according to an invoice from Thatcher Company of Montana dated July 11, 2011 to the City of Omaha.
[4] Verbal quote from PERA/Green, a representative of Solvay Chemicals, on September 23, 2011.
[5] Assuming that the disinfectant residual will be 75% of the amount of sodium hypochlorite dosed.

2012 Bench-Scale Study of Sodium Hypochlorite and Viriditec

During 2012, the City and the PMT learned about a new ozone-based disinfection technology manufactured and distributed by an Omaha company. Viriditec Sanitation Solution, supplied by BCG Solutions, has been utilized in the healthcare and food industries as a cleaning agent; however, it had not been studied for use in wastewater treatment or combined sewer overflow control. BCG Solutions had been seeking opportunities to test its technology in a wastewater application and offered to provide a Viriditec system to the City for bench-scale testing.

On June 12, 2012, bench-scale testing was conducted on raw wastewater (during dry weather conditions) from the existing Saddle Creek Grit Facility adjacent to CSO 205. Testing was performed using a skid-mounted 50 gallons per minute capacity Viriditec system. For comparison purposes, separate testing was also conducted on the same wastewater using sodium hypochlorite as the disinfectant. As with the previously described test, Wade Trim and Brown & Caldwell conducted the testing.

The testing results confirmed that sodium hypochlorite was an effective disinfectant. A 10- to 20-mg/L dose of sodium hypochlorite was needed to achieve the necessary *E. coli* removals. The Viriditec system was unable to consistently reduce the *E. coli* count below the target limit of 126 organisms (org) per 100 milliliters (mL). Only during the second round of Viriditec tests, and after 30 minutes of contact time, were the disinfection requirements met. Also, the ozone did not result in any appreciable bacteria kill once the flow left the Viriditec unit. This would indicate that the bacterial kills are occurring in the Viriditec unit itself under the relatively short contact time that occurs. The residual ozone remaining after leaving the Viriditec unit is so small that it appears to be ineffective at further bacteria reductions. Since it would be highly impractical to install units large enough to disinfect combined sewer overflows within the Viriditec units, the use of this disinfectant was not pursued further.

3.3.1.3 Potential Research Partnership Opportunities

In October 2012, the City of Omaha submitted a research proposal to the Water Environment Research Foundation (WERF) titled *Sustainable Disinfection for Wet Weather Flow Management.* In this proposal, the City outlined a disinfection technology evaluation plan for CSOs to determine optimum levels of solids removal for up to three disinfection technologies. For this proposal, the City partnered with WERF subscribers CH2M HILL, HDR, Purdue University, the University of Nebraska, and The Wells Resource, LLC and obtained commitments from five utilities other than Omaha to participate as project collaborators. The utilities included the Metropolitan Water Reclamation District of Greater Chicago; the Metropolitan Sewer District of Greater Cincinnati; the City of Fort Wayne, Indiana; the City of Evansville, Indiana; and Kansas City, Missouri, Department of Water Services. Although WERF did not select this proposal for further evaluation, the exercise of preparing the proposal and discussing the subject with the research partners proved to be beneficial to the program.

3.3.2 Green Infrastructure Analysis

As noted in Section 2, in June 2013, the City hired a consulting engineer to review portions of the CSS and evaluate whether there are additional opportunities to reduce the CSO volumes, magnitudes, or durations through the implementation of Green Infrastructure. The study area for the project includes the following CSO basins within the CSS: Cole Creek, Saddle Creek, Burt-Izard, Leavenworth, South Interceptor, and Ohern-Monroe. The Minne Lusa Basin was not included as a part of the evaluation due to ongoing work and projects placed on hold.

In preparation for this study, the PMT developed a GIS-based screening analysis of parcels within the CSS for Green Infrastructure Site suitability. The analysis utilized a scoring and ranking process that quantitatively evaluated sites where Green Infrastructure would be most applicable based on criteria developed by the City and PMT. The criteria consisted of Land Use, Terrain, Problem Areas, Impervious Area and City Right of Way. Each criterion was broken down into ranked categories depending on the relative suitability of conditions within each criterion. In addition, the criteria were weighted against one another to determine which criteria were relatively more important than the others. The sites that were ranked high quantitatively were then reviewed qualitatively by City staff to develop a list of areas (clusters of parcels) recommended for further analysis.

The project included three phases:

1. **Opportunity Identification:** The opportunity identification phase produced a wide range of possibilities for green infrastructure based on where runoff was generated and where it could be managed. This phase considered prior evaluations and new perspectives.

2. **Project Evaluation:** This phase of the project selected 10 opportunities for further evaluation. Areas that were evaluated were construction and logistical (e.g. ownership) feasibility, potential volume reduction to the CSS, and capital and present value costs. The evaluation resulted in five project areas selected for further development.

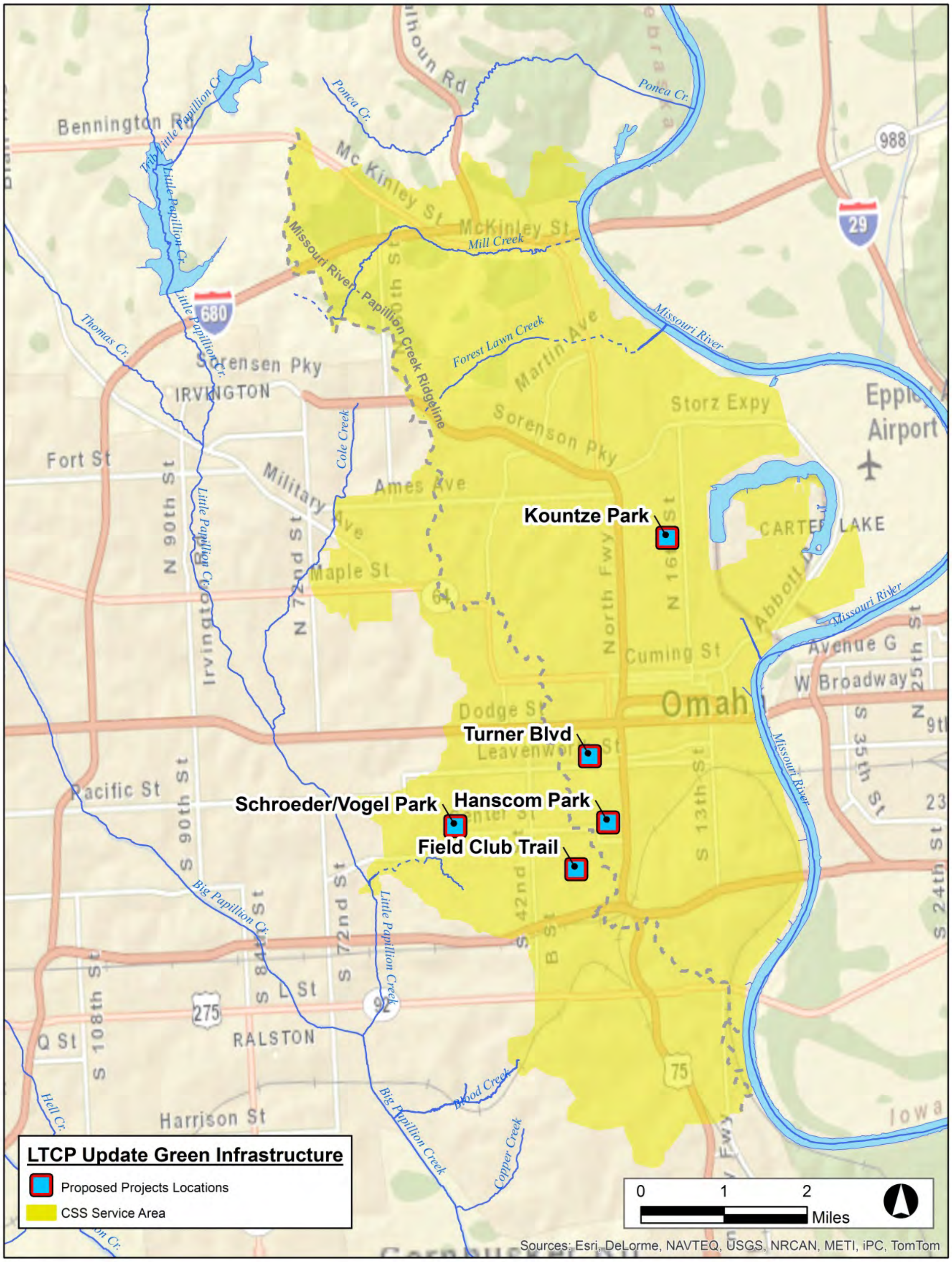
3. **Project Development:** In this phase, conceptual designs were developed for the five selected project areas. Design aspects of the projects were further refined. This included coordination with PRPP for use of park space, establishment of conceptual project footprints and profiles, development of conceptual cost estimates and hydraulic modeling to confirm the size of components and their benefits.

Table 3-3 below is a preliminary list of the projects recommended by the project team and their construction costs. Figure 3-1 shows the locations of the recommended green infrastructure projects. The Executive Summary of the report is found in Appendix C.

TABLE 3-3
Recommended Green Infrastructure Projects and Construction Cost Summary

Project Team	Location of Green Infrastructure	Construction Cost	Implementation Recommendation
Field Club Trail	Frances Street		Implement all or portions of these projects. Projects could be reduced in scale to meet overall City budget objectives or to further limit the impact of the projects on the trail. Implement Vinton practice prior to trail construction.
	Gold Street		
	Frederick Street		
	Vinton Street		
	Subtotal	$5,557,000	
Hanscom Park	Hanscom-north		Implement all of the Hanscom Park Projects. Projects need to be coordinated with the Hanscom Park Master Plan, which is scheduled for 2014.
	Hanscom-west		
	Hanscom-east		
	Subtotal	$3,076,000	
Kountze Park	Kountze Park		Implement. Coordinate final placement with Parks, Recreation and Public Property (PRPP).
	Subtotal	$1,260,000	
Schroeder-Vogel Park	SVP		Implement project if the groundwater conditions are satisfactory for subsurface storage. Coordinate placement with other parks uses.
	Subtotal	$1,504,000	
Turner Boulevard	North Turner Park		Modify Pacific Avenue / Leavenworth-south to address final PRPP comments. Do not implement North Turner at this time. Consider implementation of the North Turner project if configuration of the intersection changes or if other modifications are made to the park space in this vicinity.
	Dewey Park		
	Leavenworth-north		
	Leavenworth-south		
	Pacific Avenue		
	Subtotal	$8,582,000	
All Projects other than North Turner	**Total**	**$19,979,000**	

FIGURE 3-1
Potential Green Infrastructure Projects

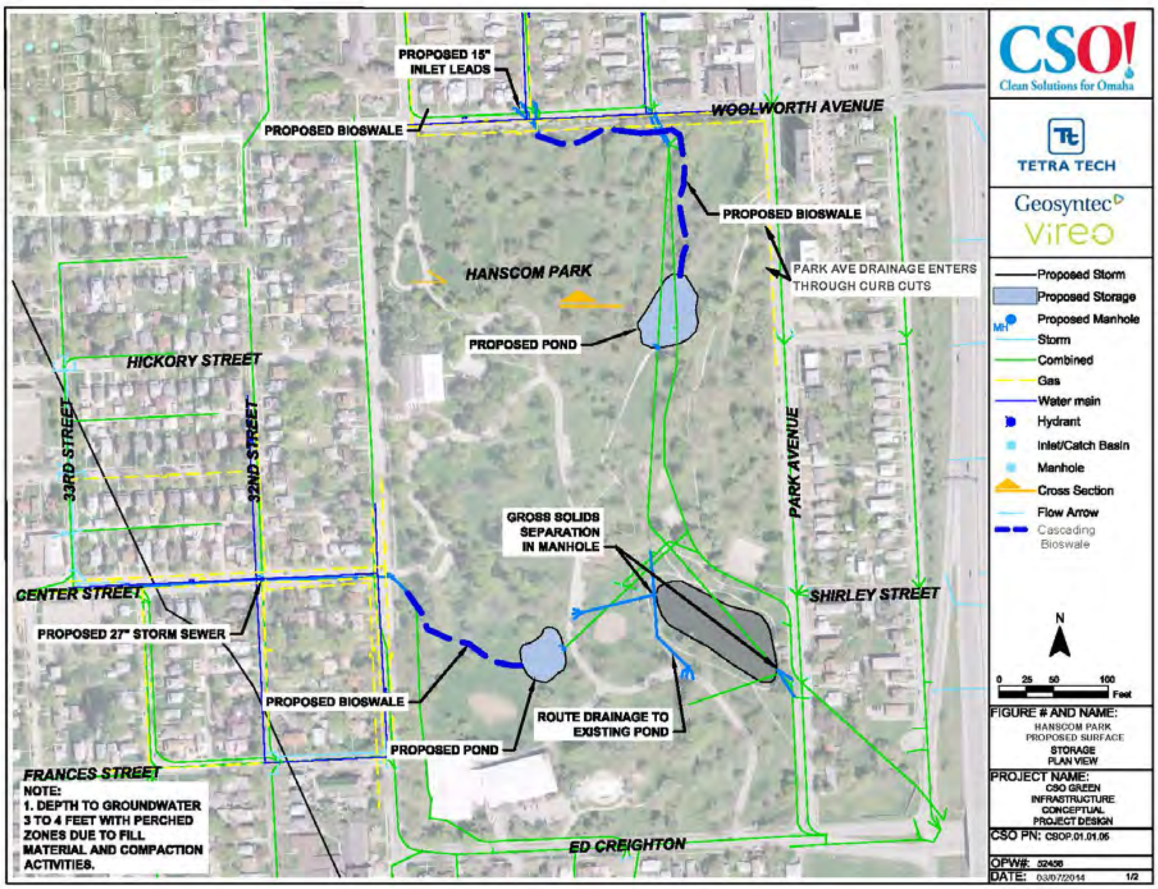


The City and PMT reviewed the recommendations of the analysis team and determined to move ahead with the following projects:

- Hanscom Park (all portions)
- Field Club Trail
- Turner Park (except for North Turner Park)
- Kountze Park
- Schroder-Vogel Park

Figure 3-2 is an example of the level of evaluation obtained from the Green Infrastructure Analysis project.

FIGURE 3-2
Potential Layout of Hanscom Park (*Courtesy of Tetra Tech*)



The City will be implementing these projects as part of a Green Infrastructure Pilot Program. The intent is to determine more precisely the effectiveness and true cost of these green infrastructure projects including maintenance costs. Construction of projects and monitoring of the projects will likely occur over the next 5 years. The results of this pilot program will be used to determine if incorporating other projects would be cost effective and to refine the process and procedures of their implementation.

In addition to the pilot project, the study identified potential areas where public/private partnerships may be of benefit. The City will continue to work with others in the establishment of stakeholder relationships that may further reduce the stormwater entering the combined system.

3.3.3 Update of the Cost-Performance Analysis

As the CSO Program has progressed from LTCP development to implementation, CSS projects have been reevaluated to determine whether specific components such as grit and floatables control facilities have been incorporated where needed. Corresponding costs for these components were also evaluated.

Upon further analysis of the 2009 Deep Tunnel cost estimate, it was determined that appropriate costs related to budget uncertainty and costs for trash racks, grit removal, diversion structures, and odor control facilities were not included. These updates, discussed in more detail in Section 3.4.2.2, were then evaluated further to determine their applicability to other future project costs.

In addition to the efforts discussed above, project costs have been updated as the project study and design efforts have transitioned to construction. Costs are continually updated in the CSO Program cost tools as the following occur:

- Actual contract amounts replace the estimated contract amounts as study and design contracts are negotiated;
- Estimated utility relocation amounts are updated with actual amounts as the extents of the relocations are refined;
- Property easement / acquisition costs are updated with actual amounts as the extents of these easements and acquisitions are identified during the design process;
- Construction management services are negotiated and the cost tool amounts adjusted to reflect the actual amounts as projects are bid and progress to construction; and
- Actual bid amounts replace the estimated amounts in the cost tool after the projects have been bid and awarded for construction.

In an effort to reduce project costs, cost reduction workshops were conducted during the designs of several projects, including MRWWTP Improvements, SIFM, Leavenworth Lift Station, and Saddle Creek RTB.

3.4 Watershed Control Updates and Evaluations

3.4.1 Papillion Creek Watershed

For the 2009 LTCP, the combined sewer areas within the Papillion Creek Watershed were divided into the Cole Creek, Papillion Creek North, Saddle Creek, and Papillion Creek South basins. No changes that affect multiple basins are being proposed for the Papillion Creek Watershed.

3.4.2 Missouri River Watershed

CSO control projects within the Missouri River Watershed include both cross-basin projects (those that control CSOs in multiple basins in the CSS) and individual basin projects (those that reduce combined sewage flows or provide control within a single basin). As described in the 2009 LTCP, these projects consist of sewer separation, maximizing wet weather flows to the MRWWTP, storage of wet weather flows in remote storage facilities for later treatment at the MRWWTP, CSO Deep Tunnel conveyance, and treatment in an HRT facility. Updates to the CSO control projects specific to the Missouri River Watershed, along with evaluations conducted as part of the LTCP Update process, and proposed changes to the LTCP are discussed in this section. Updates to projects within specific basins are discussed in Section 3.5.

3.4.2.1 Updates to Missouri River Watershed Controls

One of the primary control goals in the Missouri River Watershed is to maximize the use of the MRWWTP to treat wet weather flows. Currently, the flow rate that can enter the plant is constrained by the condition of the SIFM and by the configuration of the plant's headworks facilities. As described in the 2009 LTCP, improvements to maximize flow during wet weather include additional and improved treatment facilities at the MRWWTP; a new dedicated industrial lift station to separately deliver high-strength industrial wastewater from the Ohern/Monroe Basin to the MRWWTP; a new SIFM; a new Leavenworth Lift Station; a new Riverview Lift Station; and modifications to the Burt-Izard, In-Plant, and Monroe Street Lift Stations. Updates for these projects since the LTCP are discussed below. Updates to the CSO Deep Tunnel Project are discussed in Section 3.4.2.2.

MRWWTP

The MRWWTP was built in 1964 and treats a dry weather average wastewater flow of approximately 25 mgd. Improvements to the MRWWTP were identified in the 2009 LTCP to treat an increase in combined sewage flow during wet weather of up to approximately 150 mgd through preliminary and primary treatment, and to provide a firm capacity for secondary treatment of 64 mgd for both dry and wet weather flows. Flow in excess of the secondary treatment system capacity will be discharged through CSO 102 after chlorination and dechlorination. In the 2009 LTCP, the MRWWTP Improvements project was identified as an important early action project for the CSO Program because of its substantial benefit to water quality. Key components of the MRWWTP Improvements described in the 2009 LTCP include the following:

- New headworks facility
- New primary clarifier splitter structure
- Odor control facilities
- Chlorine contact basin
- Industrial waste treatment system
- Upgraded Transfer Lift Station

Due to factors such as the 2011 Flood, differences in the types of construction involved, and the construction timing of inter-related projects, the MRWWTP Improvements project is being constructed through three separate contracts. These contracts are discussed in more detail in the following sections.

MRWWTP - Schedule A

Construction for the Schedule A contract began in 2012 and is anticipated to be substantially complete in late 2014. During this contract, facilities were added to treat high-strength industrial waste from the SOIA (formerly known as the Ohern/Monroe Industrial Area). In addition, reliable secondary treatment capacity w Floatable controls will be addressed with the construction of CSO Deep Tunnel Drop Shaft as increased to 64 mgd to treat all dry weather flow and flows from smaller wet weather events. Benefits including water quality improvements, odor reduction, and energy sustainability were realized when these project improvements came into operation. Specifics regarding the SOIA Treatment Facility and the Transfer Lift Station are included below.

- **SOIA Treatment Facility.** New grit removal basins and two new primary clarifiers were constructed at the MRWWTP to separately treat high-strength industrial waste from the Ohern/Monroe Basin prior to combining it at the Transfer Lift Station with the rest of the flow going to secondary treatment. The high-strength wastewater was consolidated as part of the 2009 LTCP Ohern/Monroe Industrial Flow Area Sewer Separation project and is delivered to the plant by the SOIA Lift Station (formerly Industrial Lift Station), Force Main, and Gravity Sewer. The grit basins were not in the 2009 LTCP for the MRWWTP site; however, it was determined that it would be more appropriate to locate them at the plant rather than the SOIA Lift Station. The treatment facility was placed in operation in mid-2014. Along with the new treatment system at the MRWWTP, this resulted in a significant reduction in bacterial loading to the Missouri River.
- **Transfer Lift Station.** The Transfer Lift Station, which pumps primary clarifier effluent from both the municipal treatment train and the high-strength industrial train to secondary treatment, was upgraded to reliably pump 64 mgd. Upgrades included installation of five new pumps and controls, along with other associated improvements.

MRWWTP Improvements - Schedule B1

Construction of Schedule B1 improvements began in April 2014 and will continue through most of 2016. During this contract, screening, grit removal, and settleable solids removal capacity will be increased to a peak-hour flow of 150 mgd to accommodate wet weather events. Specific improvements to the headworks facility and primary clarifiers are summarized below.

- **Headworks Facility.** A new headworks facility (sometimes referred to as the Municipal Headworks) with a peak-hour capacity of 150 mgd will include influent flow measurement, parallel channels with automatic bar screens, and vortex grit removal units. Screening presses and grit washing and dewatering equipment will also be provided. The new facility will receive flow from the SIFM and force mains from the Monroe Street and In-Plant Lift Stations.
- **Primary Clarifier Improvements.** A new primary clarifier splitter structure to split flows to the existing primary clarifiers was included in the 2009 LTCP; however, it was determined to be more cost effective and constructible to rehabilitate the existing splitter box. Clarifier dewatering pumps, to facilitate emptying the wet weather clarifiers after each wet weather event in a reasonable amount of time, and odor control will be added to the north primary clarifiers. Dewatering pumps and odor control are already present on the south primary clarifiers.

  During design, it became necessary to modify the use and operation of the existing primary clarifiers during wet weather to accommodate the high-concentration first flush of wastewater from the SIFM. High initial concentrations of ammonia in the wastewater has a detrimental effect on the efficiency of chlorine disinfection. As a result, the design now incorporates the ability to store first flush wastewater in two primary clarifiers and the ability to dewater clarifiers more rapidly by gravity to accommodate back-to-back storms. The design also includes a disinfection control system that adjusts dosage according to ammonia concentration and maximizes the time when free chlorine is used as the disinfectant. This control system is unique to the MRWWTP and plant operators will need time to become familiar with and optimize it.

MRWWTP - Schedule B2

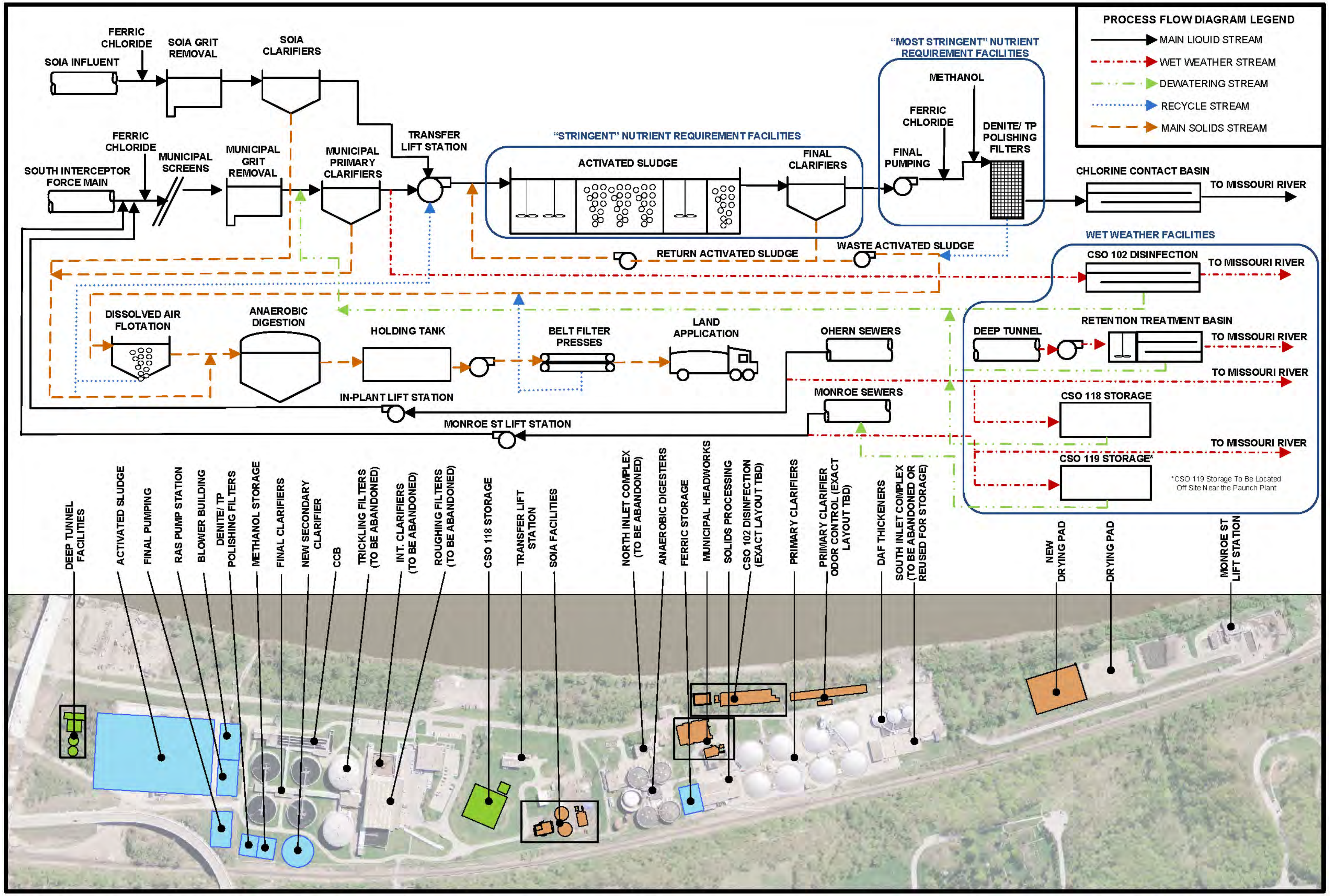
Schedule B2, which will include chlorine disinfection facilities for the CSO 102 flow and primary clarifier odor control, is anticipated to begin construction in early 2016, and to be completed by the end of 2019. A chlorine contact basin with a peak capacity of 130 mgd and new chemical feed facilities will be constructed to disinfect through CSO 102 the portion of effluent from the primary clarifiers that does not go to secondary treatment before discharge. This system will also include dechlorination facilities. Chlorination will be accomplished using sodium hypochlorite and dechlorination with sodium bisulfite. A new chemical building will be constructed to house the chemicals.

Several months after the 2011 Flood, a significant failure of the riverbank occurred between the plant road and the Missouri River in the area where the Schedule B2 facilities are planned to be located. This failure is believed to be due primarily to poor soil conditions, a rapid drop in river level, significant deposition of sediment from the floodwater, and poor drainage due to the sediment. Evaluations were conducted to determine the feasibility of stabilizing the riverbank and to compare the cost for stabilization against the cost to relocate the chlorine contact basin. It was determined that stabilization is feasible, and that it would be more appropriate to keep the chlorine contact basin in the planned location following bank stabilization. An important consideration in this decision was the conclusion that the existing plant facilities south of the flood control levee would be at eventual risk due to continued bank failure without stabilization. In other words, even if the chlorine contact basin were relocated to an area with better soil conditions, bank stabilization would still be required to protect the plant.

A bank stabilization project is anticipated to be constructed starting in the first half of 2015, followed by the start of Schedule B2 construction.

Figure 3-3 shows a MRWWTP site plan illustrating Schedule A, B1, and B2 facilities. Also shown are the updated CSO Deep Tunnel and CSO 118 Storage facilities described later in this section, along with potential future facilities for nutrient removal. It is important to emphasize that the nutrient removal facility footprints are intended only to reserve plant space based on a very conceptual analysis.

FIGURE 3-3
Site Layout for the Modified MRWWTP



Ohern/Monroe Industrial Lift Station, Force Main, and Gravity Sewer

The discharge of high-strength industrial waste, primarily from the meat packing industries, has historically been directed to the CSS and is present in overflows from CSOs 102, 118, and 119 during wet weather events. The wastewater has high concentrations of *E. coli* and other pollutants such as BOD. In the 1950s, efforts were made to separate the meat packing waste streams from the combined system. However, with the decline of meat packing activities in the 1970s and 1980s, many of these facilities were abandoned and the sanitary sewers were reconnected back into the CSS. The 2009 LTCP Ohern/Monroe Industrial Flow Area Sewer Separation project was completed in November 2010 under its City project name of SOIASS and completed the separation of these wastes.

The 2009 LTCP also identified the Ohern/Monroe Industrial Lift Station, Force Main, and Gravity Sewer Project to convey the separated high-strength waste to the MRWWTP. This project was bid in two separate packages (SOIA Lift Station and SOIA Force Main), as described in Section 2.

Completion of the lift station, force main, and gravity sewer, combined with the Schedule A treatment facilities described previously, has eliminated the presence of high-strength industrial waste from three CSO outfalls, except during extreme events: CSO 118 – South Omaha/Ohern Street, CSO 119 – Monroe Street Lift Station, and CSO 102 – MRWWTP Primary Clarifier. This elimination has resulted in an estimated 26 percent reduction in loading of bacteria to the Missouri River for a Representative Year.

South Interceptor Force Main

As described in the 2009 LTCP, replacement of the existing SIFM is necessary to reliably convey peak wet weather flows to the MRWWTP. The existing force main was constructed in the early 1960s and has remained in continuous operation for approximately 50 years. Because of the current condition of the existing force main, operators have limited the peak flow to less than the original capacity. Between 1999 and 2004, a portion of the existing force main was replaced in a new alignment from the Burt-Izard Lift Station south to a new valve vault near I-480 to accommodate redevelopment in the area. From the I-480 Bridge south to the Union Pacific Railroad (UPRR) Bridge, the existing force main is adjacent to the floodwall and encased in reinforced concrete. The remaining portion of the force main from the UPRR Bridge south to the MRWWTP was constructed in/adjacent to the existing flood control levee. The condition of the existing SIFM makes it unreliable for continued long-term use. Rehabilitation was not a viable option due to the continuous operation of the force main and concerns with the levee/flood control system. The new SIFM will provide reliability to the conveyance system in addition to increased flow capacity to the MRWWTP from the sewer basins north of the plant.

To ensure that dry weather discharges do not occur, the CSO Deep Tunnel (which extends from north of the Burt-Izard Lift Station south to the MRWWTP), will serve as a backup to the SIFM and associated lift stations for scheduled maintenance and emergency diversions. When the tunnel is being used as a backup, dry weather flows from the Burt-Izard Lift Station, new Leavenworth Lift Station, Riverview Lift Station, and/or Missouri Avenue Lift Station will be redirected to the tunnel, thus isolating the surface conveyance system and lift stations. The future Deep Tunnel Lift Station will include provisions to convey this dry weather flow directly to the MRWWTP treatment process, including secondary treatment.

Discharge piping from the new Leavenworth Lift Station and from the other lift stations that feed the SIFM (Burt-Izard, Riverview, and Missouri Avenue) will connect to the new force main. The existing Spring Street Lift Station will be abandoned when a gravity sanitary sewer is constructed to convey sanitary flows to the new Riverview Lift Station. This proposed project is the Martha Street to Riverview Lift Station Phase 2 project. The Martha Street to Riverview Lift Station Phase 1 and Phase 2 projects were not included in the 2009 LTCP. Flow from the Martha Street area was originally to be diverted north to the Leavenworth Lift Station through the South Gravity Sewer, which is part of the SIFM project. However, the discovery of an abandoned dump south of the Hickory Street Lift Station necessitated that the Martha Street flow be sent south to the Riverview Lift Station through a new gravity sewer instead. Martha to Riverview Phase 1 was constructed as part of the Martha Street Sewer Separation Phase 1 Project. Phase 2 will be constructed as part of the Riverview Lift Station Project. Until Phase 2 is built, a temporary lift station will pump the Martha Street flow to the Hickory Street Lift Station. The existing Pierce Street and Hickory Street Lift Stations will be abandoned as described in the 2009 LTCP, with flows being sent through the South Gravity Sewer to the new Leavenworth Lift Station.

The new SIFM will consist of approximately 4,360 feet of 48-inch diameter pipe from south of the I-480 bridge to the proposed Leavenworth Lift Station and 18,390 feet of 64-inch diameter pipe from the proposed Leavenworth Lift Station south to the MRWWTP. The SIFM project was described in the 2009 LTCP as a single project; however, it will now be constructed in two contracts: South/Central Segments, and North Segment, both of which are scheduled to be completed by mid-2017.

Leavenworth Lift Station

The existing Leavenworth Lift Station at 1st Street and Leavenworth Street was constructed in the early 1960s with the existing SIFM and other conveyance facilities along the Missouri River. The existing lift station, in its current operating condition, has an operating capacity of 17 mgd. Additional capacity is needed to convey more wet weather flow to the MRWWTP for treatment.

The Leavenworth Lift Station Replacement Project, included in the LTCP, was subsequently divided into two contract packages to facilitate the relocation of an OPPD power line. Construction for Contract 1, in which the power line was relocated, started in January 2012 and was substantially complete in June 2012. Construction for Contract 2, which includes the new lift station and the diversion structures at the existing Leavenworth sewer site, began in August of 2012 and is anticipated to be substantially complete in late 2014.

The 2009 LTCP described the new lift station as having a 43-mgd capacity, and noted that it would be located near the UPRR Bridge that crosses the Missouri River, either north or south of the bridge. The actual lift station was constructed south of the bridge at approximately 4th Street and Pierce Street, and was built with a firm capacity of 45 mgd. It includes screening and grit removal and has the capacity to pump approximately 7 mgd during dry weather conditions and 45 mgd during wet weather conditions. The lift station has two wet wells (one for wet weather and one for dry weather).

The new Leavenworth Lift Station does not include odor control at this point. The exhaust air system was ducted to allow reasonable transition of odorous air to a separate odor facility that could be constructed on-site in the future (if required). No floatables control was installed for the CSO outfall as part of this project. The floatables control will be addressed with the future construction of the closest Deep Tunnel Drop Shaft.

In addition to pumping flows from the Leavenworth Street Sewer, the new Leavenworth Lift Station will also convey flows diverted from the Pierce Street and Hickory Street Basins. Both the Pierce Street Lift Station and Hickory Street Lift Station will be decommissioned when the new lift station is fully operational and the flow from Martha Street is directed south to the new Riverview Lift Station. The new Leavenworth Lift Station will receive flows from the Jones Street Sewer, similar to the existing Leavenworth Lift Station.

Burt-Izard Lift Station

The existing Burt-Izard Lift Station (Figure 3-4), located just south of the Missouri River pedestrian bridge, was originally constructed in the 1960s. It was designed to pump 50 mgd during wet weather events. Although improvements and modifications have been made to the facility since the 1960s, due to concerns with the current condition of the facility, grit loading during wet weather events, the capacity of the MRWWTP, and, most notably, the condition of the existing SIFM, the Burt-Izard Lift Station currently operates at half this capacity during wet weather events.

FIGURE 3-4
Burt Izard Lift Station

As described in the 2009 LTCP and based on a 2008 preliminary engineering report developed by a team of consultants outside of the CSO Program, a number of improvements are planned for the Burt-Izard Lift Station. These improvements will ensure reliable delivery of 50 mgd to the SIFM during wet weather events. Recommended improvements include the following:

- Replace suction isolation gates
- Replace manual screen with a mechanically cleaned screen
- Improve screenings handling
- Repair and recoat wet well
- Replace pumps and motors with dry-pit submersible pumps and 4160-volt motors
- Improve piping, valves, electrical system, controls, heating, ventilation and air conditioning (HVAC), and plumbing

Preliminary design for this project began in August 2014. Construction is anticipated to begin in 2016. The schedule for this project is dependent on available funding.

Monroe Street Lift Station

Recommended improvements to the Monroe Street Lift Station to ensure reliable delivery of flow to the new MRWWTP headworks include the following:

- Replace gates
- Improve screenings handling
- Improve and coat wet well
- Replace or rebuild pumps and motors
- Improve piping, valves, electrical system, controls, and HVAC

Design of these lift station improvements is not currently scheduled and is dependent on available funding.

Riverview Lift Station

As stated in the 2009 LTCP, replacement of the Riverview Lift Station is needed to accommodate higher future flows. The existing Riverview Lift Station was originally constructed in the 1960s as part of the SIFM project and has the capacity to pump 3.5 mgd. A new lift station is needed to provide capacity for peak dry weather flows from the upstream watershed and higher wet weather flows. These flows include capacity to accommodate the Henry Doorly Zoo draining of tanks and ponds as regular cleaning activities occur. The lift station is also needed to accommodate flow from the Martha to Riverview Sewer, which was described previously as a change from the 2009 LTCP. The Riverview Lift Station is part of the overall system to maximize wet weather flows to the MRWWTP. The specific location of the lift station and the pumping capacity for the facility will be determined during preliminary design. Preliminary design for this project began in July 2014. Construction is anticipated to begin in 2016.

MRWWTP In-Plant Lift Station

The MRWWTP In-Plant Lift Station, which has been in service for the entire life of the plant, is being rehabilitated and its capacity increased as part of the MRWWTP Schedule B1 contract. This project was not specifically mentioned in the 2009 LTCP but is needed to maximize flow to the MRWWTP.

3.4.2.2 Missouri River Watershed Alternative Evaluation

As noted earlier in this section, the PMT evaluated several alternatives to the CSO Deep Tunnel system as part of the LTCP Update process. The Deep Tunnel is the most costly control element, and the purpose of the evaluations was to identify potential alternatives to the Deep Tunnel that are more economical, including alternatives involving either re-configuration/re-sizing, or elimination. The following sections discuss tunnel costs, treatment and storage alternatives, and sizing alternatives for the tunnel system.

CSO Deep Tunnel Overview

In the 2009 LTCP, a 5.4-mile-long, 17-foot-diameter tunnel was included as a conveyance/equalization facility to capture combined sewer flow from CSOs 106, 107, 108, 121, 109, 110, 111, 112, 114, 115, 117, 118, and 119 and convey it to a 52-mgd RTB facility to be located at the MRWWTP. The tunnel would be constructed between 160 and 180 feet below the ground surface (depth to tunnel invert) in a deposit of horizontally bedded limestone with shale. The primary function of the tunnel is to convey wet weather flows, while the secondary function would be to equalize the peak flow rates to allow pumping of a more constant flow to the RTB. The 2009 LTCP stated that the combined sewage would flow to the CSO Deep Tunnel through one of five drop shafts located along the tunnel alignment. The original locations are described below. (The locations of the drop shafts can be seen in Figure 4-7 of the 2009 LTCP.)

- **North Interceptor/Grace Street Drop Shaft.** At the Grace Street Ditch Site to collect flows from CSO 106 – North Interceptor and CSO 107 – Grace Street.
- **Burt-Izard Drop Shaft.** Near the Burt-Izard Lift Station to collect flows from CSO 108 – Burt-Izard Street.
- **Leavenworth Drop Shaft (3rd and Pierce or 4th and Marcy).** Near the UPRR Bridge to collect flows from CSO 109 – 1st and Leavenworth, CSO 110 – Pierce Street Lift Station, CSO 111 – Hickory Street Lift Station, CSO 112 – Martha Street, and CSO 121 – Jones Street. According to the 2009 LTCP, the site was proposed to be located on either side of the UPRR Bridge.
- **Riverview Drop Shaft.** Near the Riverview Lift Station to collect flows from CSO 114 - Grover Street and CSO 115 – Riverview Lift Station.
- **MRWWTP Drop Shaft.** Near the Ohern sewer at the MRWWTP to collect flows from CSO 117 – Missouri Avenue Lift Station, CSO 118 – South Omaha/Ohern Street, and CSO 119 – Monroe Street Lift Station.

Each drop shaft would be a vortex-type and include coarse screening, a grit pit, odor control, and additional appurtenances.

Reevaluation of CSO Deep Tunnel

The CSO Deep Tunnel is the single most expensive asset that will be completed as a part of the LTCP. Though an extensive amount of work went into proving the tunnel concept during the development of the 2009 LTCP, it was deemed appropriate to reevaluate the tunnel, considering the following as a part of the revaluation:

1. Is the cost for the tunnel defined in the 2009 LTCP appropriate; are there adjustments to be made to the tunnel costs to allow for a higher level of confidence in the cost estimate and establish a new base to allow for alternatives to be compared?
2. Are there alternatives to the tunnel; notably are there end-of-pipe treatment and/or storage alternatives that could be utilized in lieu of the tunnel or in combination with the tunnel?
3. Is the existing tunnel alignment the correct alignment? Can the tunnel alignment be changed or modified in combination with other technologies?
4. What is the appropriate size of the tunnel and RTB required to accomplish the objectives of the 2009 LTCP, considering new information, including updates to the approach for meeting the CSO policy and updates to the CSS model?

The following is a brief description of the tunnel reevaluation. An extensive amount of information not included in this document is summarized further in Technical Memorandums completed during the evaluation. The reevaluation presented here includes information on the evaluation of the Demonstration Approach. The reevaluation process for the tunnel and the evaluation of the Demonstration Approach were conducted in concert with each other, and thus information is presented in this manner.

Tunnel Base Cost Adjustment

To evaluate alternatives to the CSO Deep Tunnel, an updated base construction cost was developed. The base construction cost for the CSO Deep Tunnel system used for the 2009 LTCP included the following components:

- CSO Deep Tunnel (17-foot diameter; 28,603-foot length)
- Five Deep Tunnel drop shafts
- Conveyance sewers to tunnel drop shafts
- Deep Tunnel Lift Station
- RTB at MRWWTP
- Conveyance from RTB to CSO outfall

Further knowledge on the tunnel costs have determined that separate costs for screening, grit removal, and diversion structures should be included in the base cost. Additionally, it was identified that the 2009 LTCP cost estimate for surface conveyance required an adjustment to better account for larger diversion structures. The cost tool used during 2009 LTCP development was used to identify the additional costs, with an estimate of $20.2 million for surface conveyance and diversion structures, and $25 million for grit basins (ENRCCI 8528). In addition to those costs, it was determined to move away from the ‘risk based’ costs that were developed during the 2009 LTCP, and instead use a flat contingency of 25 percent.

Treatment and Storage Alternatives to the CSO Deep Tunnel System

As part of the CSO Program Adaptive Management Process, investigating different water quality strategies was identified as a key enhancement element aimed at potentially reducing cost. In the 2009 LTCP, the EPA CSO Control Policy Presumption Approach was followed (EPA, 1995). With this approach, water quality standards are presumed to be met if there is no more than an average of four overflows per year, or if 85 percent of the wet weather volume in the CSS is eliminated or captured and treated on a system-wide annual average basis. The LTCP was based on allowing no more than four overflows in the Representative Year, which resulted in a much higher volumetric capture than 85 percent. Using a water quality model, it was also estimated that compliance with the Presumption Approach would result in meeting water quality standards in the Missouri River.

Alternatively, under the EPA CSO Control Policy Demonstration Approach, the City would need to demonstrate through extensive water quality monitoring and modeling that implementation of the LTCP would result in meeting water quality standards. The Demonstration Approach could provide flexibility in controls by capturing and treating CSS flows only from selected outfalls during wet weather events rather than controlling to no more than four CSOs at all outfalls. The cost of the controls needed under this approach was evaluated against the Presumption Approach. Control at the selected outfalls could be accomplished by treating the flow either with or without storage equalization. When storage equalization is incorporated, peak flows would be reduced and less treatment capacity required. Evaluated treatment and storage technologies and combined treatment and storage alternatives are discussed below.

Treatment Technologies

Three HRT technologies in the wastewater industry currently being used to treat wet weather flows include ballasted flocculation, RTBs, and VTS. Ballasted flocculation and RTB facilities were considered during the development of the LTCP. Ballasted flocculation technologies were eliminated from further consideration due to much higher costs as compared to RTBs. Vertical treatment shafts were not evaluated during the development of the LTCP because the technology had not been implemented at any locations in the United States at that time. Since then, VTS's were constructed in lieu of a tunnel in Dearborn, Michigan, at a reported cost savings of approximately $100 million. Because of this new information, it was decided to evaluate this technology as a part of the LTCP Update.

The *Vertical Treatment Shaft Technology Evaluation Memorandum* (City of Omaha, 2012), provides information that indicated the potential for VTSs as a viable technology for the Omaha CSO Control Program. Additional study was needed, specifically with respect to cost differences between soil and rock excavation in Omaha, grit facility costs, and comparable RTB costs. Because bedrock typically occurs at depths between 40 and 60 feet along the Missouri River in Omaha and typical treatment shafts are constructed more than 100 feet below the ground, any VTS constructed would need to include additional bedrock excavation costs. It was estimated that overall costs of VTS similar to those constructed in Dearborn, Michigan, could cost approximately $2 million more (based on original ENRCCI) due to Omaha bedrock conditions alone. With grit facilities included, the cost of a VTS could be approximately $27 to $30 million versus $13 to $15 million less for a comparable RTB based on the Omaha cost tool. Because of this cost difference, VTSs were not considered for potential widespread use, with the exception of locations where available land may be a limiting factor.

High Rate Treatment at CSO Priority Locations Alternative

An alternative under the Demonstration Approach was developed and evaluated, consisting of capturing and treating CSS flows at priority CSOs using HRT (RTBs or VTSs) in lieu of the Deep Tunnel. Five priority CSO locations with eight CSOs (106/107, 108, 109/121, 118, and 114/115), believed to have the most impact on water quality in the Missouri River were initially selected as potential locations for HRT facilities. RTBs were selected as HRT facilities for all locations except CSO 108. Because land in the CSO 108 area continues to be commercially developed, a VTS was selected for this location to minimize footprint and visibility concerns. A brief discussion of peak rates, facility requirements, and costs for this alternative is included below. More detailed information can be found in the *LTCP Update-Summary of Treatment and Storage Alternatives at CSO Priority Locations Technical Memorandum* (City of Omaha, 2013).

Peak Rates

For the purposes of this evaluation, peak HRT rates assuming either zero untreated overflows or three untreated overflows per Representative Year were determined. Peak HRT rates were obtained from the InfoWorks Model, Interim Model Version 1.

All flows for the zero untreated overflow scenario would be provided equivalent to primary treatment by the HRT facility for up to the highest Representative Year peak flow. For the three untreated overflow scenarios, equivalent to primary treatment would be provided by the HRT facility for all flows equal to or less than the design peak-flow HRT capacity. All flows exceeding the design peak-flow HRT capacity (three events in a Representative Year) would be screened for floatables control, but would not be treated.

Facility Requirements

Depending on site layout conditions and facility design, flows through the RTB facility would be accomplished by one of the following approaches: gravity in/gravity out; pump in/gravity out; or gravity in/pump out. For the purposes of this analysis, the pump in/gravity out approach was selected for the RTB facilities because of the depth of the existing sewers and Missouri River elevations.

The following components were included for each HRT location using either RTB or VTS technology:

1. Sewer to connect the combined sewer flow to diversion structure
2. Sewer to convey flow from diversion structure to lift station
3. Grit pit and screens
4. Lift station
5. HRT facility with disinfection
6. Gravity sewer to discharge flow to Missouri River

Sewer depths, lift station depths, sewer construction type (open cut or tunnel), and HRT locations were approximated with information obtained from each of the corresponding *Basin Study Alternative Evaluation Technical Memorandum* (City of Omaha, 2009b) that were developed as part of the 2009 LTCP (City of Omaha, 2009a).

Costs

The estimated cost for HRT facilities at the five priority CSO locations assuming zero untreated overflows at a 30-minute detention time was approximately $207 million more than the estimated CSO Deep Tunnel cost. The estimated cost for HRT facilities assuming three untreated overflows at a 30-minute detention time is approximately $6 million less than the CSO Deep Tunnel alternative. However, these costs are only for construction and do not include O&M costs (e.g. manpower, chemical costs, power costs, etc.), which are much higher for the HRT option.

High Rate Treatment and Shorter Tunnel for Storage Alternative

As mentioned previously, in the 2009 LTCP, a 5.4-mile-long, 17-foot-diameter tunnel was included as a large conveyance and equalization facility to capture combined sewer flow from CSOs 106, 107, 108, 121, 109, 110, 111, 112, 114, 115, 117, 118, and 119 and convey it to a RTB facility at the MRWWTP. In this evaluation, a shortened, 1.95-mile-long tunnel with conveyance to a RTB, aimed at capturing combined sewer flow from CSOs with the largest volumes and pollutant loads, was considered. The following two scenarios were evaluated:

- Scenario 1 – Capture CSS wet weather flow from CSOs 106, 107, 108, 109, and 121 in a storage tunnel and provide HRT with a RTB at the Grace Street (CSO 107) location.
- Scenario 2 – Capture CSS wet weather flow from CSOs 108, 109, and 121 only and provide HRT with a RTB at the Grace Street (CSO 107) location. Send CSS flow from CSOs 106 and 107 directly to the Grace Street RTB facility.

In both scenarios, the tunnel would extend approximately 10,300 feet from CSO 109 to CSO 106 and compliance would be based on the Demonstration Approach. A brief discussion of peak rates, facility requirements, and costs for this alternative follows. More detailed information can be found in the *LTCP Update-Summary of Treatment and Storage Alternatives at CSO Priority Locations Technical Memorandum* (City of Omaha, 2013).

Peak Rates

For the purposes of this analysis, storage tunnel diameters and corresponding peak HRT rates assuming either zero untreated overflows or three untreated overflows per Representative Year were determined. Peak HRT rates were obtained from the InfoWorks Model, Interim Model Version 1.

Facility Requirements

The following components were included for each scenario:

1. Sewer to connect combined sewer flow to diversion structure
2. Sewer to convey flow from diversion structure to CSO Deep Tunnel drop shaft
3. CSO Deep Tunnel drop shafts
4. CSO Deep Tunnel
5. CSO Deep Tunnel Lift Station, grit facility, and force main to pump to RTB facility
6. RTB facility with disinfection
7. Gravity sewer to discharge flow from RTB facility to Missouri River

Similar to the HRT at CSO Priority Locations Alternative, a pump in/gravity out approach was assumed for evaluation of the RTB facility.

Costs

Corresponding costs for Scenarios 1 and 2 with three overflows were estimated to be approximately $55 million less and $97 million less, respectively, than the estimated CSO Deep Tunnel cost. When zero untreated overflows were assumed, total costs were estimated to be approximately $69 million and $14 million greater for Scenarios 1 and 2, respectively. However, these costs are only opinions of probable construction costs and thus, do not include O&M costs. The costs do not account for significant risks associated with sending a large majority of the CSO flows to a remote facility instead of maximizing flows to the MRWWTP.

Conclusions

Based on the preliminary evaluation of alternatives under the Demonstration Approach, the combined tunnel storage and treatment alternative with three overflows, in which flow from CSO 106/107 is sent directly to the RTB instead of being stored in the tunnel located between CSOs 106 and 109, was found to be potentially the least expensive alternative. This alternative was approximately $97 million or 26 percent less in construction cost than the LTCP CSO Deep Tunnel/RTB alternative. However, pursuit of these alternatives was not taken further for a number of key reasons, including the following:

- Although water quality calculations suggest that compliance with water quality standards would be achieved in the Missouri River downstream of the City, a more advanced water quality model would likely need to be developed to provide better accuracy and to assess water quality changes in the river because of CSO discharges.

- There is a high probability that more extensive controls would be required than is suggested by the alternatives described.
- A more rigorous and intensive, (and thus more expensive) post-construction water quality monitoring program would need to be implemented and conducted to demonstrate that water quality standards are being met or that the CSOs are not causing any exceedances.
- Scenarios involving several uncontrolled CSOs would be very difficult for NDEQ and EPA to approve, according to discussions with NDEQ.
- Floatables control would likely be needed at the CSO locations where end-of-pipe control or treatment facilities would not be included. An estimated minimum additional cost of $30 million would be required for floatables control at these locations. Information about the preliminary floatables control evaluation as well as more information about costs can be found in the *LTCP Update-Summary of Treatment and Storage Alternatives at CSO Priority Locations Technical Memorandum* (City of Omaha, 2013).
- O&M costs would be higher for these alternatives in comparison to the CSO Deep Tunnel approach. For HRT facilities at the five priority CSOs, O&M costs would be much higher due to the multiple treatment facilities that would need to be manned and operated, and due to additional floatables control. For the alternatives involving a shorter tunnel and a single HRT facility, the O&M cost would still likely be higher due to additional floatables control.
- The CSO Deep Tunnel approach has multiple advantages, and serves as the backbone for a significant portion of the LTCP. An example of an advantage is its ability to function as a backup to the SIFM, thereby eliminating the need for other redundancy approaches to the force main. Additionally, the presence of the tunnel would offer protection to the City from the significant amount of combined sewage flooding that occurred in low-lying areas of the City during the 2011 Flood.

As described in the following section, alternatives for refining the CSO Deep Tunnel under the Presumption Approach (EPA, 1995) were evaluated and will be implemented as part of this LTCP Update. However, aspects of the evaluations under the Demonstration Approach may be brought forward again in the future as affordability issues are addressed. (As discussed in Section 4, one potential approach to improve affordability is to modify the ultimate water quality target.)

CSO Deep Tunnel System Variation Alternatives

As noted previously, the tunnel evaluations and alternatives that considered the Demonstration Approach were not pursued further due to a number of reasons. The next step in the reevaluation process was to evaluate the tunnel using the latest available water quality information and the updated CSS model to evaluate potential modifications to the tunnel that meet the objectives of the 2009 LTCP, and thus the Presumptive Approach of the CSO Policy. Output from the 2027 InfoWorks Model indicated that an overall LTCP-equivalent percent capture could be met by assuming a minimum of 85 percent volume capture at each outfall, based on the 2002 wet weather volume. This approach would exceed the Presumption Approach of the EPA CSO Control Policy because the Presumption Approach refers to 85 percent volume capture overall. In addition, a limit of eight CSOs or fewer at each outfall in the Missouri River Watershed during the Representative Year was chosen for the evaluation (EPA, 1995).

Four tunnel system alternatives were evaluated:

- Tunnel System Alternative 1 – LTCP - Same CSO Deep Tunnel Size and Length as the 2009 LTCP
- Tunnel System Alternative 2 – CSO Deep Tunnel Extended to CSO 119
- Tunnel System Alternative 3 – Modify CSO Deep Tunnel and RTB Size
- Tunnel System Alternative 4 – CSO Storage Tunnel

Facility sizes, method of control for CSOs 118 and 119, number of overflows, and estimated percent capture for all evaluated alternatives are shown in Table 3-4. As shown in the table, tunnel diameters between 12 and 18 feet were evaluated. A tunnel length of 28,600 feet was used for all alternatives, except those where the tunnel was extended to CSO 119. For these alternatives, a tunnel length of 32,700 was used. More details about each of these tunnel system alternatives are discussed in the following paragraphs.

Tunnel System Alternative 1 – LTCP - Same Tunnel Size and Length

According to the 2024 InfoWorks Model, the conceptual plan for the CSO Deep Tunnel presented in the 2009 LTCP would provide 92.8 percent capture in the Missouri River Watershed when combined with other controls, and allow four CSOs per year (Alternative 1a). Using the 2027 Model with the same tunnel system dimensions, overall capture was reduced to 92.0 percent in the Missouri River Watershed, and the number of CSOs increased to 7 per year (Alternative 1b). Alternatives 1a and 1b are identified as the 'Original Baseline Alternatives' in Table 3-4.

Two alternatives aimed at achieving no more than four CSOs per year were developed as a basis of comparison to the 'Original Baseline Alternatives'. For the first alternative, the LTCP tunnel diameter was unchanged; however, the RTB size was increased from 52 mgd to 68 mgd (Alternative 1c) to achieve four CSOs. With this alternative, approximately 92.4 percent capture was achieved. For the second alternative, the LTCP tunnel diameter and RTB size were varied, but flows from CSO 118 and CSO 119 would be captured by individual storage facilities instead of being captured by the tunnel (Alternative 1d).

Tunnel System Alternative 2 - Tunnel Extended to CSO 119

The 2009 LTCP CSO Deep Tunnel had flows from the diversion structure for CSO 119 conveyed by a 96-inch-diameter pipe to a drop shaft near CSO 118 on the MRWWTP site. After further analysis, it was determined that the alignment of the 96-inch pipe through this area would be difficult and not practical. As such, adding a sixth drop shaft near CSO 119 and extending the length of the Deep Tunnel to CSO 119 was evaluated. With this alternative, the length of the Deep Tunnel would be extended by approximately 4,100 feet. Because the Deep Tunnel is sized by volume, extending the Deep Tunnel by 4,100 feet would allow the diameter to be reduced by approximately 1 foot, from 17 feet to 16 feet (based on the InfoWorks Model). This alternative (Alternative 2a) would result in the following changes:

- Increase in length of CSO Deep Tunnel
- Decrease in diameter of CSO Deep Tunnel
- Decrease in surface conveyance from CSO 119 to drop shaft
- Additional CSO drop shaft

This alternative (Alternative 2a), identified as the 'New Baseline Alternative' in Table 3-4, would capture flows from all CSOs to be controlled by the tunnel (CSOs 106, 107, 108, 109, 110, 111, 114, 115, 118, 119, 121). The designation of New Baseline Alternative was made because this alternative would provide the same level of control using the 2027 Model as the original system in the 2009 LTCP, and because it included a more constructible and operable approach for capturing CSO 119 (i.e., extending the tunnel rather than constructing a gravity sewer across the MRWWTP site). Another version of this alternative (Alternative 2b), where flows from all CSOs except CSOs 118 and 119 would be captured in the tunnel, was also evaluated. In this version, individual storage facilities would capture CSOs 118 and 119 flows. Corresponding storage facilities for CSOs 118 and 119 would be sized at 5.6 MG and 5.1 MG, respectively.

TABLE 3-4
Tunnel System Alternatives

Tunnel System Alternative	1 - LTCP - Same Tunnel Size and Length				2 - Tunnel Extended to CSO 119		3 - Modify Tunnel and RTB Size			4 - Storage Tunnel	
	1a	1b	1c	1d	2a	2b	3a	3b	3c	4a	4b
Parameter	LTCP Size (2024 Model)	LTCP Size (2027 Model)	LTCP Tunnel Size - RTB Increased to Achieve 4 Watershed CSOs (2027 Model)	LTCP Size - No Flow from 118 & 119 (2027 Model)	Flows from All CSOs Captured by Tunnel	All Flows Except CSO 118 and 119 Captured by Tunnel	Smaller Tunnel Option 1	Smaller Tunnel and Smaller RTB	Smaller Tunnel Option 2	Dewater in 48 hours - Meets Individual CSO 85% Capture Conditions	Dewater in 72 Hours - Meets Individual CSO 85% Capture Conditions
Tunnel Diameter (feet)	17	17	17	17	16	14.5	12	15	14	18	16.5
Tunnel Length (feet)	28,600	28,600	28,600	28,600	32,700	32,700	28,600	28,600	28,600	28,600	28,600
No. of Drop Shafts[1]	5	5	5	5	6	4	4	4	4	4	4
RTB Size (mgd)	52	52	68	52	63	60	50	22	50	NA	NA
Lift Station (mgd)	52	52	68	52	63	60	50	22	50	27	15
CSO 118 Control	Tunnel System	Tunnel System	Tunnel System	Storage or RTB[3]	Tunnel System	Storage or RTB[3]	Storage or RTB[3]	4.1 MG Storage	Storage or RTB[3]	Storage or RTB[3]	Storage or RTB[3]
CSO 119 Control	Tunnel System	Tunnel System	Tunnel System	Storage or RTB[4]	Tunnel System	Storage or RTB[4]	Storage or RTB[4]	2.9 MG Storage	Storage or RTB[4]	Storage or RTB[4]	Storage or RTB[4]
Watershed - No. of Overflows	4	7	4	4	4	4	8	8	7	8	10
System Percent Capture (Not Including CSO 105)[2]	92.8%	92.0%	92.4%	91.9%	92.4%	91.0%	87.7%	89.2%	89.4%	88.9%	88.8%

1 'No. of Drop Shafts' does not include the 21' Screening and 30' Pump Station drop shafts. Locations for other drop shafts are 106/107, 108, 109/121, 114/115, and 117/118/119. For alternatives where 118 and 119 flow is not being collected by the tunnel, this drop shaft has been eliminated. For the 'New Baseline Alternative', the number of drop shafts was increased to account for a drop shaft at CSO 119.

2 CSO 105 volume included in LTCP Size (2024 Model and 2027 Model) alternative. CSO 105 volume included in LTCP Size (2024 Model) alternative. CSO 105 volume not included in all other alternatives. When CSO 105 is taken into consideration, watershed percent capture is approximately 2 percent less than tunnel system percent capture shown in table.

3 CSO 118 storage alternative with 4 CSOs (5.6 MG) used for alternatives with 4 Watershed CSOs. CSO 118 storage alternative with 8 CSOs (4.1 MG) used for alternatives with 8 and 10 Watershed CSOs.

4 CSO 119 storage alternative with 4 CSOs (5.1 MG) used for alternatives with 4 Watershed CSOs. CSO 119 storage alternative with 8 CSOs (2.9 MG) used for alternatives with 8 and 10 Watershed CSOs.

Original Baseline Alternative
New Baseline Alternative
Selected Alternative

Tunnel System Alternative 3 - Modify Tunnel and RTB Size

The following three scenarios were evaluated for Tunnel System Alternative 3:

- Alternative 3a – 12-foot Tunnel Diameter, 50 mgd RTB
- Alternative 3b - 15-foot Tunnel Diameter, 22 mgd RTB
- Alternative 3c – 14-foot Tunnel Diameter, 50 mgd RTB

Flows from CSO 118 and CSO 119 would be captured by individual storage or RTB facilities for all of these alternatives. Seven or eight CSOs would occur in an average year.

Tunnel System Alternative 4 - Storage Tunnel

Two scenarios were considered for Alternative 4. Under Alternative 4a, flow would be captured in a tunnel sized for storage (as opposed to equalization/conveyance) and dewatered over a period of 48 hours. With Alternative 4b flow would be captured and dewatered over a period of 72 hours. Similar to Tunnel System Alternative 3, flows from CSO 118 and CSO 119 would be captured by individual storage or RTB facilities.

CSO Deep Tunnel Selected Alternative

For comparison purposes, construction costs for all the alternatives were developed using the Program Cost Tool (Version 2.8), with the Original Baseline Alternative (Alternatives 1a and 1b) and New Baseline Alternative (Alternative 2a) as the cost baseline. The following conclusions were made:

- Estimated construction costs for Alternatives 1c and 1d are higher than the 'Original Baseline Alternative'. As such, both of these alternatives were eliminated from further consideration.
- The estimated construction cost for Alternative 2b is approximately 6 percent more than the 'New Baseline Alternative' and thus, it was eliminated from further consideration.
- Alternative 3a is the least expensive of the 'Alternative 3-Modify Tunnel and RTB Size' Tunnel System Alternatives. However, concerns were voiced as to whether a 12-foot diameter tunnel could hydraulically convey large flows in shorter amounts of time. Given these concerns, this alternative was eliminated from further evaluation, but may be considered during preliminary design of the tunnel.
- Estimated construction costs for Alternatives 3b and 3c are 6 percent less than the 'New Baseline Alternative'.
- The estimated construction cost for Alternative 4a is approximately the same as the 'New Baseline Alternative' and thus, this alternative was eliminated from further consideration. The estimated cost for Alternative 4b is approximately 5 percent less than the 'New Baseline Alternative' cost. This alternative was eliminated from further consideration because it did not meet the set criteria of eight or fewer overflows at each CSO outfall.
- The lowest estimated construction cost alternatives as compared to the 'New Baseline Alternative' are Alternatives 3b and 3c. Given approximately equal costs, Alternative 3b was identified as the 'Selected Alternative' due to the smaller RTB size. In Alternative 3b, a 22 mgd RTB would be required. In comparison, a 50 mgd RTB would be required for Alternative 3c. The smaller RTB poses advantages, including a smaller footprint within the tight constraints of the MRWWTP, and the potential for elimination if upgrades to expanded wet weather capacity perform better than anticipated.

A complete summary of estimated construction costs for all evaluated alternatives can be found in Appendix D. Estimated construction costs for components of the 'Original Baseline Alternative', 'New Baseline Alternative', and 'Selected Alternative' are summarized in Table 3-5. Figure 3-5 shows a preliminary alignment for the CSO Deep Tunnel, with updated drop shaft locations. Four drop shafts are now planned versus the original five described in the 2009 LTCP.

FIGURE 3-5
Preliminary CSO Deep Tunnel Alignment and Updated Drop Shaft Locations

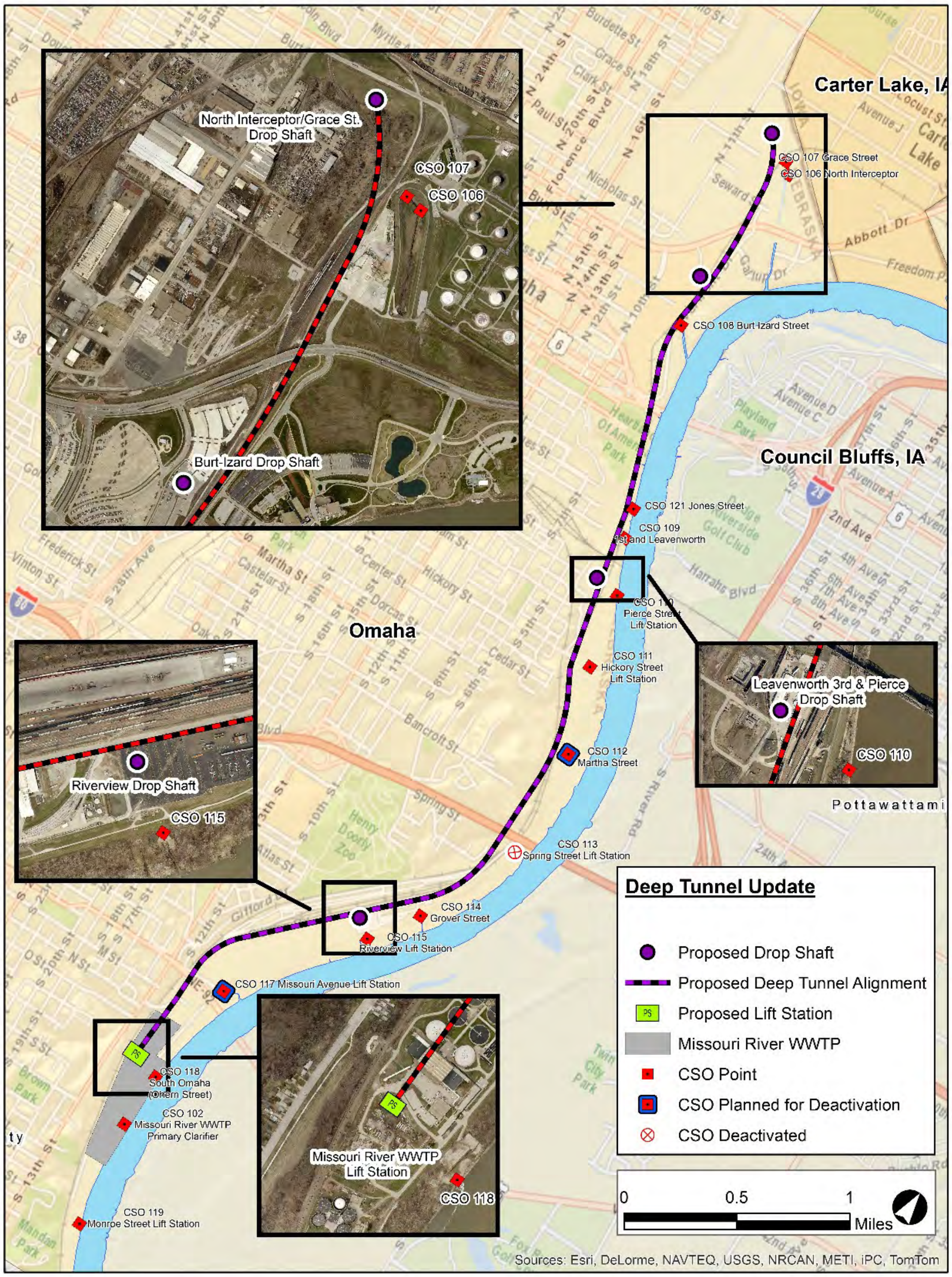


TABLE 3-5
Tunnel System Alternatives Cost Comparison

Tunnel System Alternative	1 - LTCP - Same Tunnel Size and Length		2 - Tunnel Extended to CSO 119	3 - Modify Tunnel and RTB Size
	1a	1b	2a	3b
Parameter	LTCP Size (2024 Model)	LTCP Size (2027 Model)	Flows from All CSOs Captured by Tunnel	Smaller Tunnel and Smaller RTB
Tunnel Diameter (feet)	17	17	16	15
Tunnel Length (feet)	28,600	28,600	32,700	28,600
No. of Drop Shafts[1]	5	5	6	4
RTB Size (mgd)	52	52	63	22
Lift Station (mgd)	52	52	63	22
CSO 118 Control	Tunnel System	Tunnel System	Tunnel System	4.1 MG Storage
CSO 119 Control	Tunnel System	Tunnel System	Tunnel System	2.9 MG Storage
Watershed - No. of Overflows	4	7	4	8
System Percent Capture (Not Including CSO 105)[2]	92.8%	92.0%	92.4%	89.2%
Deep Tunnel	$139,624,000		$152,847,000	$127,640,000
Deep Tunnel Drop Shafts	$42,526,000		$47,208,000	$37,844,000
Conveyance to Tunnel Drop Shafts	$18,629,000		$8,485,000	$6,096,000
MRWWTP RTB + Conveyance to CSO Outfall	$8,138,000		$9,502,000	$5,515,000
Deep Tunnel Lift Station	$21,828,000		$22,868,000	$18,392,000
CSO 118 Alternative Cost	$0		$0	$16,714,000
CSO 119 Alternative Cost	$0		$0	$14,064,000
Total Cost (ENR 7888)	$230,745,000		$240,910,000	$226,265,000
Total Cost (ENR 8528)	$249,467,000		$260,456,000	$244,623,000
Cost Difference Compared to LTCP	$0		$0	-$15,833,000
% Difference Compared to LTCP	0.0%		0.0%	-6.1%
Grit Basin Adder (ENR 8528)	$25,000,000		$25,000,000	$25,000,000
Subtotal	$274,467,000		$285,456,000	$269,623,000
25% Contingency	$68,617,000		$71,364,000	$67,406,000
Budgetary Total	$343,084,000		$356,820,000	$337,029,000

1 'No. of Drop Shafts' does not include the 21' Screening and 30' Pump Station drop shafts. Locations for other drop shafts are 106/107, 108, 109/121, 114/115, and 117/118/119. For alternatives where 118 and 119 flow is not being collected by the tunnel, this drop shaft has been eliminated. For the 'New Baseline Alternative', the number of drop shafts was increased to account for a drop shaft at CSO 119.

2 CSO 105 volume included in LTCP Size (2024 Model) alternative. CSO 105 volume not included in all other alternatives. When CSO 105 is taken into consideration, watershed percent capture is approximately 2 percent less than tunnel system percent capture shown in table.

Original Baseline Alternative
New Baseline Alternative
Selected Alternative

3.5 Basin Control Updates

As part of the LTCP Update process, the planned controls in each basin in the CSS were examined to determine if improvements could be made. In addition, each LTCP project that had been designed has been scrutinized with the intent of reducing cost while maintaining required performance as part of the overall CSO Program.

This section presents updates to CSO control projects specific to each of the CSS basins in both the Papillion Creek and Missouri River Watersheds. The discussion is generally organized into the following subsections: Completed Projects, Projects under Construction, Projects in Design, Future Projects, and Proposed Changes from the LTCP. Projects listed under Completed Projects and Projects under Construction are described in Section 2, but are listed again in this section. The descriptions for projects under Proposed Changes from the LTCP address proposed changes to the controls described in the LTCP. The updated level of control under the Presumption Approach of EPA's CSO Control Policy is described in Section 5.

3.5.1 Deactivated CSOs

The following CSO outfalls have been deactivated, resulting in a current number of 26 remaining outfalls:

- CSO 104 – Mormon Street (plugged in 2014)
- CSO 113 – Spring Street (converted to storm outfall in 2011)
- CSO 209 – 44th and Harrison (plugged in 2012)

As listed in Section 1 of this LTCP Update, an additional 10 CSO outfalls are planned to be deactivated in the future.

3.5.2 Saddle Creek Basin (CSO 205)

The Saddle Creek Basin lies to the south of the Papillion Creek North Basin and to the north of the Papillion Creek South Basin. Its eastern boundary is adjacent to the Burt-Izard, Leavenworth, South Interceptor and Ohern/Monroe Basins.

This basin contains one CSO outfall, CSO 205 – 64th and Dupont. The control approach identified for this basin in the LTCP was selected separation within the basin and HRT at CSO 205. Three projects were identified in the LTCP to accomplish this. The sewer separation projects have been completed and the Saddle Creek RTB project will be under construction in October 2015.

3.5.2.1 Completed Projects

The following projects (described in Section 2) in the Saddle Creek Basin are completed:

- Aksarben Village Phases A and B
- Bohemian Cemetery Sewer Separation (Saddle Creek Area – 55th to 64th Street Sewer Separation)

3.5.2.2 Projects under Construction

The following project is anticipated to be under construction by October 2015:

- The Saddle Creek CSO 205 – 64th & Dupont RTB, described in Section 2, will be under construction in October 2015

In the 2009 LTCP, the Saddle Creek CSO 205 – 64th and Dupont RTB project (Saddle Creek RTB project [OPW 52049]), was identified as a major project to treat overflows at CSO 205. Figure 3-6 shows CSO 205 during a storm event. Figure 3-7 shows the location of the RTB.

FIGURE 3-6
CSO 205 (Courtesy of the City of Omaha)

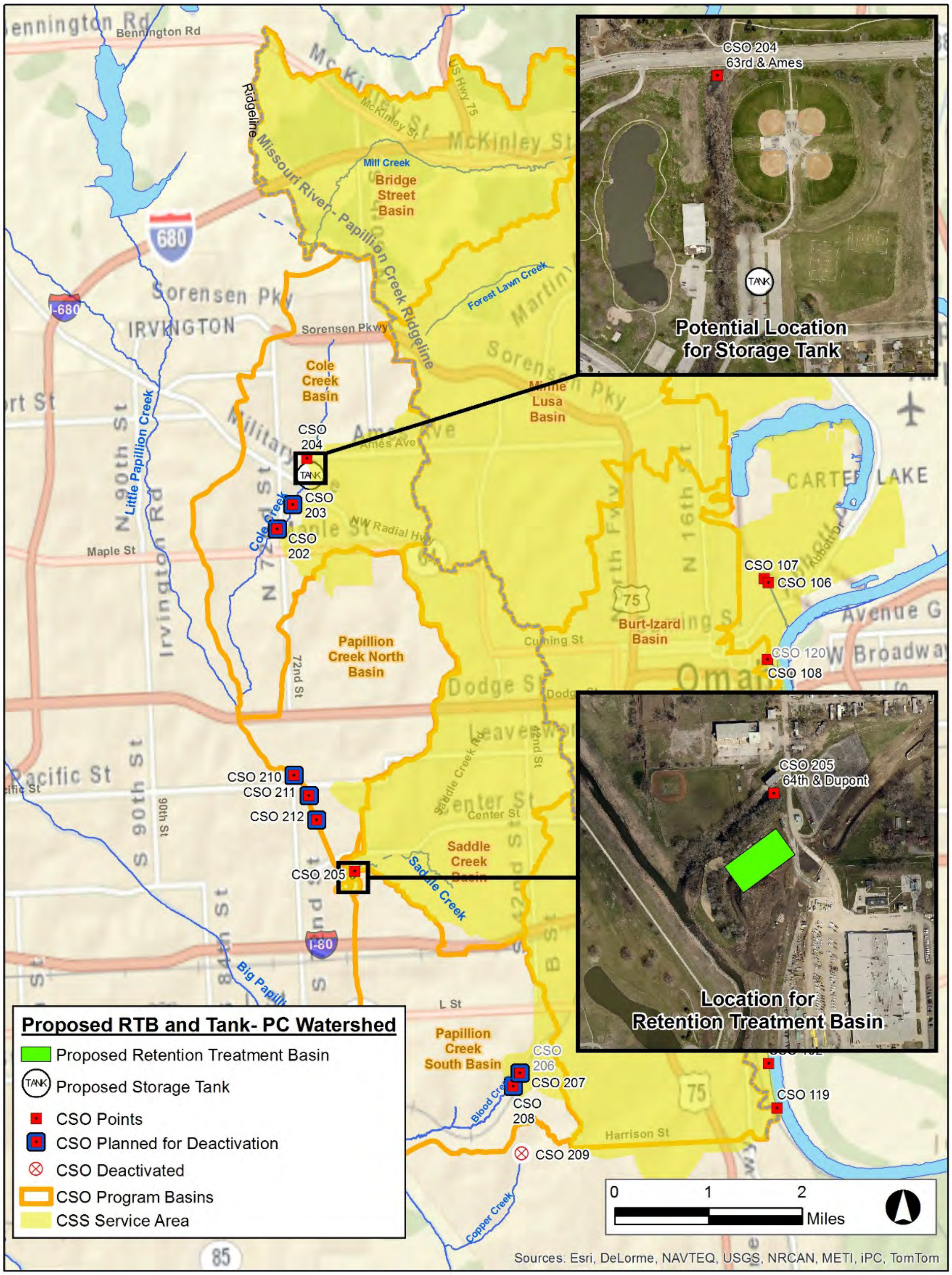
InfoWorks Model runs using hourly precipitation input data had demonstrated that a 315-mgd facility with a 30-minute contact time would be needed to achieve the required level of control. In late 2011, conceptual design for the Saddle Creek RTB project began. Based on the findings from the model that had been recalibrated for the Saddle Creek Basin, work was done to determine the required design flow rate needed to achieve an equivalent level of control as in the 2009 LTCP. As a result, it was determined pending further evaluation that the RTB facility size would need to increase to accommodate a design flow of 360 mgd.

To reduce facility costs, detention or contact times required to achieve the equivalent of primary clarification were investigated. To analyze this, a bench-scale study was conducted to determine TSS and BOD removal efficiencies at 15 minutes, 30 minutes, and 45 minutes. For this study, eight wet weather events were sampled at CSO 205 during the late spring and summer of 2011. Although averages obtained for both TSS and BOD after 15 minutes of settling were above the typical removal efficiencies reported for primary clarification, the City and PMT later confirmed in discussions with NDEQ that the intent of the equivalent-to-primary criterion is to provide 30 minutes of solids settling in settling compartments. As such, the preliminary design proceeded with the definition of 'equivalent to primary clarification' as providing 30 minutes of detention of the peak design flow rate within the settling compartments.

In addition to determining TSS and BOD removal efficiencies, bench-scale testing confirmed the following:

- CSO flow characteristics were typical as compared to findings at other similar CSOs and RTB installations.
- The facility could expect to achieve more than 50 percent capture of TSS loadings on an annual basis.
- Sodium hypochlorite is an adequate disinfectant that can achieve required bacteria kills in less than 15 minutes.
- First flush loads could potentially require higher than typical dosages of disinfectant to achieve adequate treatment.

FIGURE 3-7
Potential Locations of Storage Tanks and Retention Treatment Basins in the Papillion Creek Watershed



Complete details on the bench-scale testing results can be found in the *Saddle Creek RTB Sampling Technical Memorandum* (Wade Trim, 2011).

During preliminary design, the InfoWorks Model was re-calibrated for the full Papillion Creek Watershed. It was determined that the original 315-mgd design flow for the RTB, along with the other planned controls in the Watershed would provide a comparable annual average volumetric capture as in the 2009 LTCP. As explained further in Section 5, five partially treated CSOs are predicted by the Model to occur in an average year; however, the volumetric capture provided compliance with the EPA CSO Control Policy. The design of the RTB is proceeding with a 315-mgd design flow and a 30-minute settling time.

3.5.2.3 Projects in Design

No projects are anticipated to be in design in the Saddle Creek Basin in October 2015.

3.5.2.4 Future 2009 LTCP Projects

There are no future 2009 LTCP projects planned for the Saddle Creek Basin.

3.5.2.5 Proposed Changes to the LTCP

There are no major proposed changes to the LTCP for the Saddle Creek Basin. However, as noted in Section 2, green infrastructure features were incorporated into the Aksarben Village and Bohemian Cemetery projects, and the ability to maximize flow to the Little Papillion Interceptor was made part of the Saddle Creek RTB project.

3.5.3 Cole Creek Basin (CSOs 202, 203, and 204)

The Cole Creek Basin encompasses approximately 4,450 acres, of which 860 acres are within the Combined Sewer Service Area. The basin is comprised of 221,000 feet of combined sewer. Four diversion structures are associated with three basin outfalls that discharge to Cole Creek: CSO 202 - 72nd and Bedford; CSO 203 -69th and Evans; and CSO 204 - 63rd and Ames (two diversions contribute to this outfall). In the 2009 LTCP, sewer separation was chosen as the primary approach to reduce overflows in this basin. Because private infrastructure separation would cause significant disruption on private property, the City determined it would be appropriate to also include a storage tank at CSO 204 to reduce the number of CSO events to four, if required, assuming Representative Year precipitation.

3.5.3.1 Completed Projects

As of October 2015, the following project, described in Section 2, will be completed:

- Cole Creek CSO 204 Phase 1 Sewer Separation

3.5.3.2 Projects under Construction

No projects are anticipated to be under construction in the Cole Creek Basin in October 2015.

3.5.3.3 Future 2009 LTCP Projects

The following projects within the Cole Creek Basin were included as future projects in the 2009 LTCP and remain essentially unchanged in the LTCP Update:

- Cole Creek CSO 202 Sewer Separation (Phases 1, 2 and 3) – Construct both sanitary sewer and storm sewer to allow for conversion of the existing combined sewer to either storm or sanitary sewer and to provide separation to this 101-acre area. This reduces flows into the collection system and allows for the future deactivation of CSO 202.

- Cole Creek CSO 203 Sewer Separation – Similar to the Cole Creek CSO 202 Sewer Separation project, construct both sanitary and storm sewer to allow for conversion of the existing combined sewer to either storm or sanitary sewer. This provides separation to a 125-acre area, reduce flows into the collection system, and allow for the future deactivation of CSO 203.
- Cole Creek Diversions – Reconstruct the CSO 204 diversions to ensure proper operation to contain dry weather flows and capture the required amount of wet weather flows.
- CSO 204 – 63rd and Ames Storage Tank (see Figure 3-7) – Construct a 50,000-gallon storage tank, which is a small change in size from the 80,000-gallon tank included in the 2009 LTCP.

3.5.3.4 Proposed Changes to the LTCP

The Cole Creek CSO 204 Sewer Separation project is comprised of multiple phases, as stated previously. Along with the study for the Phase 1 project, a project was conducted to study and gather field data for the entire area contributing to CSO 204. The City determined early in the preliminary design that an increase in the peak discharge of stormwater to Cole Creek would not be allowed by the City. The design of the CSO 204 area was modified from the conceptual plan in the 2009 LTCP, which called for new storm sewers sized for the 10-year design storm, to a design that would address sewer backups and localized street flooding without increasing the peak runoff from the area. This new concept relies more on a reuse of existing combined sewers converted to storm sewers. This change in concept, along with a determination that a portion of the area contributing to CSO 204 was already separated, allowed for the work schedule to be modified to be accomplished in six phases of work instead of the nine phases included in the 2009 LTCP. The project identified in the LTCP as Cole Creek CSO 204 Phase 2 and 3 has been split into separate projects, and the following projects included in the LTCP are no longer needed:

- Cole Creek CSO 204- Phase 7
- Cole Creek CSO 204- Phase 8
- Cole Creek CSO 204 Sewer Separation Phase 3 Rehabilitation
- Cole Creek CSO 204 Sewer Separation Phase 9 Rehabilitation

Also, as noted previously, the planned size of the storage tank at CSO 204 has been adjusted from 80,000 to 50,000 gallons. The potential location of this tank is shown in Figure 3-7.

3.5.4 Papillion Creek South Basin (CSOs 206, 207, 208, and 209)

The Papillion Creek South Basin is located in the southwest portion of the CSO basins. The Papillion Creek South Basin contains 3,500 acres and 253,000 feet of combined sewer, with approximately 190 acres upstream of the diversions that lead to the CSOs. The area that contributes to CSO 206 – 43rd and S Street lies within the extended area of this basin. This CSO was in the 2002 CSO Permit, but was plugged in 2005 and is no longer a permitted CSO outfall. Three additional CSOs are located within this basin: CSO 207 – 44th and Y Street, CSO 208 – 45th and T Street, and CSO 209 – 44th and Harrison. As noted previously in this section, CSO 209 has been deactivated. Two projects within this basin were identified in the

2009 LTCP to accomplish sewer separation. One of these projects is complete and the other will be in design in October 2015.

3.5.4.1 Completed Projects

The following project, described in Section 2, has been completed:

- 42nd Street and X Street Sewer Separation

3.5.4.2 Projects under Construction

No projects in the Papillion Creek South Basin are anticipated to be under construction in October 2015.

3.5.4.3 Projects in Design

The following project is anticipated to be under design in October 2015.

42nd Street and Q Street Sewer Separation Project

This project will provide sewer separation to the area bounded by Orchard Avenue on the north, 39th Street on the east, R Street on the south, and 44th Street on the west. The conceptual plan for this project includes construction of both new sanitary sewer and storm sewer. New storm sewers will be constructed along 42nd Street, Q Street, and R Street. Sanitary sewer will be constructed to carry newly separated sanitary sewer flow into an existing combined sewer that will be converted to a sanitary sewer. This project is being coordinated with the design and construction of a City transportation project to replace a railroad bridge and provide intersection improvements. Construction of the storm sewer as part of the roadway/bridge project is anticipated to begin in 2015. The remaining sewer separation in the surrounding area is anticipated to be completed in 2018.

3.5.4.4 Future 2009 LTCP Projects

There are no future projects planned for the Papillion Creek South Basin.

3.5.4.5 Proposed Changes to the LTCP

There are no proposed changes to the LTCP for the Papillion Creek South Basin.

3.5.5 Papillion Creek North Basin (CSOs 210, 211, and 212)

The Papillion Creek North Basin is located to the south of the Cole Creek Basin and to the west of the Saddle Creek Basin. The Papillion Creek North Basin contains 2,500 acres and includes 166,000 feet of combined sewer. Approximately 220 acres are upstream of known diversions within the basin that lead to CSO outfalls. Three diversion structures and three outfalls are in the basin: CSO 210 - 72nd and Mayberry Streets; CSO 211 - 69th and Pierce Streets; and CSO 212- 69th and Woolworth Streets. The Little Papillion Interceptor passes through the basin along Little Papillion Creek. The 2009 LTCP called for sewer separation and deactivation of CSOs 211 and 212. Although the 2024 Model predicted that CSO 210 would overflow during the Representative Year, it was stated that the City's goal was to deactivate this CSO as well, pending the outcome of sewer separation work and further study as needed.

3.5.5.1 Completed Projects

- The CSO 211 Sewer Separation (also known by the common name of Pacific Street 63rd to 66th Sewer Separation) project has been completed and is described in Section 2.

3.5.5.2 Projects under Construction

No projects in the Papillion Creek North Basin will be under construction in October 2015.

3.5.5.3 Projects in Design

No projects in the Papillion Creek North Basin will be in design in October 2015.

3.5.5.4 Future 2009 LTCP Projects

The following Papillion Creek North Basin projects were also included in the 2009 LTCP:

- CSO 210 Sewer Separation – This sewer separation project includes construction of both sanitary and storm sewer to allow for conversion of the existing combined sewer to either storm or sanitary sewer. This project will reduce flows in the collection system and may allow for the abandonment of CSO 210. Deactivation of this CSO outfall is a goal pending monitoring results.
- CSO 212 Sewer Separation – This project includes construction of storm sewer to provide sewer separation to this 41-acre area. Deactivation of this CSO outfall is a goal pending monitoring results.
- CSO 210 Interceptor Improvements
- CSO 211 Interceptor Improvements

3.5.5.5 Proposed Changes to the LTCP

Proposed changes to Papillion Creek North Basin projects are intended to focus on inflow reduction measures in the basin rather than construction of new interceptors. Therefore, the names of the following projects have been changed as indicated:

- CSO 210 Interceptor Improvements Project renamed to CSO 210 Inflow Reduction Project
- CSO 211 Interceptor Improvements Project renamed to CSO 211 Inflow Reduction Project

3.5.6 Bridge Street Basin (CSO 103)

The Bridge Street Basin is the northernmost basin in the Missouri River Watershed and contains one CSO discharge point to the Missouri River. The basin includes CSO 103, which will be deactivated upon completion of the 36th Street sewer separation project. Two projects from the Bridge Street Basin were included in the 2009 LTCP to accomplish sewer separation and enhance system reliability.

3.5.6.1 Completed Projects

The following project is anticipated to be completed by October 2015:

- 36th Street Sewer Separation project.

3.5.6.2 Projects under Construction

No projects in the Bridge Street Basin are anticipated to be under construction in 2015.

3.5.6.3 Projects in Design

No projects in the Bridge Street Basin will be in design in October 2015.

3.5.6.4 Future 2009 LTCP Projects

The Bridge Street Lift Station Improvements project was included in the 2009 LTCP as a system reliability project. This project is anticipated to begin construction in 2026.

3.5.6.5 Proposed Changes to the LTCP

There are no proposed changes to the LTCP for the Bridge Street Basin.

3.5.7 Burt-Izard Basin (CSO 108)

The Burt-Izard Basin is located south of the Minne Lusa Basin and north of the Leavenworth Basin. It contains a single CSO discharge point, CSO 108 – Burt-Izard Street, which overflows to the Missouri River. The primary proposed control at this CSO is a combination of increased conveyance to the new SIFM and connection to the CSO Deep Tunnel with a single drop shaft located near the Century Link Center, with treatment of the tunnel flows at the RTB located at the MRWWTP. The CSO outfall will remain in place. The 2009 LTCP anticipated no more than four untreated overflows from CSO 108 based on Representative Year precipitation.

The 2009 LTCP also described sewer separation within the Burt-Izard Basin totaling approximately 470 acres. The separation was targeted at areas with a history of street flooding and basement backups. The Nicholas Street stormwater outfall, which was originally constructed as a part of the riverfront re-development, allows for stormwater to be removed from the combined system as separation occurs. Separation of portions of the Burt-Izard Basin is intended to maximize flows to the Nicholas Street sewer and reduce CSO peak flows and volume to the existing combined sewers.

3.5.7.1 Completed Projects

The following three Burt-Izard Basin projects, described in Section 2, will be completed by October 2015:

- Webster Street Sewer Separation Phase 2
- Nicholas Street Phase 1 (10th Street to 16th Street)
- Nicholas & Webster Sewer Separation Phase 1

3.5.7.2 Projects under Construction

The following project, described in Section 2, is anticipated to be under construction in October 2015:

- Nicholas Street Phase 2 (to 23rd & Grace)

3.5.7.3 Projects in Design

The Burt Izard Lift Station Improvement project is anticipated to be under design by October 2015.

While this project is located in the Burt-Izard Basin, it is interrelated to projects aimed at maximizing flows to the MRWWTP and was discussed in Section 3.4.2.1. Modifications will be made to upgrade the Burt-Izard Lift Station to convey up to 50 mgd to help maximize flow to MRWWTP.

3.5.7.4 Future 2009 LTCP Projects

Future projects within the Burt-Izard Basin that were included in the 2009 LTCP include the following:

- Nicholas and Webster Sewer Separation Phase 2 – Construction of both sanitary and storm sewer to allow conversion of existing combined sewer to sanitary or storm sewer.
- Nicholas Street Sewer Separation Phase 3 – Construction of both sanitary and storm sewer to provide capacity for flows from other sewer separation projects upstream of the area.
- 18th Street and Seward Street Sewer Separation – Construction of both sanitary and storm sewer. This project will reduce flows to the downstream CSS.
- 16th Street and Grant Street Sewer Separation – Construction of both sanitary and storm sewer, using the existing combined sewer for either storm or sanitary flows, as appropriate.
- 26th & Corby Sewer Separation Phases 2, 3, 4 and 5
- 23rd Street and Seward Street

3.5.7.5 Proposed Changes to the LTCP

The following projects are proposed to be eliminated from the LTCP:

The scope of the CSO projects in the Burt-Izard Basin has been modified from what was included in the 2009 LTCP to take advantage of more sewer separation further south in the Basin, closer to the termination of the 108-inch diameter storm sewers completed as part of Nicholas Street Phase 1 at 16th and Nicholas. By focusing sewer separation efforts in the southerly portion of the Burt-Izard Basin rather than in the 26th & Corby area, the City is able to reduce costs associated with the extension of the large 108-inch sewers further north into the basin. This change also results in removal of significant stormwater flow from the CSS to the 108-inch storm sewers extended to 16th Street, providing additional water quality benefits and reduced CSOs much earlier in the Program.

As a result of this change in scope, the following projects are proposed to be eliminated:

- 26th and Corby Sewer Separation Phases 1 through 5 – These projects are now being constructed through the City's RNC program, which addresses sewer backups and street flooding.
- 23rd Street and Seward Street Sewer Separation
- 30th Street and Burdette Street Sewer Separation

The other future projects noted above have been revised in accordance with the new concept for the Burt Izard Basin.

3.5.8 Leavenworth Basin (CSOs 109, 121)

The Leavenworth Basin is located south of the Burt-Izard Basin and north of the South Interceptor Basin. The basin contains two CSOs: CSO 121 – Jones Street and CSO 109 – 1st and Leavenworth, which overflow to the Missouri River. The proposed controls for these CSOs include redirection of flows from the Jones Street Sewer to the Leavenworth Sewer, increased conveyance to the new SIFM, and connection to the Deep Tunnel with a single drop shaft located north or south of the existing UPRR bridge. Tunnel flows will be treated at the RTB located at the MRWWTP. The CSO outfalls will remain in place. The LTCP envisioned no more than four CSOs per year based on Representative Year precipitation. One project for each CSO was included in the LTCP.

3.5.8.1 Completed Projects

The following project, described in Section 2, will be completed by October 2015:

- Leavenworth Lift Station Replacement project.

This project was also described in Section 3.4.2.1 because it is part of the Missouri River Watershed work intended to maximize flow to the MRWWTP.

3.5.8.2 Projects under Construction

No projects in the Leavenworth Basin are anticipated to be under construction in October 2015.

3.5.8.3 Projects in Design

No projects in the Leavenworth Basin are anticipated to be in design in October 2015.

3.5.8.4 Future 2009 LTCP Projects

The following future project is described in the 2009 LTCP:

- Jones Street to Leavenworth Diversion Structure

Combined flows will be diverted from the Jones Street diversion structure to the Leavenworth diversion structure by installing twin sluice gates to redirect the flow from this CSO. The gates will be installed at the existing Jones Street diversion structure in place of existing manual sluice gates that are open and not normally operated (and will be removed). Because the depth of flow in the sewer cannot be raised significantly without causing concern for basement backups, the gates will cover only the lower portion (about 4 feet) of the twin 7-foot-high by 6-foot-wide pipes so that in higher flows the gates can be overtopped. The sluice gates will be raised automatically so that flows can be relieved quickly enough to protect the surrounding sewer system during more extreme wet weather events. In the LTCP, the gates were envisioned to be designed so that CSO 121 – Jones Street would experience four partially treated overflows based on Representative Year precipitation. Dry weather flows and wet weather flows for smaller storm events will be conveyed to the Leavenworth Lift Station.

3.5.8.5 Proposed Changes to the LTCP

There are no proposed changes to the 2009 LTCP for the Leavenworth Basin.

3.5.9 South Interceptor Basin (CSOs 110, 111, 112, 113, 114, 115, 116, and 117)

The South Interceptor Basin is located south of the Leavenworth Basin and north of the Ohern/Monroe Basin. It contains the following seven CSOs (CSO – 116 was deactivated prior to the 2009 LTCP):

- CSO 110 – Pierce Street Lift Station
- CSO 111 – Hickory Street Lift Station
- CSO 112 – Martha Street
- CSO 113 – Spring Street Lift Station

- CSO 114 – Grover Street
- CSO 115 – Riverview Lift Station
- CSO 117 – Missouri Avenue Lift Station

The overall control approach for CSOs in the South Interceptor Basin includes re-direction of flows, sewer separation, and a combination of increased conveyance to the new SIFM and connection to the CSO Deep Tunnel, with treatment of the tunnel flows at the RTB. The 2009 LTCP envisioned CSO outfalls 110, 111, 112, 114, 115, and 117 remaining active and having no more than four overflows based on Representative Year precipitation. CSO outfall 113 was envisioned to be deactivated.

3.5.9.1 Completed Projects

The following projects, described in Section 2, have been completed:

- Spring Street Sewer Separation
- Martha Street Sewer Separation, Phases 1 and 2

3.5.9.2 Projects under Construction

The following project, described in Section 2, is anticipated to be under construction in October 2015:

- Missouri Avenue Sewer Separation Phase 1

3.5.9.3 Projects in Design

The following project is anticipated to be in design in October 2015:

- Riverview Lift Station Replacement.

A new lift station along with a drop shaft to the tunnel (drop shaft to be designed in a future project) will be constructed for this subbasin. The new lift station will be sized for approximately 7 mgd, as noted in the 2009 LTCP. The project is required to handle the increase in flows due to redirection of sanitary flows from other areas in the South Interceptor Basin and expansion of the Henry Doorly Zoo. No separation is planned for this subbasin. This project also includes completion of the Martha Street to Riverview Lift Station Phase 2 project. The Riverview Lift Station project is also described in Section 3.4.2.1 in the context of the Missouri River Watershed Controls.

3.5.9.4 Future 2009 LTCP Projects

The following are future projects within the South Interceptor Basin that were included and described in the 2009 LTCP:

- Martha Street Sewer Separation Phase 2 – Continuation of work from the Phase 1 project, including construction of both sanitary and storm sewer to allow conversion of the existing combined sewer to either storm or sanitary sewer and to complete sewer separation of this 240-acre area. Flows from this sub-basin were described in the 2009 LTCP as being conveyed to the new Leavenworth Lift Station.
- Missouri Avenue Sewer Separation (Phases 2 and 3) – Separate the remaining area of the Missouri Avenue Sub-basin. All sanitary flow from the Missouri Avenue Sub-basin directed via separate sanitary sewer to the Missouri Avenue Lift Station.
- Pierce Street Sewer Separation – Separate approximately 60 acres in the Pierce Street Sub-basin. Because the Pierce Street Lift Station will be abandoned, convey flow from

this sub-basin by gravity to the new Leavenworth Lift Station through the South Gravity Sewer being constructed as part of the SIFM project.

- Hickory Street Sewer Separation – Separate approximately 75 acres in the Hickory Street Sub-basin. Because the Hickory Street Lift Station will be abandoned, convey flow from this sub-basin by gravity to the new Leavenworth Lift Station through the South Gravity Sewer being constructed as part of the SIFM project.

3.5.9.5 Proposed Changes to the LTCP

Changes to the 2009 LTCP controls in the South Interceptor Basin that are being proposed as part of this LTCP Update include:

- Remove Martha Street Sewer Separation Phase 2 Project. All separation was accomplished during the Martha Street Sewer Separation Phase 1 Project.
- Remove Missouri Avenue Sewer Separation Phase 3 Project. All work associated with the Phase 3 project will be accomplished as part of the Phase 1 and 2 projects.
- Send Martha Street sanitary flows to the Riverview Lift Station through the Martha-to-Riverview Sewer, instead of sending them to the Leavenworth Lift Station. Phase 1 of this sewer was built as part of the Martha Street Sewer Separation project. Phase 2 will be built as part of the Riverview Lift Station project.
- Deactivate CSO 112 after completion of the Martha-to-Riverview Sewer project and monitoring.
- Deactivate CSO 117 after completion of separation as part of the Missouri Avenue Sewer Separation Phase 2 project.

3.5.10 Ohern/Monroe Basin (CSOs 118 and 119)

The Ohern/Monroe Basin is the southernmost basin in the Missouri River Watershed and contains two CSO outfalls that flow into the Missouri River: CSO 118 – South Omaha/Ohern Street and CSO 119 – Monroe Street Lift Station. CSS flows from these basins are currently transferred to the MRWWTP through two existing lift stations: the In-Plant Lift Station serving Ohern and flows from within the MRWWTP, and the Monroe Street Lift Station serving Monroe. As described in the 2009 LTCP, the proposed control at these CSOs was to connect to the CSO Deep Tunnel with a single drop shaft located on the MRWWTP property, with treatment of the tunnel flows at the RTB located at the MRWWTP. To serve CSO 119, a large gravity conveyance line was envisioned across the MRWWTP plant site to the drop shaft. The CSO outfalls would remain in place. The LTCP envisioned no more than four overflows based on Representative Year precipitation.

As discussed in Section 3.4.2.2, in the 2009 LTCP, combined sewer flow from several CSOs along the Missouri River, including CSOs 118 and 119, was to be captured by the CSO Deep Tunnel and conveyed to a RTB facility at the MRWWTP. After additional analysis, it was determined that overall costs could be reduced and that constructability and operability could be improved by not putting combined sewer flows from CSOs 118 and 119 into the tunnel and instead diverting these flows to individual storage facilities. This change to a tank for Monroe eliminates the need for a gravity sewer from CSO 119 to the CSO Deep Tunnel drop shaft, which would be very difficult and expensive to construct. The change to a tank for Ohern eliminates the need to drop this flow into a drop shaft, only to pump it back out a short distance away. The storage tanks will be dewatered to the MRWWTP headworks following a wet weather event.

3.5.10.1 Completed Projects

Prior to commencing with implementation of the 2009 LTCP, the City initiated a study with the intent of eliminating the overflow of high strength waste streams to the Missouri River during wet weather periods. Per study recommendations, design work was divided into three major phases: separation, conveyance, and treatment. Separation work was accomplished through the Ohern/Monroe Industrial Flow Area Sewer Separation project (also referred to as the SOIA Sewer Separation project), conveyance was accomplished through the Ohern/Monroe Industrial Lift Station Force Main and Gravity Sewer, and treatment was accomplished through the MRWWTP Improvements Schedule A project.

Consistent with this, the following 2009 LTCP projects, described in Section 2 and Section 3.4.2.1, have been completed in the Ohern/Monroe Basin:

- Ohern/Monroe Industrial Flow Area Sewer Separation
- Ohern/Monroe Industrial Lift Station, Force Main and Gravity Sewer.

3.5.10.2 Projects under Construction

The following project, described in Section 2, is anticipated to be under construction by October 2015:

- Gilmore Avenue Sewer Separation Phase 1 and 2 project.

3.5.10.3 Projects in Design

No projects are anticipated to be in design in the Ohern/Monroe Basin in October 2015.

3.5.10.4 Future 2009 LTCP Projects

Future projects within the Ohern/Monroe Basin that were included and described in the 2009 LTCP are following:

- 20^{th} Street and U Street Sewer Separation - Construct sanitary and storm sewers to allow for conversion of the existing combined sewer to either storm or sanitary sewer and to provide separation to this 57-acre area.
- Gilmore Avenue Sewer Separation Phase 2 - Sewer separation of an approximately 226-acre area through abandonment of some existing pipes, rehabilitation, and construction of new storm and sanitary sewers.
- South Barrel Diversion – Isolate the North and South Barrels to convert the South Barrel to a storm sewer while leaving the North Barrel in place. Abandon three existing diversion structures that currently allow overflows to the South Barrel. Also abandon the two sets of “windows” that currently exist to allow flows to pass from one barrel to the other. Stormwater flows to the South Barrel will be maximized through other projects.
- Monroe Street Lift Station – Construct improvements to the Monroe Street Lift Station to ensure reliable delivery of flow to the new MRWWTP headworks.

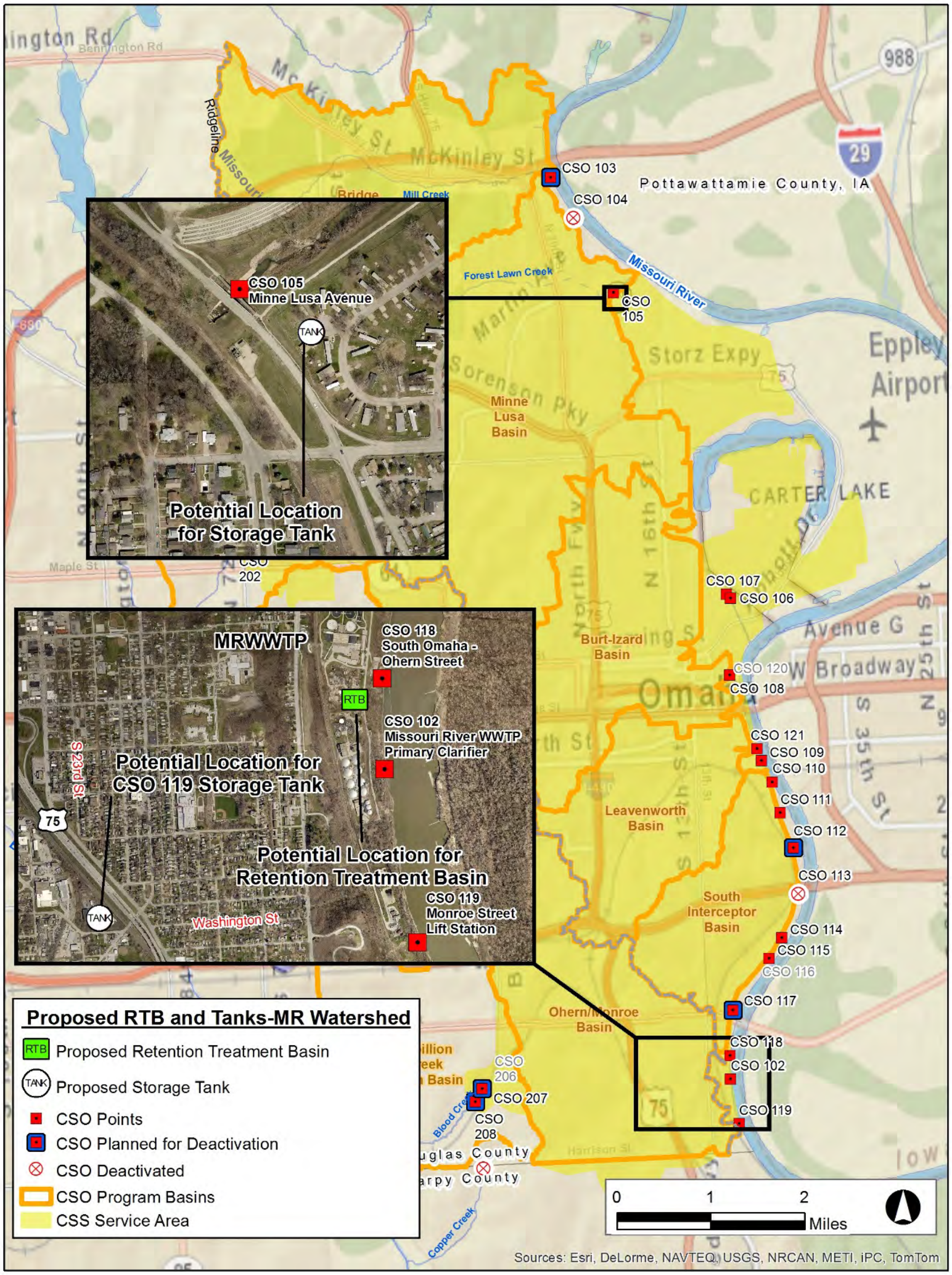
3.5.10.5 Proposed Changes to the LTCP

The following changes to controls in the Ohern/Monroe Basin are proposed in the LTCP Update:

- Remove 20th Street and U Street Sewer Separation Project – The project was included in the 2009 LTCP as an area to remove stormwater from the system, as it was thought that it would help to alleviate potential basement backups. It was determined by City staff that a previous sewer project completed in the early 1990s constructed a separate sanitary sewer in this area that ties directly into the MRWWTP. In addition, the construction of a separate storm sewer with an alignment that would go through the MRWWTP would be difficult and expensive.
- Remove Gilmore Avenue Sewer Separation Phase 2 project from the LTCP – Planned work for this project was incorporated into the Gilmore Avenue Sewer Separation Phase 1 project.
- Add a storage tank to capture flow from CSO 118 – See discussion in Section 3.4.2.2. A 4.1 MG storage facility is now planned to accommodate CSO 118 flows.
- Add a storage tank to capture flow from CSO 119 – See discussion in Section 3.4.2.2. A 2.9 MG storage facility is now planned to accommodate CSO 119 flow.

Storage tanks for CSO 118 and 119, are shown on Figure 3-8, along with the proposed storage tank at CSO 105 described in Section 3.5.11. They would be underground and would include grit removal, coarse screening and odor control for incoming flow. Pumps would be included to dewater the storage facilities within 24 hours of the end of the wet weather event.

FIGURE 3-8
Potential Location of Storage Tanks and Retention Treatment Basins in the Missouri River Watershed



3.5.11 Minne Lusa Basin (CSOs 104, 105, 106, and 107)

The Minne Lusa Basin is located south of the Bridge Street Basin and north of the Burt-Izard Basin. It contains four CSO discharge points to the Missouri River: CSO 104 – Mormon Street; CSO 105 – Minne Lusa Avenue (Figure 3-9); CSO 106 – North Interceptor; and CSO 107 – Grace Street.

FIGURE 3-9
Discharge from CSO 105 during the June 3, 2014 Storm Event *(photo courtesy of CH2M HILL)*

As described in the 2009 LTCP, the proposed control for CSO 104 – Mormon Street was to deactivate it. As noted in Section 1, CSO 104 has been deactivated since the 2009 LTCP was submitted and approved. The area within the Minne Lusa Basin was to be removed from the City's designated combined sewer service area, and the point no longer listed as a permitted CSO discharge. More than 95 percent of this sub-basin had been previously separated through a series of projects, with the most recent project included increasing conveyance downstream to CSO 105 – Minne Lusa Avenue and partial closure of the CSO overflow pipe at the diversion structure.

The 2009 LTCP describes the proposed control for CSO 105 – Minne Lusa Avenue as a combination of storage and separation. The CSO was to remain in place, with no more than four overflows based on Representative Year precipitation. To accomplish this, the following were to be completed:

1. Construction of an offline storage facility near the outfall.
2. Construction of a stormwater conveyance sewer and improvements to the downstream detention area. The stormwater conveyance sewer would connect to existing separation projects to remove the stormwater from the CSS and provide capacity for future separation in the LTCP.
3. Separation of approximately 1,800 acres of the basin. The separation would be directed at areas with historic basement backup problems. A majority of the separation within the basin would direct flows to the proposed stormwater conveyance system. Additional major separation projects include the following:
    - A project to remove Forest Lawn Creek from the CSS. This project would remove a constant source of inflow from the collection and treatment system and provide separation of a subbasin within the Minne Lusa Basin of over 900 acres.
    - A project to remove flows from the CSS by constructing a sewer from the existing Miller Park lagoon/stormwater detention facility to the Pershing Stormwater Detention Basin.

The storage facility was to be constructed to store combined sewage near CSO 105 – Minne Lusa Avenue. It was envisioned that the facility would be built in two phases: first, a 1.0-MG tank on City property near the outfall and later, a 2.7–MG tank across Pershing Drive to the east. The tanks would be dewatered through the existing CSS for full secondary treatment at the MRWWTP within 24 hours after a wet weather event.

The stormwater conveyance sewer was envisioned in the 2009 LTCP as a 12.5-foot-diameter, 7,900-foot-long soft-ground stormwater collector sewer to convey separate stormwater from sewer separation projects in the Minne Lusa Basin to the Missouri River. The stormwater collector would have the capacity to convey a 10-year storm event from the separated areas of the basin. The invert of the collector sewer was expected to range from approximately 45 to 75 feet below the ground surface in soft ground. The stormwater collector would commence near the intersection of North 31st Avenue, Paxton Boulevard, and JCB. The collector sewer would extend north along North 31st Avenue to Sorensen Parkway, then east to an outlet at the existing Pershing/Storz Detention Basins. Improvements to the existing Pershing/Storz Detention Basins were to include a concrete apron to prevent scour and erosion, modifications to the Pershing Detention Basin embankment to maximize storage for the increased flows, and a 1,800-foot-long trapezoidal open channel to convey flows north from the collector sewer outlet through the Pershing Detention Basin to the Minne Lusa outfall channel for subsequent conveyance to the Missouri River. Two main branch collector sewers would be constructed, one to the west to Paxton Boulevard and 49th Street, and one to the south to the Adams Park area. The branch collectors would tie the system into existing separation projects and provide capacity for future separation in the LTCP.

The 2009 LTCP describes the proposed control for CSO 106 – North Interceptor and CSO 107 – Grace Street as a connection to the CSO Deep Tunnel with a single drop shaft for both CSOs to be constructed near the existing Grace Street Channel, with treatment of flows at the RTB located at the MRWWTP. To achieve the goals of the CSO Program and to enable the tunnel to function as planned, the following would occur in the areas that contribute to these CSOs:

1. Separation within the Minne Lusa Basin would reduce flows to the Minne Lusa Relief Sewer (MLRS), which diverts flows from CSO 105 – Minne Lusa Avenue to CSO 106 – North Interceptor.
2. Separation within the Burt-Izard Basin would reduce flows to the Grace Street Sewer.

3.5.11.1 Completed Projects

The following projects, described in Section 2, have been completed in the Minne Lusa Basin:

- 24th Street and Ogden Street Sewer Separation
- Miller Park to Pershing Detention Basin Sewer Separation

3.5.11.2 Projects under Construction

The following projects in the Minne Lusa Basin, described in Section 2, are anticipated to be under construction by October 2015:

- Minne Lusa – 105-1 JCB & Miami Phase 1 and 2
- Minne Lusa Stormwater Conveyance Sewer
- Minne Lusa Storz Detention Basin Improvements

In 2013, the final design of the Minne Lusa Stormwater Conveyance Sewer and the Minne Lusa Storz Detention Basin was put on hold due to increases in projected construction costs and complexities arising from the detention basin's potential classification as a High-Hazard Dam. To ensure that the best, most cost effective project was being implemented, several potential configurations including No-Tunnel Options were developed and evaluated for comparison purposes. The No Tunnel options included the following:

- Diverting combined flows at the 33rd and Paxton and 31st and Sprague diversion structures that have historically been conveyed via the combined sewer to CSO 105 into the MLRS instead.
- Raising the weir at the CSO 105 outfall by 1.5 feet to send additional flow to the North Interceptor and to a storage tank downstream, thereby eliminating the need for a storage tank at CSO 105.
- Constructing a 10.5-MG covered combined sewage storage tank in Boyd Park near the confluence of the MLRS and North Interceptor to control the hydraulic grade line at that location to an elevation no higher than what currently occurs during a 10-year storm event.
- Constructing a 15-MG open stormwater storage basin at the Gunderson Rail site, with a potential gravity connection to the Sorensen Sewer. This connection, if allowed by NDOR, would allow for 90 percent of the Representative Year stormwater volume to be conveyed to the river through the Storz West Detention Basin; excess stormwater from larger storm events would be routed to the MLRS and the original combined sewer at CSO 105.
- Removing the embankment between Storz West and Pershing basins to allow flow out through new 8-by-8-foot conduits to the Minne Lusa Outfall Channel.

In addition, an Alternative Tunnel Option was developed, which would consist of a downsized tunnel diameter of 10 feet, designed to convey a peak flow rate of 1,000 cfs, combined with a 5-MG open stormwater detention basin at the Gunderson Rail site. Both Tunnel Options were evaluated with an auxiliary spillway configuration rather than the shutoff gates described previously.

A thorough evaluation of the options resulted in a decision to proceed with the 14-foot-diameter Tunnel Option with shutoff gates, as described previously. Key reasons for this included the following:

- The costs for the 14-foot conveyance sewer and the 10-foot conveyance sewer with Gunderson Rail storage were determined to be essentially equal, and there was a strong preference by the City to avoid the presence of an open detention basin at the Gunderson Rail site.
- Communications with the NDNR indicated that the gate control option would be permittable, whereas the auxiliary spillway approach was less certain from a permitting perspective. In addition, the spillway was believed to be less acceptable to the public.
- Whereas the No Tunnel Option was potentially less expensive than the Tunnel Options by up to $15 million, the costs for the No Tunnel Option were based on limited design information compared with the Tunnel Option that was based on final design work, and therefore had the strong likelihood of increasing when more detail was developed. In addition, the No Tunnel Option would send much more flow to the low-lying areas near Boyd Park and significantly contribute to an increase in the risk of flooding similar to what was experienced during the storm event of June 3, 2014.
- The Tunnel Option offers the strong advantage of getting stormwater out of the system rather than re-combining all or part back into the CSS. Keeping all or part of

the stormwater in the CSS would increase the uncertainty associated with the ultimate performance of the No Tunnel Option, and presented an increased possibility of not achieving performance goals.

3.5.11.3 Projects in Design

The following projects are anticipated to be in design by October 2015:

FIGURE 3-10
Fontenelle Park Lagoon (*Courtesy of Black and Veatch*)

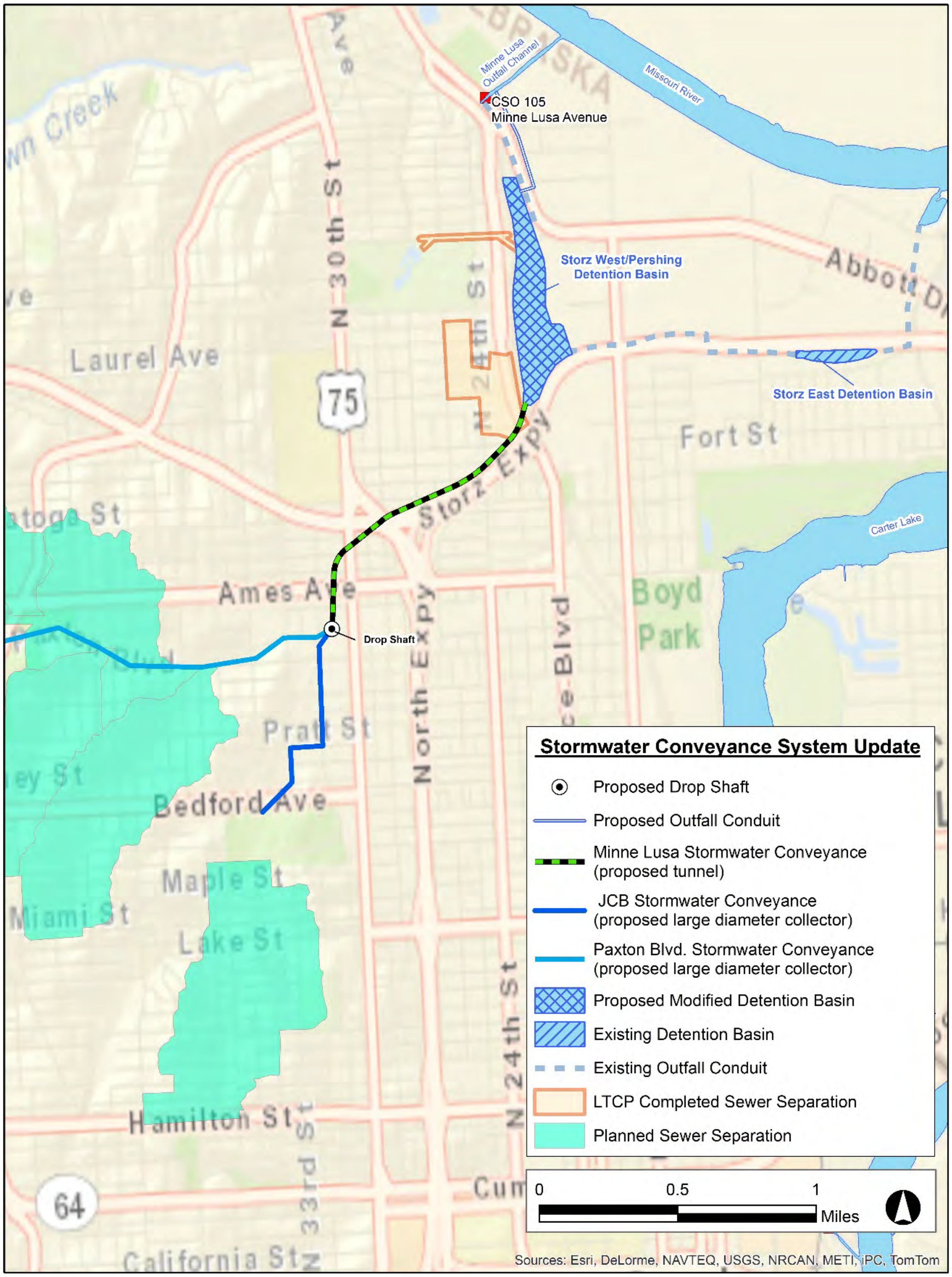
- Forest Lawn Sewer Separation (ML 105-15): Will provide partial sewer separation of the Minne Lusa Basin, particularly in the eastern third of the Forest Lawn Sub-basin, resulting in reduced flows to the existing combined sewer along Forest Lawn Avenue and CSO 105.
- Sewer separation projects: 46th & Grand Street (ML 105-5); 49th Street & Fowler Street (ML 105-4); and 50th Street & Sigwart Street (ML 105-3). As part of the latter project, a project to make improvements to the Fontenelle Park/Lagoon (Figure 3-10) has been identified and will be under construction. The sewer separation projects are located upstream of Fontenelle Park.

3.5.11.4 Future 2009 LTCP Projects

The following projects will be designed and constructed after October 2015:

- Paxton Boulevard Stormwater Conveyance Sewer (ML 105-13A) will provide stormwater conveyance capacity for separated stormwater from sewer separation projects in the Minne Lusa Basin. This large-diameter storm sewer will be constructed along Paxton Boulevard from 30th Street to 49th Street, discharging into the Minne Lusa Conveyance Sewer (see Figure 3-11) near the intersection of Paxton Boulevard, John Creighton Boulevard, and North 31st Street.
- JCB Stormwater Conveyance Sewer (ML 105-13B) will provide stormwater conveyance capacity for separated stormwater from sewer separation projects within the Minne Lusa Basin to the Minne Lusa Stormwater Conveyance Sewer. This large-diameter sewer will be constructed along John Creighton Boulevard from Paxton Boulevard to Spaulding Street, discharging into the Minne Lusa Conveyance Sewer near the intersection of Paxton Boulevard, John Creighton Boulevard, and North 31st Avenue.
- Sewer separation projects: 41st & Sprague SE & NW (ML 105-2a and 2b, respectively; except for SE Phase 3 and NW Phase 3), 43rd & Boyd (ML 105-6), and 46th & Grand East (ML 105-5) will provide stormwater flow to the Paxton Boulevard Conveyance Sewer. These sewer separation projects are located downstream of Fontenelle Park.

FIGURE 3-11
Proposed Stormwater Conveyance System in the Minne Lusa Basin



3.5.11.5 Proposed Changes from the LTCP

The following changes to the controls in the Minne Lusa Basin are being proposed for the LTCP Update:

- Change the size of the storage tank at CSO 105 from an early 1-MG Phase 1 tank followed by a later 2.7-MG Phase 2 tank, to a single 4.0-MG tank constructed near the end of the Program.
- Increase in the diameter of the Minne Lusa Conveyance Sewer from 12.5 feet to 14 feet. This increase took place during the conceptual design phase as a result of a detailed hydraulic analysis. This analysis determined that a 12.5-foot sewer would experience an exceedance of the maximum allowable surcharge and surcharging of the upstream collector sewers. The analysis was done for both an open channel flow and pressurized flow system. Working within industry standard guidelines, analyses were performed to optimize the size of the conveyance sewer, which resulted in a 14-foot diameter sewer that will operated under pressurized conditions.
- More extensive improvements to the existing Storz West and Pershing Detention Basins, and meeting NDNR High Hazard Dam requirements. NDNR regulations for this type of dam require either an auxiliary spillway with a designated conveyance corridor or other measures to eliminate the potential of overtopping. In order to meet these requirements, shutoff gates are planned to be installed on the upstream collector sewers to prevent flow from entering the Minne Lusa Conveyance Sewer under extreme or emergency conditions.
- Change the alignment of the tunnel, as illustrated in Figure 3-11.
- Change the sewer separation concept for the Paxton Area to an 'inflow reduction' approach for the CSS that will fully use the downstream Minne Lusa Conveyance Sewer in a cost effective manner. Priority will be given to separation of large areas with a minimal stormwater pipe system. For example, there may be areas where a single stormwater collector/main can be located along the basin valley and side stormwater connections can be eliminated. Flow slipping will be used where feasible to eliminate side connections and reduce pipe construction. Where storm sewers have already been constructed, it may not be cost effective to construct additional stormwater infrastructure to reach the upper reaches of the basin.

  In addition, the project sequencing in the Paxton Area has been modified to focus on separation projects upstream of Fontenelle Park, and Fontenelle Park/Lagoon improvements have been included with these projects. Modify the 46th & Grand Street Sewer Separation project to be the 46th & Grand Street West project. The Paxton Conveyance Sewer and Sewer Separation projects downstream of Fontenelle Park will be constructed later. A few sewer separation projects have been eliminated after being shown to not be cost effective (41st & Sprague SE Phase 3, 41st & Sprague NW Phase 3, and 33rd & Taylor [ML 105-2a, ML 105-2b, and ML 105-14, respectively]).
- Change the sewer separation concept in the JCB Area. The JCB & Miami Sewer Separation project was moved up in the schedule so that it will be built in advance of the JCB Conveyance Sewer. In addition, because increasing the detention storage volume of the wet basins in Adams Park will reduce the overall cost of the JCB

Conveyance Sewer, the Adams Park Detention Facility was included with the JCB & Miami Sewer Separation project.

3.6 Cost Analysis of Updated Controls

The 2009 LTCP included cost-performance curves, plots of capital costs versus remaining untreated overflows at all Control Levels, for the Missouri River and Papillion Creek watersheds. For both watersheds, a "knee-of-the-curve" was apparent at Control Level 2 (four remaining partially treated overflows per year), indicating that it would be relatively cost effective to reach Control Level 2, but much more costly and less cost effective to go from Control Level 2 to Control Levels 3 and 4, which would reduce the number of partially treated overflows.

For the following reasons, Control Level 2 was the proposed endpoint of CSO controls for both the Missouri River Watershed and Papillion Creek Watershed in the LTCP:

- In the comparison of capital costs versus remaining overflows, significant "knees-of-the- curve" were apparent, as explained above.
- Control Level 2 would meet or exceed the Presumption Approach criteria as defined by EPA's CSO Control Policy (EPA, 1995). More specifically, the remaining CSOs would be equal to the presumption criterion of four overflows per year, and the percentages of volume and loading captured would exceed the presumption criterion of 85 percent capture.
- The geometric mean of *E. coli* levels in the Missouri River downstream of all CSOs from May 1 to September 30 (the recreation season) was predicted to be in compliance with the water quality standard of 126 org/100 mL.
- The geometric mean of *E. coli* levels in Papillion Creek downstream of all CSOs from May 1 to September 30 was not predicted to be in compliance with the water quality standard; however, further treatment of CSOs would not result in compliance due to loading sources other than CSOs.

As explained in Section 5 of this LTCP Update, the level of control for the Omaha CSO Program is still based on the Presumption Approach (EPA, 1995). The overall volumetric capture of wet weather flows is approximately the same as what was proposed in the 2009 LTCP. The Missouri River is predicted to be in compliance with the water quality standard of 126 org/100 mL for *E. coli*, and compliance with water quality standards in Papillion Creek is not precluded by remaining partially treated overflows. In addition, the City utilized a design criterion of no more than eight CSOs in the Missouri River Watershed under Representative Year precipitation conditions. The number of partially treated overflows in the Papillion Creek Watershed is shown to be no more than five under the same conditions.

The schedule presented in this LTCP Update has been developed to achieve this level of control by October 2027 and is based on the most recent Rate Model developed by the City. However, as explained in Section 4, the Affordability Study conducted in 2013 predicts a high economic burden on portions of the Omaha community beginning in 2018. This may require future modifications to the implementation of CSO controls. Such modifications could take the form of schedule changes, project cost controls, alternative sources of funding, and/or changes to the ultimate level of control.

4.0 Program Financing and Financial Considerations

4.1 Introduction

The purpose of this section is to meet Part V. E. Cost/Performance Considerations of the City's CSO Permit. As noted in Table 1-1 of the LTCP Update, this section requires:

> "By October 1, 2014, the City must submit a financial report to the NDEQ that sets forth a strategy to obtain sufficient revenue to fund the CSO program through at least the year 2020 that includes funding for the specific projects in the Implementation Schedule, Section 7 of the LTCP."

The City's 2009 LTCP, approved by the NDEQ in February of 2010, referred to Section 11 of the City's Consent Order, which noted that the LTCP will be dynamic in nature and, therefore, there are uncertainties in program costs, funding, and financing. While Omaha's user fees have met revenue requirements through the first NPDES permit cycle, and Omaha's financial plan and cost-of-service rate model have been updated to extend throughout the LTCP schedule ending in 2027, financial uncertainties beyond Omaha's control remain a concern and will be managed adaptively.

4.2 Current Status

The most notable event impacting City's progress since NDEQ's approval of the 2009 LTCP was the unprecedented flooding along the Missouri River in 2011, as described in Section 2. In May 2011, the City notified NDEQ that it believed the severity and expected duration of flooding constituted a *force majeure* condition under the provision of the Consent Order. After the flooding abated in August 2011, Omaha and NDEQ evaluated the impacts of the flood on the LTCP compliance schedule, and in 2012, NDEQ issued an amendment to the Consent Order (Appendix A - Amended Consent Order) that extended the deadline for LTCP completion from October 2024 to October 2027. In August 2013, the City submitted to NDEQ a proposed amendment to the schedule of projects in the 2009 CSO Permit, which NDEQ approved after public notice and review by the EPA, Region 7.

Through July 2014, the City has expended more than $125 million on LTCP construction and has an additional $270 million of work either out for bid or awarded for construction. Additionally there is over $314 million worth of construction under some stage of design. As mentioned in Section 4.1, rate revenues have been sufficient to support these expenses, and interest rates on both revenue bonds sold and State Revolving Fund loans secured have been more favorable than what was programmed into the financial plan and rate model.

The City's Ratepayer Assistance Program has been augmenting assistance to residents who qualify for help with their sewer user fees through the Low Income Home Energy Assistance Program. Through 2013, a total of $1.6 million had been distributed to low income households.

In June 2009, the City adopted a rate ordinance that provided for annual rate increases of approximately 25 percent for the years 2011 through 2014. In the fall of 2012, the City and the Chamber of Commerce worked with the business community to adopt an alternate rate structure that kept the residential share of the costs static while more evenly spreading the non-residential share of costs across the industrial and commercial customers. The proposed revisions were adopted by the City Council and the new commercial/industrial rate structure went into effect in January 2013.

In 2013 Omaha's sewer enterprise financial plan and cost-of-service rate model were again updated by Red Oak Consulting. The financial plan, which runs through 2027 can be found in Appendix E. On July 15, 2014, the City Council adopted an updated ordinance (Appendix F) that established sewer rates for the period 2015-2018. The impact of these rate increases on a typical household is a 13 percent increase in sewer use fees in 2015 and a 9 percent increase per year thereafter through 2018. The average resident who paid $10 per month in 2006 is now paying $37 per month in 2014. By 2018, it is expected that the sewer use fee for that same household will exceed $50 per month.

4.3 Affordability

The City's latest financial plan suggests that annual rate increases of about 9 percent will be necessary to fund the LTCP and other foreseeable wastewater collection, treatment, and capital expenses through 2027. These projections do not include impacts from new or stricter regulatory requirements that may be mandated. Some type of integrated planning will be needed if additional requirements are implemented.

In May 2013, the University of Cincinnati completed a financial capability assessment for Omaha's wastewater enterprise fund. This report can be found in Appendix G and was previously provided to NDEQ for review. The conclusion of the report was that with the sewer rate increases adopted by the City Council on July 15, 2014, by 2018, the Omaha wastewater service area, as a whole, will be at a "Medium Burden" level as defined by EPA[1]. However, the report also notes that some "Communities of Concern" within the service already approach the "High Burden" threshold, and by the end of 2027, the entire service area may be near "High Burden."

The report also notes that some "Communities of Concern" within the service already approach the "High Burden" threshold, and by the end of 2027, the entire service area may be near "High Burden."

The report recommends that Omaha closely monitor costs associated with its LTCP and "manage the overall Program approach, level of control and schedule." The report also recommends that the City work with NDEQ to "ensure solutions that are financially and environmentally sustainable."

[1] The terms "Medium Burden" and "High Burden" are determined based on indicators related to a Financial Capability Indicator Score (based on the socioeconomic, debt and financial indicators) of the municipality and the Residential Indicator (based on the cost per household of the program as a percent of median household income) as defined in the EPA guidance document, *Combined Sewer Overflows Final Guidance for Financial Capability Assessment and Schedule Developmen*t. USEPA, Office of Water, Office of Wastewater Management (4204) February 1997, EPA 832-B-97-004.

4.4 Grant and Loan Availability

Although it would take a major change in national policy for significant funding to become available, the City has received and will continue to pursue grants and loans. In the past the City's congressional delegation obtained federal funds appropriated to assist with sewer separation work. The annual earmarks varied between $400,000 and $1,400,000 and are not anticipated as a source of funds in the future.

In conjunction with the American Recovery and Reinvestment Act of 2009, Omaha received $3.75 million for clean water projects, half of which was at zero interest and half with loan forgiveness (effectively grant funding). The City has also recently received a State Revolving Fund loan. This loan was initially for $40 million, and was amended to provide a total of $55 million for improvements to the MRWWTP as planned by the 2009 LTCP at an interest rate of 2.0 percent for 20 years. Again, while this funding is helpful, the magnitude provides little financial relief for the City's ratepayers.

In addition to the funds and loans listed above, the City and the CSO PMT have pursued grant funding options. Several of the CSO projects that have green infrastructure components are eligible for grant funding for design and/or construction. The three major grant sources for projects that include green infrastructure components are the NET, NDEQ/EPA Nonpoint Source Water Quality [Section 319(h)], and PMRNRD Urban Drainageway Grants.

While each grant program has a particular environmental emphasis, all three (NET, NDEQ/ EPA Nonpoint Source Water Quality [Section 319(h)], and PMRNRD Urban Drainageway Grants) will fund stream rehabilitation (i.e. reduction in stream bank erosion and enhancement of aquatic habitat) and stream creation (creation of new aquatic habitat) projects. The NET grant program will also fund flood control projects (detention). Public education/outreach/involvement components are encouraged in the NET, NDEQ, and EPA grants. The City actively coordinates grant applications for projects from the CSO Program, the City's Stormwater Program, and the PRPPD so that City projects do not compete against one another for grant funds.

To date the City has been awarded four grants for two separate CSO projects. The Missouri Avenue/Spring Lake Park Sewer Separation Phase 1 (OPW 51997) project was awarded two grants from NET for a total of $900,000 for both design and construction phases on the project. The extensive use of green infrastructure throughout Spring Lake Park resulted in an estimated savings of approximately $7.7 million that the City did not have to spend on additional grey infrastructure. The use of green infrastructure will also increase the diversity of aquatic habitat within the park and will become a public amenity.

The Saddle Creek Area Sewer Separation, 55th – 64th Street project (OPW 51777) was awarded a grant for $817,500 from NET for the design, construction, and monitoring of new wetlands and detention facilities on the Westlawn-Hillcrest Cemetery property. These facilities detain and retain peak storm flows, allowing a reduction in the size of the new downstream stormwater pipe sizes. A major element of this project was the removal of a stream from the CSS. For this same project, the PMRNRD awarded the City an $811,380 grant for the construction of approximately 700 feet of new open channel to convey the stream to the Little Papillion Creek and associated aquatic habitat. The combination of the detention facilities and the new open channel green infrastructure on this project saved the City from spending about $506,000 on additional grey infrastructure, and made the project eligible for the total of $1,628,880 in grant funds it was awarded.

4.5 Summary and Conclusions

With the adoption of July 2014 rate ordinance, Omaha has clearly shown a continued commitment to the goals of the LTCP Update and is making a very significant investment to do so.

The LTCP Update may meet the EPA affordability criteria as they exist now, but the criteria are flawed and the anticipated rate increases beyond 2018 necessary to fund the CSO Program may be determined to be unaffordable. With the adoption of the July 2014 rate ordinance, Omaha has clearly shown a continued commitment to implementation of the LTCP and is making a very significant investment to do so. However, the City believes that it is not too early to establish a dialog with NDEQ on how Omaha can continue to improve water quality without creating an unsustainable burden on area residents and businesses.

5.0 Updated CSO Controls

5.1 Introduction

This section describes the updated controls included in the City's LTCP Update to its CSO Program to improve water quality in the Missouri River and Papillion Creek watersheds.

This section includes a list of controls for each watershed and whether the controls have changed compared with what was planned in the 2009 LTCP. The last part of this section provides a discussion of the expected water quality improvements and control level after full implementation of the controls and the schedule for implementation of the controls. This LTCP Update is based on the results of the alternatives evaluation and refinements described in Section 3 - Control Alternatives, the public input described in Section 6 - Public Participation Process, and the affordability analysis described in Section 4 - Financial Analysis. The operational strategies for the controls discussed in this section are updated in Section 7 - Post-Construction Monitoring Program and Wet Weather Operations Strategy Update.

This section was developed in compliance with both the City's CSO Permit and Consent Order requirements. Specifically:

From the CSO Permit:

- Part V.D. Evaluation of Alternatives - Any significant changes or revisions to the controls set forth in the LTCP must be submitted to the NDEQ for review by October 1, 2014. This is also stated in Part VIII. F. Revisions to the Long Term Control Plan.
- Part VIII.F. Revision of the Long Term Control Plan – As stated previously, proposed significant revisions to the LTCP must be submitted by October 1, 2014 for review and approval by the NDEQ.

In addition, the LTCP Update as a whole complies with the following from the Amended Consent Order (see Appendix A) dated May 20, 2012, which states:

1) The 2009 LTCP shall be revised and submitted to NDEQ on or before October 1, 2014; the amended LTCP shall address all *force majeure* related delays. The revision shall be subject to, and contingent upon, approval by NDEQ. Upon approval by NDEQ, the LTCP shall be performed by the City according to its terms and schedule.

In particular, this section provides the modified implementation schedule.

5.2 Description of Modified Controls

The processes undertaken to evaluate the controls in the 2009 LTCP are described in Section 3. This section provides a list of those controls to be implemented and the ultimate level of control to be achieved. The tables clarify whether the controls are proposed to be modified in the LTCP Update, and what the proposed changes consist of. It should be noted that the majority of the projects have not changed from the 2009 LTCP. Figure 5-1 summarizes the controls that are planned to be in existence in 2027.

FIGURE 5-1
Omaha Combined Sewer System in 2027

5.2.1 Description of Controls

Section 2 of this update provides an overview of those projects that will be completed by October 2015 and those that will be under construction. Section 3 provides information on projects that are under design and future projects and also summarizes evaluations that led to proposed changes described in this section. The following sections summarize those changes in controls being proposed in the LTCP Update. It should be noted that this discussion is not meant to reflect design-level changes. In other words, any changes to controls that were made during project design that have been approved by the NDEQ in issuing construction permits are not listed as proposed changes in this LTCP Update. Figure 5-2 shows the relative basins containing updated controls.

5.2.1.1 Update of the Missouri River Watershed Controls

The Missouri River Watershed Controls include the projects listed in Tables 5-1 and 5-2. Table 5-1 presents a list of CSO control projects within the Missouri River Watershed. The table includes a summary of what was included in the 2009 LTCP and proposed changes in the LTCP update.

Table 5-2 provides technical details on the LTCP projects in the Missouri River Watershed. Similar to Table 5-1, it shows both what was included in the 2009 LTCP and what changes are proposed, if any, in the LTCP Update. Projects in Table 5-2 that have received construction permits from NDEQ are noted as being either completed or under construction. As noted previously, no proposed changes are listed for those projects. Level of control is discussed in Section 5.3.

TABLE 5-1
Updated Summary of CSO Control Projects in the Missouri River Watershed

Basin	2009 LTCP Sewer Separation Area (Acres)	2009 LTCP Projects	Proposed Changes in LTCP Update
Bridge Street (CSO 103)	36	Replace Bridge Street Lift Station Construct parallel force main Deactivate CSO 103 – Bridge Street Lift Station outfall Floatables control at CSO Deep Tunnel Drop Shaft	No changes proposed
Minne Lusa (CSOs 104, 105, 106, and 107)	2,234	Construct two phased storage tanks as part of a single facility: Phase 1 = 1.0 MG and Phase 2 = 2.7 MG Deactivate CSO 104 – Mormon Street outfall Construct 12.5-foot-diameter stormwater conveyance sewer and associated collector sewers Construct CSO Deep Tunnel Drop Shaft Complex for CSOs 106 and 107 Install floatables control at CSO 105 – Minne Lusa Avenue outfall	Changed storage tank concept to a single 4.0 MG tank facility to be constructed later in the CSO Program schedule Sewer separation area reduced to 1,629 acres because of removal of projects Increase diameter of stormwater conveyance sewer to 14 feet Floatable controls will be addressed with the construction as part of the CSO 105 – Minne Lusa Avenue Tank

TABLE 5-1
Updated Summary of CSO Control Projects in the Missouri River Watershed

Basin	2009 LTCP Sewer Separation Area (Acres)	2009 LTCP Projects	Proposed Changes in LTCP Update
Burt-Izard (CSO 108)	472	Construct CSO Deep Tunnel Drop Shaft Complex Implement modifications to Burt-Izard Lift Station	Sewer separation acres increased to 556 based on project changes
Leavenworth (CSOs 109 and 121)	None	Construct CSO Deep Tunnel Drop Shaft Complex Install diversion gates at Jones Street Diversion Structure Construct new Leavenworth Lift Station Install floatables control at CSO 109 – 1st and Leavenworth and CSO 121 – Jones Street outfalls	No changes proposed Floatable controls will be addressed with the construction of CSO Deep Tunnel Drop Shaft
South Interceptor (CSOs 110 to 117)	776	Construct CSO Deep Tunnel Drop Shaft Complex Abandon Pierce Street and Hickory Street lift stations and route flow to new Leavenworth Lift Station, along with flow from Martha Street Deactivate CSO 113 – Spring Street Lift Station Abandon Spring Street Lift Station and route flow to CSO 114 – Grover Street Replace Riverview Lift Station Install floatables control at outfalls for the following CSOs: 110 – Pierce Street Lift Station 111 – Hickory Street Lift Station 112 – Martha Street 114 – Grover Street 115 – Riverview Lift Station 117 – Missouri Avenue Lift Station	CSOs 112 and 117 are planned to be deactivated with sewer separation and completion of Martha to Riverview sewer Route flow from the Martha Street area to new Riverview Lift Station instead of Leavenworth Floatable controls will be addressed with the construction of CSO Deep Tunnel Drop Shaft
Ohern/Monroe (CSOs 118 and 119)	365	Construct CSO Deep Tunnel Drop Shaft Complex Construct industrial lift station and force main Implement modifications to Monroe Street Lift Station Install floatables control at CSO118 – South Omaha/Ohern Street and 119 – Monroe Street Lift Station outfalls	The diversion of flows from CSOs 118 and 119 will be to storage tanks facilities rather than to drop shaft / tunnel (see below), stored flow volume will then be pumped to the MRWWTP for treatment following wet weather events Construct at MRWWTP 4.1 MG storage facility for CSO 118 Construct at Industrial Lift Station site a 2.9 MG storage tank facility for CSO 119 Sewer separation area reduced to 111 acres, because the 20th and U Sewer Separation project has been removed Floatables control will be addressed with the construction of the CSO – 118 and 119 storage tanks

FIGURE 5-2
Basins with Updates

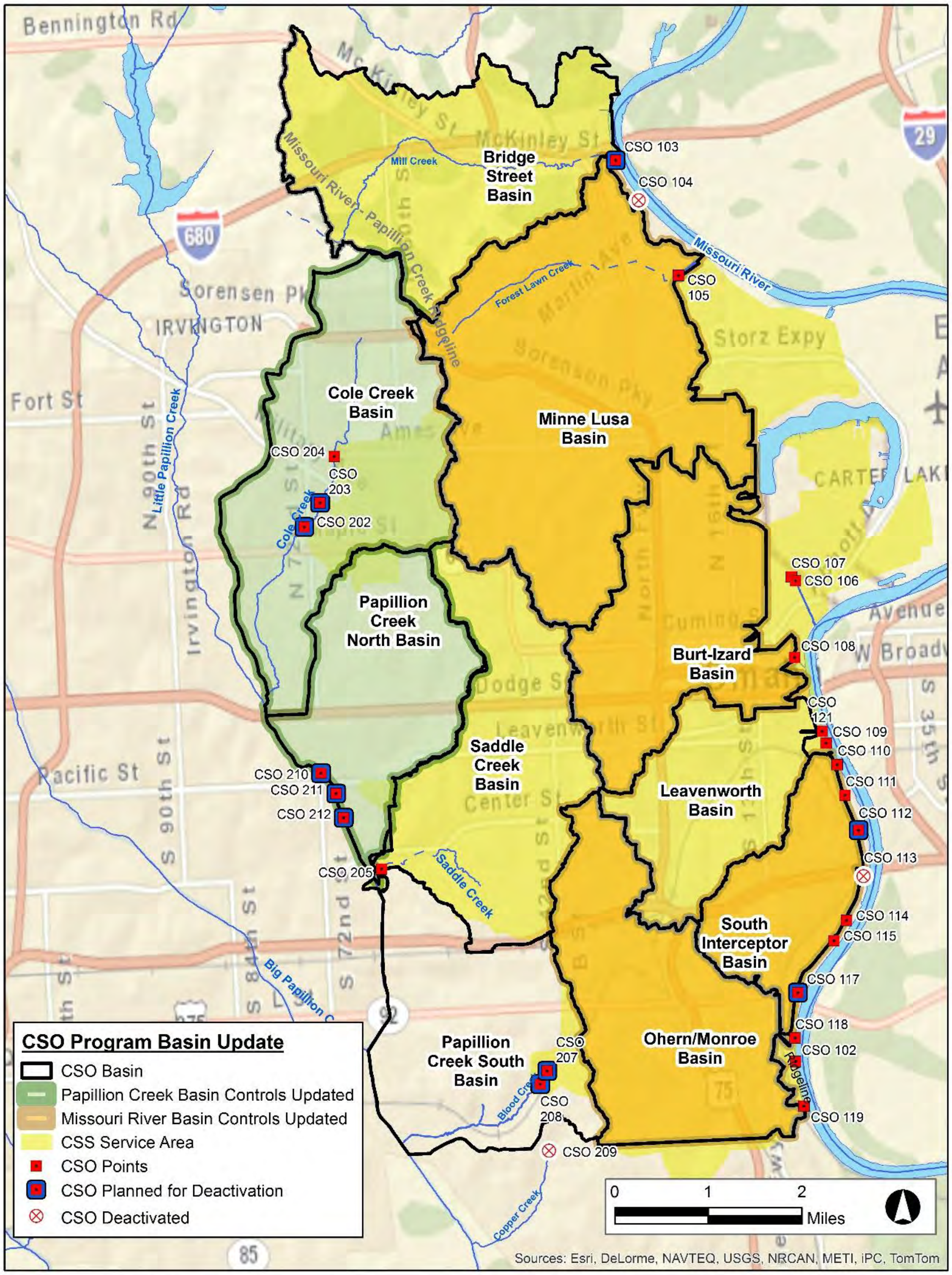


TABLE 5-2
Technical Details of CSO Control Projects in the Missouri River Watershed

Facility	2009 LTCP Description	Proposed Changes in LTCP Update
Cross-Basin Project		
MRWWTP Improvements		
	New headworks instantaneous peak capacity: 180 mgd Disinfection of CSO 102 – MRWWTP Primary Clarifier, instantaneous peak rate: 130 mgd New preliminary and primary treatment system for flow from SOIA	Schedules A and B1 under construction No changes proposed for Schedule B2
Industrial Force Main and Gravity Sewer		
	Force Main: 3,050 feet of 30 inches Gravity Pipe: 3,650 feet of 30 inches	Project complete
Industrial Lift Station		
	Rate: 18.3 mgd	Project complete
SIFM		
	Force main: 3,800 feet of 42 inches Force main: 19,500 feet of 66 inches	Project under construction
CSO Deep Tunnel		
	Diameter: 17 feet Equalization volume: 48.2 MG Length: 5.4 miles Slope: 0.1 percent Maximum dewatering time: 24 hours Depth to invert: range of 160 to 180 feet Number of drop shafts: 5	Diameter reduced to 15 feet Reduced the Equalization volume: 37.8 MG Added Drop Shaft Grit Removal facilities Number of drop shafts: 4
Tunnel Lift Station and Force Mains		
	Rate: 52 mgd	Rate 22 mgd
RTB at MRWWTP		
	Maximum rate: 52 mgd Volume: 1.1 MG Number of basins: 3 Surface loading rate: 4,000 gallons/day/square foot Chlorine dosage: 15 mg/L Detention Time: 30 minutes	Maximum Rate: 22 mgd Volume: 0.5 MG
RTB Dewatering Lift Station		
	Rate: 1.1 mgd Maximum dewatering time: 24 hours	Rate changed: 0.5 mgd
Bridge Street Study Basin		
Lift Station and Force Main		
	Rate: 8 mgd Automatic bar screens	No changes proposed

TABLE 5-2
Technical Details of CSO Control Projects in the Missouri River Watershed

Facility	2009 LTCP Description	Proposed Changes in LTCP Update
Sewer Separation to Deactivate CSO 103 – Bridge Street Lift Station		
	Area: 36 acres	No changes proposed
Minne Lusa Study Basin		
Sewer Separation to Reduce Combined Sewage Volume and Deactivate CSO 104 – Mormon Street		
	Separation, with monitoring and rehabilitation to take place prior to deactivation	No changes proposed
Stormwater Conveyance Sewer		
	Diameter: 12.5 feet Length: 1.5 miles Depth to invert: range of 45 to 75 feet Discharge to Storz Detention Basin; 1,800-foot-long trapezoidal channel	Diameter increased to 14 feet Added gate control structures at John Creighton Blvd, Paxton, Crown Point, and Miller Park to control flows to Storz/Pershing Detention Basin Storz/Pershing Basin to be permitted through NDNR as High Hazard Dam
Phase 1 Storage Facility at CSO 105 – Minne Lusa Avenue		
	Tank storage volume: 1.0 MG Maximum dewatering time: 24 hours Dewatering rate: 1.0 mgd	Eliminated phased implementation. Resized to one Storage Tank at CSO 105 with a 4.0 MG capacity
Phase 2 Storage Facility at CSO 105 – Minne Lusa Avenue		
	Tank storage volume: 2.7 MG Maximum dewatering time: 24 hours Dewatering rate: 2.7 mgd	Eliminated phased implementation. Resized to one Storage Tank at CSO 105 with a 4.0 MG capacity
Sewer Separation to Reduce Combined Sewage Volume		
	Area: 2,235 acres	Change in sewer separation concept in Paxton and JCB area Sewer separation area reduced to 1,629 acres Eliminated: 41st & Sprague SE Phase 3, 41st & Sprague NW Phase 3, and 33rd & Taylor projects JCB & Miami Phase 1 and Phase 2 combined into single construction contract.
Burt-Izard Study Basin		
Sewer Separation to Reduce Combined Sewage Volume		
	Area: 472 acres	Sewer separation increased to 550 acres 23rd & Seward and 30th & Burdette sewer separation projects eliminated 26th & Corby Phases 1 – 5 removed from LTCP Changed sewer separation concept to focus on southern portion of Basin
Leavenworth Study Basin		
Lift Station		
	Rate: 43 mgd	Project complete

TABLE 5-2
Technical Details of CSO Control Projects in the Missouri River Watershed

Facility	2009 LTCP Description	Proposed Changes in LTCP Update
Jones Street Flow Diversion		
	Number of automatic sluice gates: 2 Size of sluice gates (height by width): 4 by 6 feet	No changes proposed
South Interceptor Study Basin		
Sewer Separation to Reduce Combined Sewage Volume and Deactivate CSO 113 – Spring Street		
	Area: 33 acres	Project complete
Sewer Separation to Reduce Combined Sewage Volume		
	Area: 776 acres	Martha Street Phase 2, and Missouri Avenue Phase 3 eliminated (rehabilitation projects) CSOs 112 and 117 to be deactivated
Ohern / Monroe Study Basin		
Sewer Separation to Reduce Combined Sewage Volume		
	Area: 365 acres	4.1 MG storage tank added for CSO 118 2.9 MG storage tank added for CSO 119 Deletion of 20th & U Sewer Separation Project Sewer separation area reduced to 111 acres Gilmore Phase 1 and Gilmore Phase 2 combined into single construction contract

5.2.1.2 Update of the Papillion Creek Watershed Controls

The Papillion Creek Watershed Control projects include those listed in Tables 5-3 and 5-4. Table 5-3 presents a list of CSO control projects within the Papillion Creek Watershed. The table includes a summary of what was included in the 2009 LTCP and proposed changes in the LTCP Update.

Table 5-4 provides technical details on the LTCP projects in the Papillion Creek Watershed. Similar to Table 5-3, it shows both what was included in the 2009 LTCP and proposed changes in the LTCP Update. Projects in Table 5-4 that have received construction permits from NDEQ are noted as being either completed or under construction. As noted previously, no proposed changes are listed for those projects. Level of control is discussed in Section 5.3.

TABLE 5-3
Summary of CSO Control Projects in the Papillion Creek Watershed

Basin	Sewer Separation Area (Acres)	Other Projects	Proposed Changes in LTCP Update
Cole Creek (CSOs 202, 203 and 204)	860	Construct storage tank at CSO 204 – 63rd and Ames, 0.08 MG Install floatables control at CSOs 202 – 72nd and Bedford, 203 – 69th and Evans, and 204 – 63rd and Ames outfalls	Sewer separation reduced to 776 acres CSO 204 storage tank reduced to 0.05 MG due to model update and recalibration CSOs 202 & 203 are planned to be deactivated
Papillion Creek North (CSOs 210, 211, and 212)	219	Deactivate CSOs 211 – 69th and Pierce, and 212 – 69th and Woolworth Deactivate outfall or install floatables control at CSO 210 – 72nd and Mayberry outfall	Sewer separation increased to 238 acres based on mapping CSO 210 is planned to be deactivated
Saddle Creek (CSO 205)	549	Construct RTB at 64th and Dupont for flow rate of 315 mgd Install floatables control at outfall	Sewer Separation Projects Complete (reduced to 305 acres based on refined Aksarben Service area) No major proposed changes Floatables control will be addressed with the construction of the RTB
Papillion Creek South (CSOs 206, 207, 208, and 209)	186	Deactivate CSOs 207 – 44th and Y Street, 208 – 45th and T Street, and 209 – 44th and Harrison	No changes proposed

TABLE 5-4
Technical Details of CSO Control Projects in the Papillion Creek Watershed

Facility	Description	Proposed Changes in LTCP Update
Cole Creek Basin		
Storage Tank at CSO 204 – 63rd and Ames		
	Total storage volume: 0.08 MG Maximum dewatering time: 72 hours Dewatering rate: 0.03 mgd	Total storage volume changed to 0.05 MG
Sewer Separation to Reduce Combined Sewage Volume		
	Area: 860 acres	Reconfigured phases to eliminate phases 7 - 9 and reduced amount of sewer separation area to 776 acres

TABLE 5-4
Technical Details of CSO Control Projects in the Papillion Creek Watershed

Facility	Description	Proposed Changes in LTCP Update
Papillion Creek North Basin		
Sewer Separation to Reduce Combined Sewage Volume and Deactivate CSOs 211 – 69th and Pierce, 212 – 69th and Woolworth, and, if possible, 210 – 72nd and Mayberry		
	Area: 219 acres	Increased sewer separation area to 238 acres Changed scope of the CSO 210 and 211 projects from interceptor construction to inflow reduction
Saddle Creek Basin		
RTB at CSO 205 – 64th and Dupont		
	Maximum treatment rate: 315 mgd Total volume: 6.6 MG Number of basins: 3 Dimensions, each basin (length by width by depth): 264 by 66 by 16.7 feet Surface loading rate: 6,000 gallons/day/ square foot Chlorine dosage: 15 mg/L Detention time: 30 minutes	Chlorine Dosage: 20 mg/L Dimensions, each basin (width by length by depth): 80 by 225 by 16.7 feet
RTB Dewatering Lift Station		
	Dewatering rate: 6.6 mgd Maximum dewatering time: 24 hours	No changes proposed
Sewer Separation to Reduce Combined Sewage Volume		
	Area: 549 acres	Reduced to 305 acres
Papillion Creek South Basin		
Sewer Separation to Reduce Combined Sewage Volume and Deactivate CSOs 207 – 44th and Y Street, 208 – 45th and T Street, and 209 – 44th and Harrison		
	Area: 186 acres	No changes proposed

5.2.2 Costs of Controls

Table 5-5 summarizes the changes in capital cost for implementation from the 2009 LTCP to the LTCP Update. The costs are categorized according to a number of significant project categories. Higher projects costs, which are responsible for much of the increases in the project categories, were discussed in Section 1.2.4, along with key reasons for those increases. Other key reasons for the cost changes include the following:

- Escalation of the ENRCCI from 8528 in April 2009 to 9668 in December 2013 to reflect inflation.
- Adjustments in percentages for study and conceptual (10%) design, preliminary design, final design and construction management to reflect on lessons learned during implementation of projects to date.

- Increased costs for property acquisition based on project experience during implementation.
- Conversion of dollars included to address risks associated with projects (Risk Dollars) to construction contingencies based on percentages of estimated construction costs.
- CSO Deep Tunnel project costs were reduced as a result of the planned tunnel diameter change from 17 feet to 15 feet and reduction in tunnel length as a result of the construction of tanks to address CSOs 118 and 119 rather than a drop shaft, but increased due to addition of grit basin facilities at the drop shafts based on experience from other CSO Programs.
- Stormwater conveyance sewer project costs were increased to address regulatory issues related to the detention and conveyance of flows to the Missouri River and to address the flow control structures.
- Addition of two storage tanks at CSO 118 and 119, which resulted in a reduced tunnel length, one less drop shaft, and a lower cost overall.
- WWTP projects including: addition of MRWWTP River Bank Stabilization project due to bank failure along the river, Wetlands Mitigation project, design modifications for flood protection, and splitting the original MRWWTP Improvement project into three separate schedules.
- Sewer separation projects costs were reduced due to changes of sewer separation concepts in the Paxton Area of the Minne Lusa Basin and the Cole Creek CSO 204 area; elimination of individual sewer rehabilitation projects, with funds being transferred to Inflow Reduction Category; and reduced project costs due to incorporation of green infrastructure.
- Miscellaneous/inflow reduction/green infrastructure projects costs increased because of the addition of miscellaneous projects associated with the CSO Program, such as flow monitoring; creation of an Inflow Reduction category of work, including funds from previously identified rehabilitation projects as noted above; identification of five green infrastructure pilot projects as described elsewhere; and creation of a separate Program Management category.

As explained in Section 4, the LTCP Update costs are covered by the revenue from the Rate Model that serves as the basis for the City's sewer use fees.

TABLE 5-5
Changes in Capital Cost for Implementation from the 2009 LTCP to the LTCP Update

Project(s)	2009 LTCP Cost	LTCP Update Cost	% of Total of LTCP Update Costs
CSO Deep Tunnel Project	$442,082,000	$401,393,000	19.2
Minne Lusa Stormwater Collector Projects	$112,750,000	$206,680,000	9.9
High Rate Treatment Projects	$126,326,000	$131,457,000	6.3
SIFM Project	$77,249,000	$92,763,000	4.5
MRWWTP Improvements	$90,934,000	$165,749,000	8.0

TABLE 5-5
Changes in Capital Cost for Implementation from the 2009 LTCP to the LTCP Update

Project(s)	2009 LTCP Cost	LTCP Update Cost	% of Total of LTCP Update Costs
Lift Station Projects	$131,196,000	$147,584,000	7.1
Storage Structure Projects	$30,878,000	$117,878,000	5.7
Sewer Separation Projects	$614,361,000	$544,423,000	26.1
Green Inflow Reduction Projects	$0	$15,000,000	0.7
Miscellaneous/Inflow Reduction/Flow Monitoring/Program Management	$36,448,000	$261,596,000	12.5
Totals	**$1,662,224,000**	**$2,084,523,000**	

5.3 Compliance with CSO Policy

The CSO controls were developed using criteria from the EPA Presumption Approach (EPA, 1995) for addressing CSOs. This section discusses that approach and how this LTCP Update meets the requirements of the EPA policy.

Consistent with the evaluation developed for the 2009 LTCP, the hydraulic model shows that the 85 percent capture criterion will be met during a Representative Year for the updated controls. As is discussed in greater detail in Section 5.3.2, the Water Quality Model anticipates that the *E. coli* standard will be met on the Missouri River and that the controls will not preclude the streams from meeting the standards in the various Papillion Creek tributaries.

5.3.1 Presumption Approach

The alternatives included in the LTCP were developed using the Presumption Approach (EPA, 1995). Under this approach, it is presumed that if the CSO controls meet one of the criteria listed in the EPA CSO Control Policy under "Presumption Approach," then water quality standards will be met. The Presumption Approach criterion being met or exceeded by the LTCP Update is:

> "The elimination or the capture for treatment of no less than 85% by volume of the combined sewage collected in the combined sewer system (CSS) during precipitation events on a system-wide annual average basis."[1]

5.3.1.1 Wet Weather Capture of at Least 85 Percent of Volume

During development of the 2009 LTCP, criteria were developed to define what constitutes wet weather. These include the following:

- Any period of active rainfall or snowmelt

[1] U.S. EPA, 1995, Guidance for Long-Term Control Plan, EPA 832-B-95-002.

- A dry period between two periods of precipitation separated by fewer than 12 hours[2]
- Elevated flows entering or exiting the wastewater treatment plants in the model, as follows:
  - Flow into MRWWTP greater than 40.3 mgd
  - Flow into MRWWTP at the end of a precipitation event that is at least 7.5 mgd above the typical dry-weather flow with diurnal pattern
  - For Existing Conditions, flow into PCWWTP greater than 68.5 mgd (weekdays) and 76.3 mgd (weekends), sometimes including lower flows that occurred for short periods between two periods of higher flows due to the lengthy lag time in this large watershed
  - For LTCP conditions, flow into PCWWTP greater than 96.4 mgd (weekdays), 106.0 mgd (Saturdays), and 106.1 mgd (Sundays), sometimes including lower flows that occurred for short periods between two periods of higher flows due to the lengthy lag time in this large watershed

The values to use for the flow criteria were determined by selecting values greater than the peak of the diurnal dry-weather flow and achieving a balance of flow volumes when all flow elements were considered. The same approach was used for the LTCP Update.

The flows included in the calculation of wet weather capture include the volume of combined sewage collected in the combined and upstream sanitary sewer system during precipitation events, thus including all sanitary flows, groundwater infiltration, industrial waste flows, and similar dry-weather flows once they are mixed with runoff from a precipitation event. In addition, flows that used to be part of the combined system but that have been separated as part of achieving CSO control were also considered to be captured.

Representative Year

In the Missouri River Watershed, 91 percent of the wet weather combined sewer flows are predicted to be captured during Representative Year precipitation.[3] The volumes of flow captured by the various controls and the CSO volume are shown in Table 5-6. Figure 5-3 provides a comparison of captured partially treated CSO volumes between existing and LTCP Update conditions for Representative Year precipitation. Because the CSS in the Missouri River Watershed is in an area that is already developed, the volumes under Existing Conditions (2002) and LTCP Conditions are directly comparable.

[2] The interevent time was selected as 12 hours based on an analysis of the period of time the CSS is typically affected by precipitation events. More information on this analysis can be found in Appendix L of the 2009 LTCP, Interevent Time Technical Memorandum.

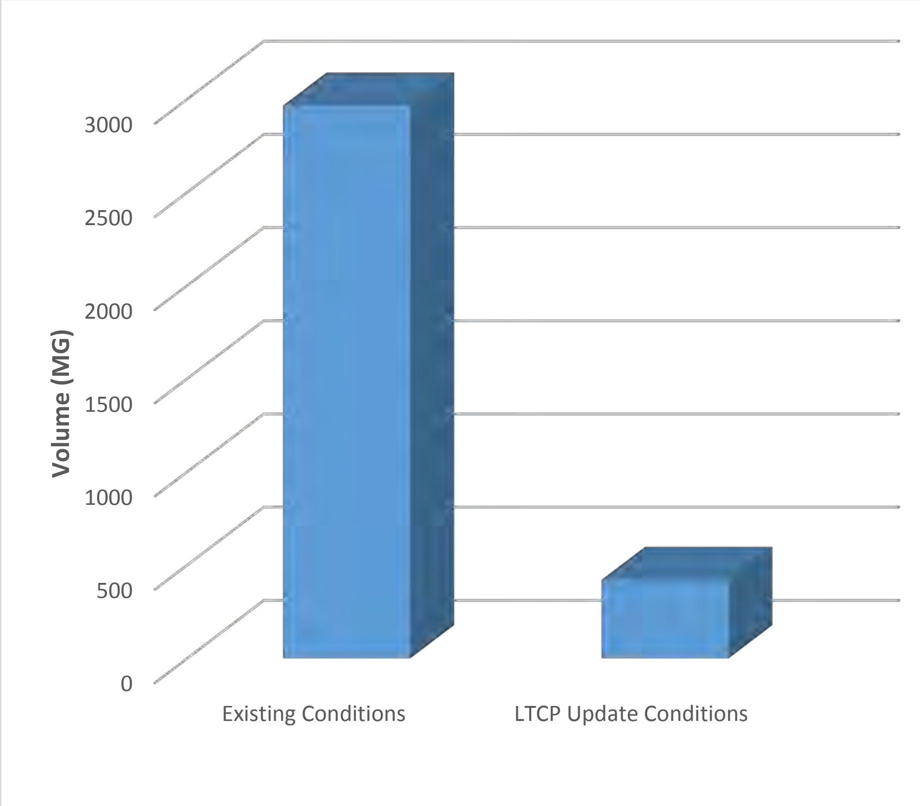
[3] The Representative Year Precipitation is the result of a statistical evaluation of rainfall data over the course of a 34-year period. This analysis was included in Appendix M of the 2009 LTCP. The analysis determined that the precipitation in 1969 was most representative.

TABLE 5-6
Wet Weather Volume Captured in the Missouri River Watershed in the Representative Year

Control	2009 LTCP Volume Captured (MG)	LTCP Update Volume Captured (MG)	2009 LTCP Volume Not Captured (MG)	LTCP Update Volume Not Captured (MG)
MRWWTP Secondary Treatment	1,882	1,872	—	—
Facility Dewatering to MRWWTP Secondary Treatment	121	182	—	—
CSO 102 – MRWWTP Primary Clarifier Primary Treatment and Disinfection	488	599	—	—
Missouri River RTB	793	647	—	—
Stormwater Separated Out of CSS	913	692	—	—
Partially Treated CSO	—	—	307	418
Unaccounted Volume[1]	—	—	52	0.5
TOTAL	**4,197**	**3,992**	**359**	**419**
PERCENT CAPTURE	**92%**	**91%**	**—**	—

[1] Unaccounted volume is the balance of volume needed to make the total volume available in the CSS under LTCP conditions match that under Existing Conditions. To be conservative, it is presumed to not be captured.

FIGURE 5-3
Partially Treated CSO Volume Comparison for Missouri River Watershed in the Representative Year



In the Papillion Creek Watershed, 98 percent of the wet weather combined sewer flows are predicted to be captured during LTCP Update conditions. The volumes of flow captured by the various controls and the CSO volume are shown in Table 5-7 and Figure 5-4. In the Papillion Creek Watershed, development is expected to occur before the LTCP is fully implemented, and thus the total volumes under Existing Conditions and LTCP Conditions are not the same.

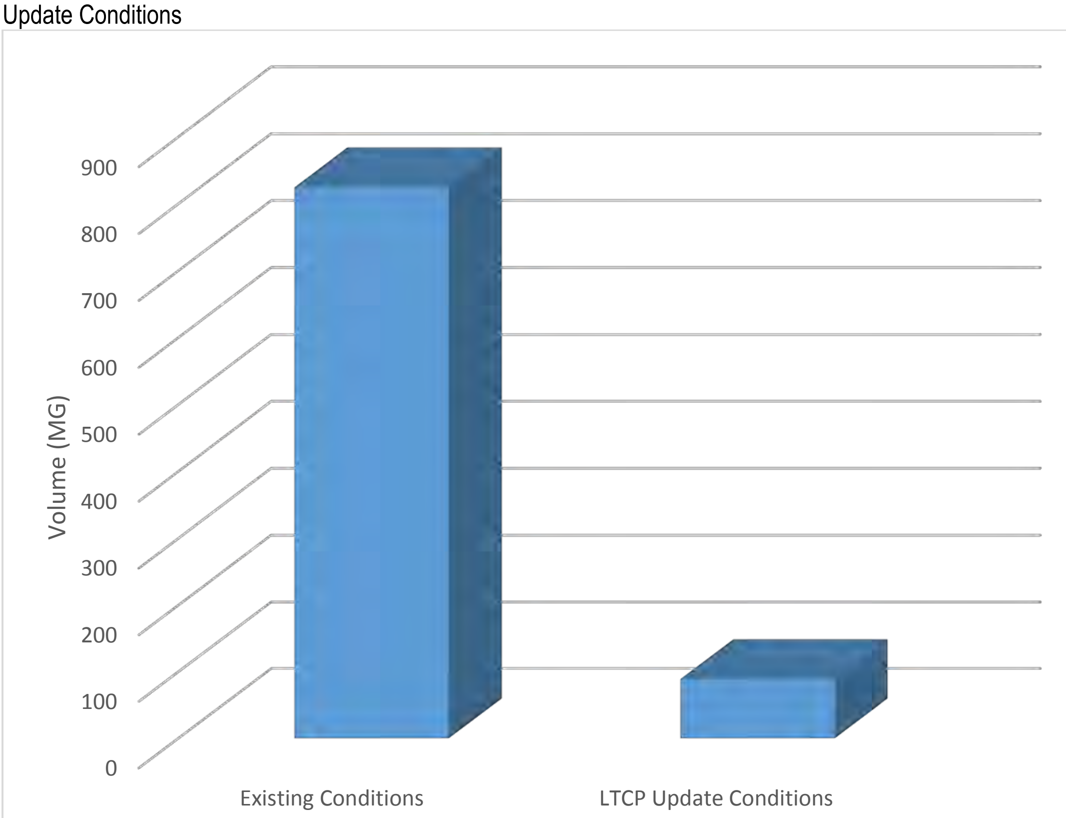
Because the volume of combined sewage captured during wet weather under Representative Year precipitation exceeds 85 percent in both watersheds, this criterion of the Presumption Approach is exceeded by the proposed controls. It should be noted that the overall percent capture for both the 2009 LTCP and the LTCP Update are 94 percent.

TABLE 5-7
Wet Weather Volume Captured in the Papillion Creek Watershed in the Representative Year Precipitation

Control	2009 LTCP Volume Captured (MG)	LTCP Update Volume Captured (MG)	2009 LTCP Volume Not Captured (MG)	LTCP Update Volume Not Captured (MG)
PCWWTP Secondary Treatment	3,689	3893	—	—
Facility Dewatering to PCWWTP Secondary Treatment	194	217	—	—
Saddle Creek RTB	252	270	—	—
Stormwater Separated Out of CSS	239	338	—	—
Partially Treated CSO	—	—	89	83
Unaccounted Volume[1]	—	—	84	5
TOTAL	**4,374**	**4,718**	**173**	**89**
PERCENT CAPTURE	**96%**	**98%**	**—**	**—**

[1] Unaccounted volume is the balance of volume needed to make the total volume available in the CSS under LTCP conditions match that under Existing Conditions plus the new volume resulting from base sanitary flow and runoff due to development. To be conservative, it is presumed to not be captured.

FIGURE 5-4
Partially Treated CSO Volume Comparison for Papillion Creek Watershed in the Representative Year for LTCP Update Conditions



Beyond Watershed Percent Capture

The plan proposed in this LTCP Update exceeds the presumption approach criterion of 85 percent capture by several percentage points in both watersheds. This is necessary to assure that the LTCP meets the in-stream water quality based standards of the CWA. The City utilized design criteria of a minimum of 85 percent capture at each outfall and no more than eight partially treated overflows at each outfall in the Representative Year. The CSO Controls are sized to ensure that both of these design criteria are met. Table 5-8 shows the percent capture by outfall estimated by the model for the Representative Year for the LTCP Update. Table 5-9 shows the number of CSOs estimated by the model for the Representative Year under the LTCP Update.

TABLE 5-8
Percent Capture by CSO Outfall

CSO	Location	Existing Condition (2002) Wet Weather Volume (MG)	LTCP Update (2027) CSO Volume (MG)	2027 Wet Weather Capture (%)
102	MRWWTP	202.0	0	100
103	Bridge Street Lift Station	26.1	0	100
104	Mormon Street	49.3	0	100
105	Minne Lusa Avenue	790.5	37.8	95
106	North Interceptor	648.8	41.9	94
107	Grace Street	337.2	47.0	86
108	Burt-Izard Street	790.4	89.7	89
109	1st and Leavenworth	833.8	101.8	88
110	Pierce Street Lift Station	23.2	0	100
111	Hickory Street Lift Station	11.5	0	100
112	Martha Street	25.3	0	100
113	Spring Street Lift Station	0.9	0	100
114	Grover Street	15.4	1.1	93
115	Riverview Lift Station	102.2	8.6	92
116	Homer Street	36.4	0	100
117	Missouri Ave Lift Station	69.8	0	100
118	South Omaha – Ohern Street	337.7	39.6	88
119	Monroe Street Lift Station	677.0	45.2	93
121	Jones Street	57.5	5.4	91
201	PCWWTP	3,039.4	11.9	99.6
202	72nd and Bedford	23.1	0	100
203	69th and Evans	18.2	<0.1	99.9
204	63rd and Ames	133.1	0.2	99.8
205	64th and Dupont	1,215.2	71.1	94
206	43rd and S Street	1.7	0	100
207	44th and Y Street	23.2	0	100
208	45th and T Street	22.9	0	100
209	44th and Harrison	12.3	0	100

TABLE 5-8
Percent Capture by CSO Outfall

CSO	Location	Existing Condition (2002) Wet Weather Volume (MG)	LTCP Update (2027) CSO Volume (MG)	2027 Wet Weather Capture (%)
210	72nd and Mayberry	23.1	0.1	99.6
211	69th and Pierce	3.0	0	100
212	69th and Woolworth	5.5	0	100

TABLE 5-9
Number of CSOs during Representative Year Under LTCP Update

CSO	Location	Number of CSOs
102	MRWWTP	0 (*)
103	Bridge Street Lift Station	—
104	Mormon Street	—
105	Minne Lusa Avenue	8
106	North Interceptor	7
107	Grace Street	7
108	Burt-Izard Street	7
109	1st and Leavenworth	7
110	Pierce Street Lift Station	0
111	Hickory Street Lift Station	0
112	Martha Street	—
113	Spring Street Lift Station	—
114	Grover Street	7
115	Riverview Lift Station	7
116	Homer Street	—
117	Missouri Avenue Lift Station	—
118	South Omaha – Ohern Street	8
119	Monroe Street Lift Station	7
121	Jones Street	3
201	Papillion Creek WWTF	2
202	72nd and Bedford	—
203	69th and Evans	— (3)
204	63rd and Ames	3
205	64th and Dupont	5
206	43rd and S Street	—
207	44th and Y Street	—
208	45th and T Street	—
209	44th and Harrison	—
210	72nd and Mayberry	— (3)

TABLE 5-9
Number of CSOs during Representative Year Under LTCP Update

CSO	Location	Number of CSOs
211	69th and Pierce	—
212	69th and Woolworth	—

Note: "—" denotes an outfall that is or will be closed. "0" denotes an outfall that had no CSOs in the Representative Year but is not currently planned to be closed. For CSOs 203 and 210, the plan is for closure; however, the 2027 model still indicates CSOs; additional inflow reduction work may be required to allow closure to occur.
(*) CSO is a bypass rather than a CSO; however, it is included in the City's CSO Permit. Flow from CSO 102 will received primary treatment and disinfection and is therefore listed with a 0 number of CSOs.

As demonstrated in Section 2, the City has invested a significant amount of resources to maintain a state of the art CSS Model. A high level of confidence is placed on the model's ability to accurately assess the level of control of the selected controls in the LTCP.

A model cannot predict or assess all conditions that may be encountered. It is a representation of the variables that effect the infrastructure of the CSS with the actual performance of the CSS being driven by more dynamic and variable factors, such as:

- Rainfall variability, both spatially and in magnitude.
- Sediment and debris buildup and transport.
- Downstream tail water conditions, in particular, high water levels in the Missouri River and the Papillion Creek.
- Actual fluctuations in the ground water table effect.
- Numerous other factors that impact the duration, frequency, and magnitude of the quantity of overflows from the CSS.

These factors need to be considered when reviewing model results. Even with conservatism built into the model and the high level of confidence is due to the quality of the data used to build the model. The results must be interpreted with a level of understanding of the various conditions that may affect the results.

5.3.2 Water Quality Impacts from Controls

An important element of the development of the LTCP Update was to evaluate the impact of the proposed changes to the controls on the water quality in the Missouri River, Papillion Creek, and tributaries. As noted in the 2009 LTCP, the primary focus of the pollutant evaluation and modeling is *E. coli* because this is the only pollutant of concern for CSOs identified by NDEQ.

The standard for *E. coli* applies to all streams with a Recreational Use classification, as established by NDEQ. The numeric standard for *E. coli* is 126 org/100 mL and applies from May 1 to September 30. Based on NDEQ guidance, compliance with the standard is judged by taking the geometric mean of all data, during both wet and dry weather, collected during the recreation season. To determine whether the proposed updated controls will still be able to achieve this value, the Water Quality Model used in the 2009 LTCP was updated with new data and to align with the 2017 Info Works Model. The model is structured to calculate downstream *E. coli* concentrations on a daily basis for the Representative Year precipitation under Existing Conditions and after implementation of the LTCP Update controls. Assumptions on the model are described in Section 4 of the 2009 LTCP and are not repeated here. Missouri River water quality data was updated with data collected by the USGS. The CSO *E. coli* levels were also updated in the model. All other data remains unchanged.

Representative Year *E. Coli* Load Results

Figure 5-5 compares the estimated loadings of *E. coli* in the Missouri River below Papillion Creek under two different conditions – Existing Conditions and after implementation of the LTCP. The significant reduction in loading from partially treated CSOs can be seen in this figure.

FIGURE 5-5
Estimated Annual *E. coli* Loadings in Missouri River below Papillion Creek Confluence in the LTCP Update

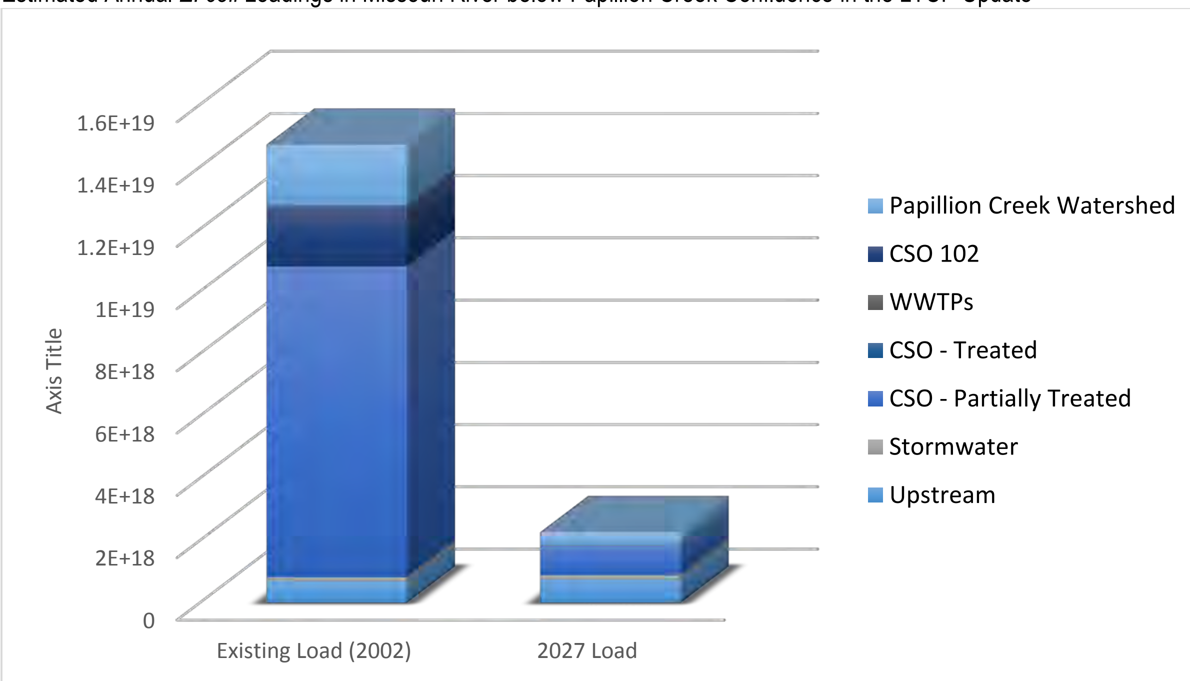
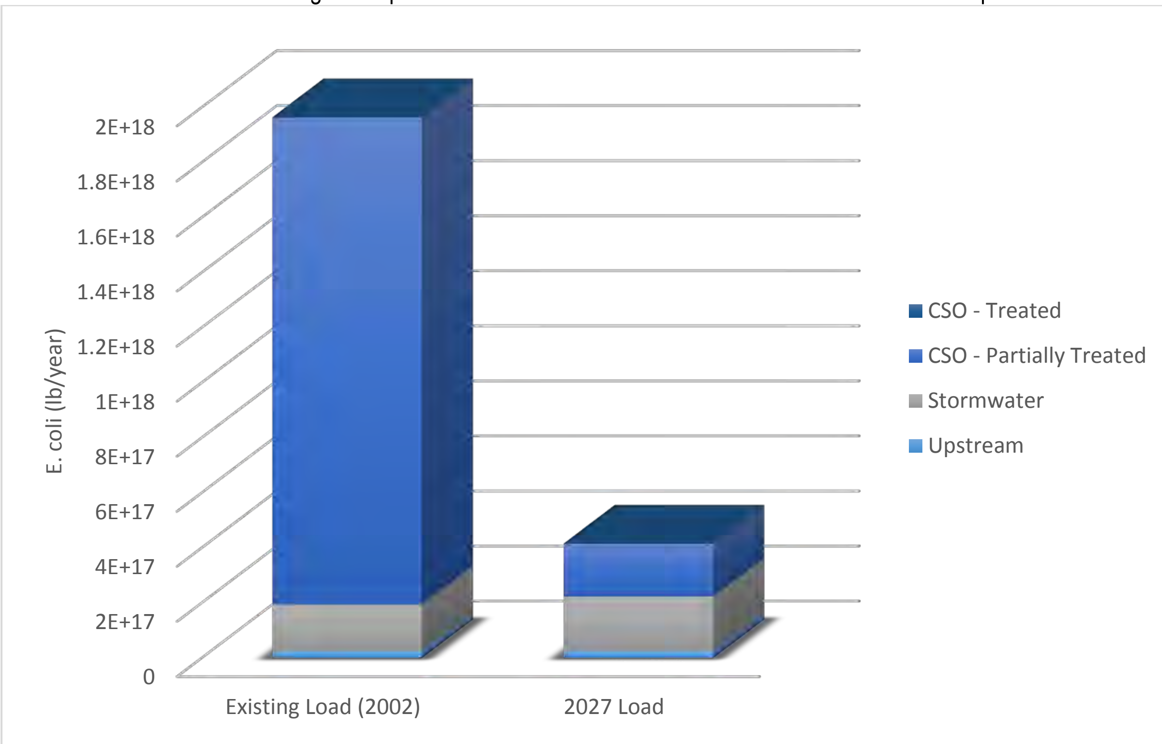


Figure 5-6 compares the estimated *E. coli* loading in Papillion Creek upstream of its confluence with the Missouri River under Existing Conditions and after implementation of the LTCP. As with the Missouri River, the significant reduction in loading from partially treated CSOs can be seen in this figure.

FIGURE 5-6
Estimated Annual *E. coli* Loadings in Papillion Creek above Missouri River Confluence in the LTCP Update



Recreation Season *E. coli* Results

Because the model estimates daily *E. coli* levels, it allows predictions to be made of the geometric mean of *E. coli* levels in the recreation season (May 1 to September 30) under Existing Conditions and after implementation of the LTCP. Three points along the Missouri River and the Papillion Creek are evaluated to determine if it can be reasonably presumed that the water quality standard can be met. These are shown on Figure 5-7 and consist of MR End Point 4, Missouri River above Papillion Creek; PC End Point 4, Papillion Creek above the confluence with the Missouri River; and MR End Point 5, Missouri River below Papillion Creek. Table 5-10 presents the results of this analysis for both watersheds.

FIGURE 5-7
Location of Compliance Points for the Water Quality Model

TABLE 5-10
Geometric Mean Concentrations of *E. coli* during the Recreation Season (org/100 mL) for the LTCP Update

	2009 LTCP Missouri River Above Papillion Creek[1] *(MR End Point 4)*	**LTCP Update Missouri River Above Papillion Creek**[1] *(MR End Point 4)*	**2009 LTCP Papillion Creek Above Confluence with Missouri River**[1] *(PC End Point 4)*	**LTCP Update Papillion Creek Above Confluence with Missouri River**[1] *(PC End Point 4)*	**2009 LTCP Missouri River Below Papillion Creek**[1] *(MR End Point 5)*	**LTCP Update Missouri River Below Papillion Creek**[1] *(MR End Point 5)*
Existing Conditions	222	222	3,414	3,414	233	233
After LTCP	122	117	2,306	2,309	134	127
After LTCP and Papillion Creek TMDL	122	117	296	289	130	124
E. coli Water Quality Standard	126	126	126	126	126	126

[1]These locations are shown on Figure 5-7.

Missouri River Water Quality

As noted in the 2009 LTCP, the Water Quality Model shows that the Missouri River downstream of the CSOs (and above the Papillion Creek confluence) does not meet the *E. coli* water quality standard of 126 org/100 mL under Existing Conditions. However, the Missouri River above the Papillion Creek confluence can meet the standard after implementation of the LTCP. The value downstream of the Papillion Creek confluence barely exceeds the standard and is probably within the margin of error in the model. Once the TMDL for the Papillion Creek Watershed (NDEQ, 2009)[4] is fully implemented, it is anticipated that the Missouri River below Papillion Creek would be meeting the standard. This suggests that the proposed controls can be presumed to meet the water quality standard for *E. coli* in the Missouri River.

Papillion Creek Water Quality

The Water Quality Model results in Table 5-10 suggest that Papillion Creek does not meet the *E. coli* water quality standard of 126 org/100 mL under Existing Conditions. In addition, as in the 2009 LTCP, the LTCP Update controls will not result in compliance in Papillion Creek, despite a significant reduction in the *E. coli* load from the CSOs. Also, as in the 2009 LTCP evaluation, the CSO controls do not preclude or prevent the standards for *E. coli* from being met in Papillion Creek. It is necessary for NDEQ to address other pollution sources outside of the CSO Program and likely outside of the City of Omaha to bring the streams into compliance.

CSO Pollutant Reductions

As CSO volumes are reduced, CSO pollutant loadings also will be reduced. In the Missouri River Watershed, it was estimated that the *E. coli* load to the Missouri River would be reduced by 89 percent under Representative Year precipitation conditions after implementation of the 2009 LTCP controls. In the Papillion Creek Watershed, it was estimated that the *E. coli* load to the creek would be reduced by 81 percent for the Representative Year. Table 5-11 summarizes the CSO pollutant reductions.

TABLE 5-11
Estimated *E. coli* CSO Load Reduction after Implementation of LTCP Controls (org/year)

Watershed	Load (2002)	2009 LTCP Load	LTCP Update	2009 LTCP Load Reduction	LTCP Update Reduction
Missouri River	1.40E+19	1.51E+18	1.51E+18	89%	89%
Papillion Creek	0.194E+19	0.366E+18	0.390E+18	81%	80%

Table 5-11 shows that the *E. coli* loading into the Missouri River is unchanged from that estimated in the 2009 LTCP, even though there were modifications of controls and the number of overflows has increased. For Papillion Creek, the loading is less by 1 percent, reflecting slightly higher load from CSO 205 after recalibration of the model. While the

[4] Based on information from "Total Maximum Daily Loads for the Papillion Creek Watershed (Segments MT1-10100, MT1-10110, MT1-10111.1, MT1-10120 and MT1-10200), Parameter of Concern: E. coli Bacteria", Nebraska Department of Environmental Quality Planning Unit, Water Quality Division, October 2009.

CSO volume and associated loading from CSO 201 decreased, the benefit from that decrease is for the Missouri River rather than Papillion Creek due to the outfall's location.

As noted in the 2009 LTCP, these load reductions are lower than the CSO volume reduction (see below) for several reasons:

1. Sewer separation results in a reduction in the volume of combined sewage entering the system. However, stormwater has relatively high *E. coli* concentrations, and thus it still provides a significant *E. coli* loading to the receiving streams.

2. Increasing flows to the MRWWTP results in a decrease in the volume of untreated combined sewage that is discharged; however, there is still an *E. coli* loading from the treated discharges at the MRWWTP.

3. Combined sewage that is treated in one of the RTBs is included in the "volume captured" calculations. However, the discharge from these systems still results in an *E. coli* loading to the stream.

CSO Volume Reductions

While CSO volumes are reduced as the result of the implementation of controls, the volumes are shifted to other types of discharges such as stormwater that still have *E. coli* loads, albeit much smaller, into the receiving waters. For example, as noted above, stormwater discharges that result from sewer separation still have a significant load of *E. coli*, however the source of the *E. coli* is not related to sanitary sewage. In this section, the reduction in CSO volume is presented. Reduction in CSO volume is a different criterion than either percent volume reduction or percent treated, which were presented previously in this section.

Under the LTCP Update, CSO volumes are substantially reduced. Several existing CSO outfalls will be deactivated, sewer separation will decrease flows in the CSS, and treatment and/or storage at other locations will result in a reduction of overflows.

Missouri River Watershed

In the Missouri River Watershed, five CSO outfalls are planned to be deactivated, nine diversions will send flow to the tunnel/RTB for treatment, and three CSOs will have storage tanks. Overall, it is expected that the LTCP will result in an 86 percent reduction in partially treated CSO volume to the Missouri River based on Representative Year precipitation. Table 5-12 presents partially treated CSO volume reductions for each of the outfalls. Again, these percent reductions must not be confused with percent captured data presented previously in this section and required under the EPA CSO Control Policy. They are provided so that the expected benefits at specific CSO outfalls can be shown.

TABLE 5-12
Estimated Partially Treated[1] CSO Volume Reduction in the Missouri River Watershed for the Representative Year, LTCP Update

CSO Outfall	Primary CSO Control	Partially Treated[1] CSO Volume (2002) (MG)	Partially Treated[1] CSO Volume (LTCP Update) (MG)	Partially Treated[1] CSO Volume Reduction (%)
102 – MRWWTP Primary Clarifier	Primary treatment and disinfection	202.4	0	100
103 – Bridge Street Lift Station	Sewer separation and outfall deactivation	<0.1	0	100
104 – Mormon Street	Sewer separation and outfall deactivation	0.6	0	100
105 – Minne Lusa Avenue	Storage tank and sewer separation	286.6	37.8	87
106 – North Interceptor	Tunnel/RTB	514.3	41.9	92
107 – Grace Street	Tunnel/RTB	281.6	47.0	83
108 – Burt-Izard Street	Sewer separation and Tunnel/RTB	485.9	89.7	82
109 – 1st and Leavenworth	Tunnel/RTB	623.7	101.8	84
110 – Pierce Street Lift Station	Sewer separation and Tunnel/RTB	5.1	0	100
111 – Hickory Street Lift Station	Sewer separation and Tunnel/RTB	0.2	0	100
112 – Martha Street	Sewer separation, rerouting of flow and outfall deactivation	3.8	0	100
113 – Spring Street Lift Station	Rerouting of flow and deactivation of outfall	<0.1	0	100
114 – Grover Street	Tunnel/RTB	6.1	1.1	82
115 – Riverview Lift Station	Tunnel/RTB	48.0	8.6	82
116 – Homer Street	(already separated and deactivated)	19.0	0	100
117 – Missouri Avenue Lift Station	Sewer separation and outfall deactivation	44.7	0	100
118 – South Omaha/Ohern Street	Storage tank	102.3	39.6	61

TABLE 5-12
Estimated Partially Treated[1] CSO Volume Reduction in the Missouri River Watershed for the Representative Year, LTCP Update

CSO Outfall	Primary CSO Control	Partially Treated[1] CSO Volume (2002) (MG)	Partially Treated[1] CSO Volume (LTCP Update) (MG)	Partially Treated[1] CSO Volume Reduction (%)
119 – Monroe Street Lift Station	Storage tank	279.9	45.2	84
121 – Jones Street	Tunnel/RTB	59.9	5.4	91
	TOTAL	**2964**	**418.1**	**86**

[1]CSO volumes presented in this table are for partially treated CSO discharges.

Note – CSO 102 – MRWWTP Primary Clarifier is a bypass rather than a CSO. It is included in this table because it is in the City's CSO Permit. All of the discharge from CSO 102 will be treated through preliminary and primary treatment and disinfection. Disinfection is only required during the recreation season.

Papillion Creek Watershed

In the Papillion Creek Watershed, eight CSOs are planned to be deactivated, two CSOs will have significantly reduced CSO volumes due to sewer separation, and one CSO will have a RTB for treatment of large flow rates. Overall, it is expected that the LTCP will result in a 90 percent reduction in partially treated CSO volume to the Papillion Creek and its tributaries for Representative Year precipitation, as compared to Existing Conditions. Table 5-13 presents partially treated CSO volume reductions for each of the outfalls. Again, these percent reductions must not be confused with percent captured data presented previously in this section and required under the EPA CSO Control Policy. They are provided so the expected benefits at specific CSO outfalls can be shown.

TABLE 5-13
Estimated Partially Treated[1] CSO Volume Reduction in the Papillion Creek Watershed for the Representative Year, LTCP Update

CSO Outfall	Primary CSO Control	Partially Treated[1] CSO Volume (2002) (MG)	Partially Treated[1] CSO Volume (LTCP Update) (MG)	Partially Treated[1] CSO Volume Reduction (%)
201 – PCWWTP Interceptor	Sewer separation and wet weather treatment capacity at PCWWTP	46.2	11.9	74
202 – 72nd and Bedford	Sewer separation and outfall deactivation	10.2	0	100
203 – 69th and Evans	Sewer separation and outfall deactivation	7.5	<0.1	100
204 – 63rd and Ames	Sewer separation and storage tank	62.0	0.2	99.7
205 – 64th and Dupont	Sewer separation and RTB	672.6	71.1	89

TABLE 5-13
Estimated Partially Treated[1] CSO Volume Reduction in the Papillion Creek Watershed for the Representative Year, LTCP Update

CSO Outfall	Primary CSO Control	Partially Treated[1] CSO Volume (2002) (MG)	Partially Treated[1] CSO Volume (LTCP Update) (MG)	Partially Treated[1] CSO Volume Reduction (%)
206 – 43rd and S Street	(already separated and deactivated)	0	0	NA
207 – 44th and Y Street	Sewer separation and outfall deactivation	5.4	0	100
208 – 45th and T Street	Sewer separation and outfall deactivation	0.7	0	100
209 – 44th and Harrison	Sewer separation and outfall deactivation	0.3	0	100
210 – 72nd and Mayberry	Sewer separation and outfall deactivation	18.9	0.1	99.5
211 – 69th and Pierce	Sewer separation and outfall deactivation	0.1	0	100
212 – 69th and Woolworth	Sewer separation and outfall deactivation	<0.1	0	100
	TOTAL	**824.1**	**83.3**	**90**

[1]CSO volumes presented in this table are for partially treated CSO discharges.

5.3.3 Summary of Control Approach

As the preceding sections have detailed, Omaha's LTCP meets the criteria of the Presumption Approach, as summarized below:

- The criterion of capturing at least 85 percent of volume during wet weather is achieved under Representative Year precipitation.
- The Water Quality Model shows that water quality standards for *E. coli* can be presumed to be attained in the Missouri River.
- The Water Quality Model shows that, while Papillion Creek is not expected to achieve attainment of water quality standards and designated uses because of significant background loads, it can be presumed that achievement of this standard will not be precluded by the loads contributed by CSOs.

The overall percent capture of 94 percent of the flow during wet weather is the same as in the 2009 LTCP and in the LTCP Update.

5.3.4 Proposed Performance Criteria for the CSS

The City anticipates requesting that the CSO Permit be written as follows when the LTCP is complete:

- The CSO controls for each CSS shall be operated and maintained in a manner to achieve, the capture and treatment through CSO controls (RTBs, storage tanks, etc.), including treatment provided at the MRWWTP or the PCWWTP, and sewer separation of no less than 85 percent by volume of the combined sewage collected in the CSS as the result of precipitation events on an annual average basis.

5.4 Costs of Controls and Affordability

As noted in Section 4, the City has passed a rate ordinance that established rates to fund the CSO Program, along with other required functions of the City's wastewater collection and treatment system. The rate ordinance, along with the City's rate model, demonstrates the City's financial plan to fund the CSO Program through 2020, as required by the CSO Permit, and throughout the duration of the LTCP. It will be necessary to adaptively manage the implementation of the controls as defined in the LTCP Update. This includes controlling costs to ensure that the controls are implemented according to the schedule. Section 4 describes in greater detail the Program financial plan along with affordability concerns that will require the City to work with NDEQ.

The schedule provided in Section 5.5 is based on the ability to pay for the projects, as currently defined in this LTCP.

5.5 LTCP Update Implementation Schedule

The schedule provided in Section 5.5 is based on the ability to afford the projects as designed. Assuming no changes in current conditions, the City will need to work with NDEQ to address affordability concerns in the future.

This section provides a revised LTCP schedule and describes the scheduling assumptions that differ from the 2009 LTCP.

As explained in the LTCP, projects in this LTCP Update are categorized as either Major Projects or Sewer Separation Projects. Major Projects consist of projects that are associated with four major elements of the LTCP: namely, maximizing flow to the MRWWTP, the Saddle Creek RTB, the Stormwater Conveyance Sewer in the Minne Lusa Basin, and the CSO Deep Tunnel. Based on this definition, there are four Sewer Separation Projects that are defined as Major Projects. The rest of the sewer separation projects in the LTCP are defined as Sewer Separation Projects.

5.5.1 Prioritization and Scheduling

In the 2009 LTCP, after selection of the CSO controls, the City reviewed each project to determine its impact on water quality, priority in construction sequence, and cost. These factors were balanced when the original schedule was developed.

This has held true for the LTCP Update schedule provided in this section. The LTCP Update schedule also reflects the 3-year LTCP extension to 2027 authorized by the NDEQ due to the 2011 Flood impacts. The 2009 LTCP should be consulted for a discussion of how the factors were considered in the original schedule.

5.5.2 Description of Schedule

This section presents the LTCP Update schedule and describes the basic design and construction elements considered during its development. Similar to the 2009 LTCP, the updated schedule identifies implementation phases for the selected control projects under each phase, and the years when the phases are proposed to start and be completed. For the Major Projects, the "phase start date" is the start of final design; for sewer separation, it is the year when the project bidding process will begin. The "phase completion date" is the date anticipated for completion of all projects in that phase. Project completion is defined as Operationally Complete for facility projects such as an RTB, and Substantially Complete for sewer separation projects.

5.5.2.1 Description of Implementation Steps for Projects

The implementation steps, such as preliminary design, for projects are consistent with Section 7.3.1 in the 2009 LTCP and will not be repeated here. As done originally, the LTCP Update construction sequencing and schedule were developed for each project. These project steps are based on a traditional design-bid-build approach.

5.5.2.2 Project Schedule

The City developed a preliminary LTCP Update implementation schedule based on the 2009 LTCP schedule. As necessary, project interrelationships, priorities, and construction sequencing were factored into the schedule. This schedule was then adjusted to conform to the City's financing capability identified in Section 4, along with other changes described elsewhere such as building the storage tank at CSO 105 in a single phase.

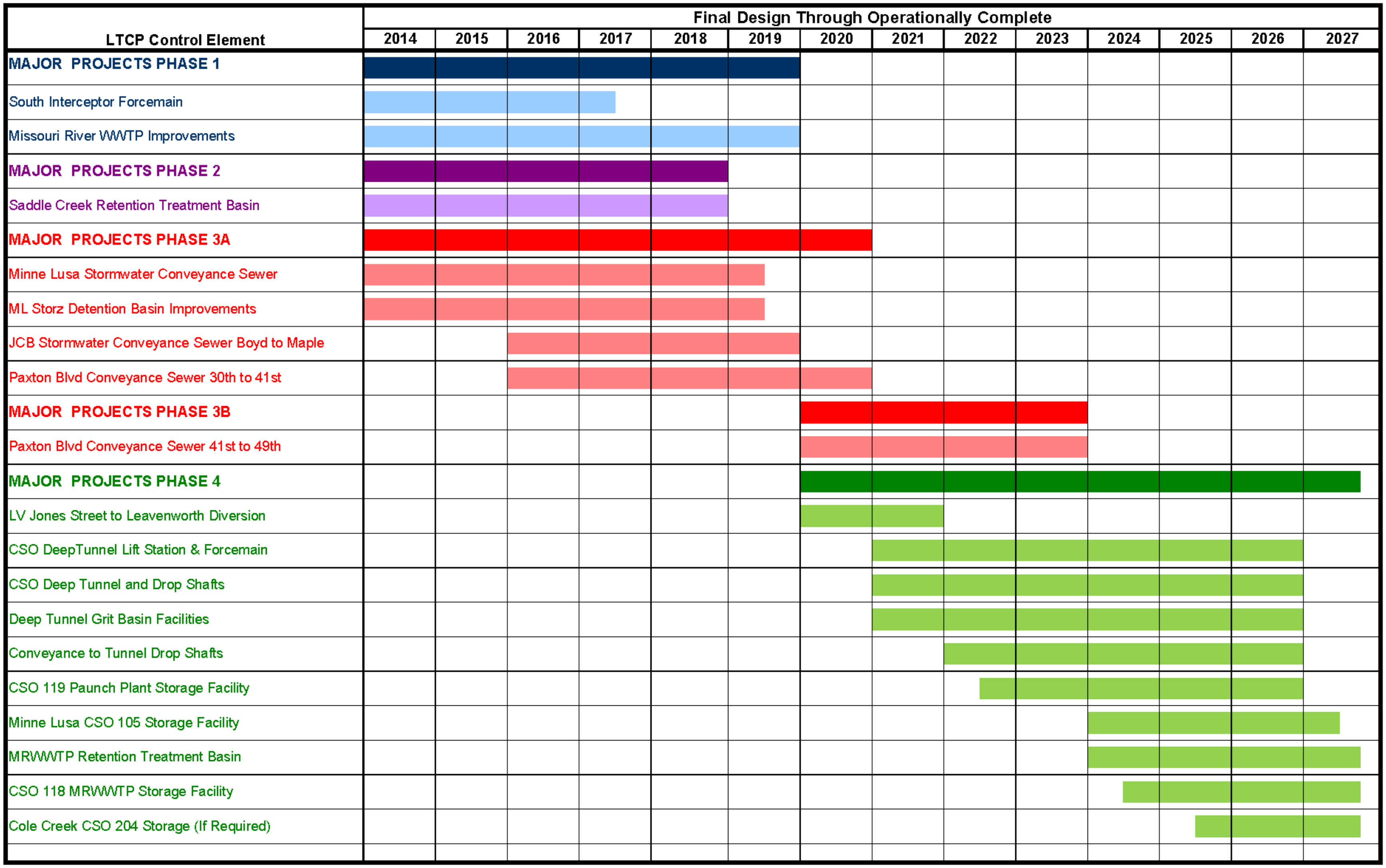
It is important to point out that these schedules are based on the current situation, and timeframes are likely to change. In addition, it is difficult to predict with much certainty the precise dates for implementation of project steps 5 to 10 years in the future. To address this uncertainty, the projects have been grouped into phases. For the Major Projects, these phases reflect projects that are related to each other. For Sewer Separation Projects, they have been grouped into phases based primarily on anticipated bid dates.

Major Projects

Figure 5-8 shows the schedule of the Major Projects, with the "start" dates as the beginnings of final designs and the "end" dates when the controls are operationally complete. The phases for the Major Projects are the same as in the 2009 LTCP. Projects that have currently been completed have been removed from the phase.

The details of the individual projects in Figure 5-8 were discussed in Section 3 and above. The following summary provides the basis for updates to the schedule.

FIGURE 5-8
Schedule of Major Control Phases



Phase 1 – MRWWTP and Collection System Improvements

All projects in this phase, with the exception of MRWWTP Improvements – Schedule B2, have either been completed or are in construction. The Schedule B2 project is anticipated to start construction in early 2016. Per the 2009 LTCP, all projects were to have been completed by September 30, 2015. However, due to the 2011 Flood, design work for the projects along the Missouri River Flood Control levee, specifically the SIFM and the MRWWTP Improvements, was delayed due to the inability to perform field investigations or receive project reviews from the USACE. As noted in Section 2, the west bank Missouri River is sloughing toward the Missouri River near the MRWWTP where additional facilities are to be constructed and the bank must be stabilized before construction can begin. As a result, construction completion of all of the MRWWTP facilities is not anticipated until the end of December 2019, which coincides with the end date for Phase 1.

In addition, the SIFM was delayed as a result of modifications in methods and alignment due to utility conflicts, poor soils, and additional permitting and review associated with work through Lewis and Clark Landing and Heartland of America Park. SIFM construction is anticipated to be completed in mid-2017.

Phase 2 – Saddle Creek Retention Treatment Basin

Phase 2 began in 2010 and will be completed by the end of December 2018. Sewer Separation in the area of Bohemian Cemetery and Aksarben Village has been completed. The only remaining project under Phase 2 is the RTB. The Saddle Creek RTB is currently under design and will be under construction by October 2015 with completion in 2018.

Phase 3A – Minne Lusa Stormwater Conveyance System and Storage Basin

The original Phase 3 has been divided into two phases as a result of long construction schedules for the Paxton Conveyance Sewer. The Miller Park to Pershing Sewer Separation project has been completed. Phase 3A consists of the Minne Lusa Conveyance Sewer, JCB Conveyance Sewer, Minne Lusa Storz Detention Basin, and the Paxton Conveyance Sewer 30th to 41st. The construction of the Minne Lusa Tank at CSO 105 has been removed from Phase 3 and placed into Phase 4. Phase 3, as described in the 2009 LTCP, began in 2012 with the commencement of construction of the Miller Park to Pershing Sewer Separation project. Those projects now under 3A will be completed by the end of December 2019.

Phase 3B – Minne Lusa Stormwater Conveyance System and Storage Basin

Phase 3B will begin by 2020 and will be completed by the end of December 2023. This is a new phase to address the long construction schedule for the Paxton Conveyance Sewer. It includes the construction of the second phase of the Paxton Conveyance Sewer project from 41st to 49th.

Phase 4 – CSO Deep Tunnel/Missouri River RTB/ Storage Tanks/Miscellaneous Projects

Phase 4 will begin by 2020 and will be completed by October 1, 2027. This phase includes construction of the CSO Deep Tunnel and associated drop shafts, lift stations and conveyance sewers, the Missouri River RTB, and storage tanks at CSO 118 and CSO 119. These projects are at the end of the implementation schedule because of the number of upstream projects to be constructed and the associated level of uncertainty about their final sizing, as well as their significant costs. By scheduling them near the end of the construction period, the City will be able to gather data on the effectiveness of sewer separation and other projects and optimize their sizing to maximize their effectiveness in controlling the remaining CSOs.

- The Cole Creek Basin CSO 204 – 63rd and Ames Storage Tank project will store combined sewage until conveyance capacity in downstream interceptors and treatment capacity at PCWWTP are available. The CSO 204 tank is scheduled later in the implementation period since it is believed that the current sewer separation projects and other inflow reduction work may result in the elimination of the need for the tank.

By scheduling them near the end of the construction period, the City will be able to gather data on the effectiveness of sewer separation and other projects and optimize their sizing to maximize their effectiveness in controlling the remaining CSOs.

- The CSO 105 – Minne Lusa Avenue Storage Tank project will be constructed during this phase. Originally it was to be a two-phase tank. However, it was determined that it would be more efficient to perform sewer separation in the basin as this could provide a more immediate reduction in the CSOs. The final size will be based on the effectiveness of sewer separation in the contributing basin.

Sewer Separation Projects

Figure 5-9 shows the schedule of the Sewer Separation Projects, with the "start" dates as the beginning of bidding and the "end" dates when the controls are substantially complete. This schedule addresses the elimination of separate rehabilitation projects, projects (such as 26th and Corby) that are being re-assigned to the City's RNC sewer separation program, and the addition of projects identified since the preparation of the 2009 LTCP that reflect adaptive management efforts.

It should be noted that the phases described here are unique and are not the same as the phases in Figure 7-2 of the 2009 LTCP or Table 7-2. Phase 1 is not included because the projects in this phase that were included in the 2009 LTCP have all been completed.

5.5.3 Phase Tables

Tables 5-14 and 5-15 provide dates for the Major Projects and Sewer Separation Projects listed in Figures 5-7 and 5-8 respectively. The tables provide compliance dates that could be used in CSO Permits. Project descriptions and design criteria are included in Section 3 and are not repeated in these tables.

It should be noted that the phases described here are unique and are not the same as the Phases in Figure 7-2 of the 2009 LTCP or Table 7-2.

The "2009 LTCP ID" is include for information purposes. It is an indicator where a project with was in the schedule in the 2009 LTCP. The values are in Table 7-1 Major CSO Control Phases and Milestones and Table 7-2 Sewer Separation Phases and Milestones in the 2009 LTCP. However, for sewer separation projects it is important to note that the projects, may have the same names, but are not necessary the same project. Section 3 of the LTCP should be consulted for descriptions of the projects.

FIGURE 5-9
Schedule of Sewer Separation Project Phases

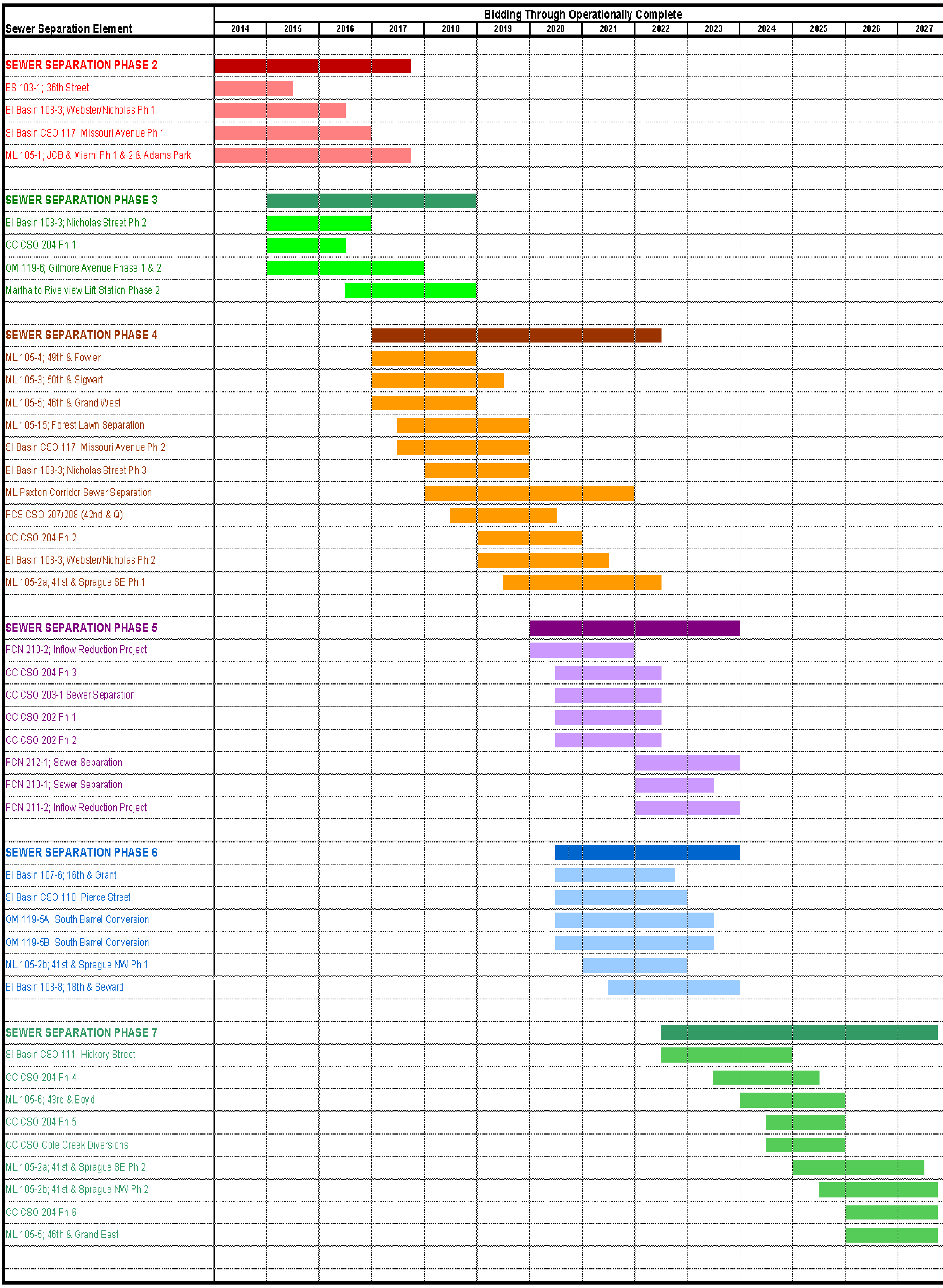


TABLE 5-14
Major Projects Phases and Milestones

Major Projects Phase 1

Critical Milestones:

Begin final design of one project by December 31, 2009 (Met September 1, 2009)

Begin construction of one project by December 31, 2010 (Met June 8, 2010)

All projects operationally complete by December 31, 2019

ID	CSO Control	2009 LTCP ID[a]
1C	SIFM	1C
1D	MRWWTP Improvements	1D

Major Projects Phase 2

Critical Milestones:

Begin final design of one project by December 31, 2010 (Met September 30. 2010)

Begin construction of one project by December 31, 2011 (Met September 29, 2011)

All projects operationally complete by December 31, 2018

ID	CSO Control	2009 LTCP ID[a]
2C	Saddle Creek CSO 205 – 64th and Dupont RTB	2C

Major Projects Phase 3A

Critical Milestones:

Begin final design of one project by December 31, 2011 (Met December 27, 2011)

Begin construction of one project by December 31, 2013 (Met July 8, 2013)

All projects operationally complete by December 31, 2020

ID	CSO Control	2009 LTCP ID[a]
3B	Minne Lusa Stormwater Conveyance Sewer	3B
3C	JCB Stormwater Conveyance Sewer (Project No. ML-105-13B)	3C
3D	Minne Lusa Storz Detention Basin Improvements	3D
3E	Paxton Blvd Stormwater Conveyance Sewer 30th to 41st (ML-105-13A Phase 1)	3E

Major Projects Phase 3B

Critical Milestones:

Begin final design of one project by December 31, 2019

Begin construction of one project by December 31, 2022

All projects operationally complete by December 31, 2023

ID	CSO Control	2009 LTCP ID[a]
3F	Paxton Blvd Stormwater Conveyance Sewer 41st to 49th (ML-105-13A Phase 2)	Part of 3E

TABLE 5-14
Major Projects Phases and Milestones

Major Projects Phase 4 *Critical Milestones:* Begin final design of one project by December 31, 2019 Begin construction of one project by December 31, 2023 All projects operationally complete by September 30, 2027		
ID	**CSO Control**	**2009 LTCP ID[1]**
4G	LV Jones Street to Leavenworth Diversion	4G
4B	Deep Tunnel Lift Station and Force Main	4B
4A	CSO Deep Tunnel and Drop Shafts	4A
4H	Deep Tunnel Grit Basin Facilities	New
4C	Conveyance to Deep Tunnel Drop Shafts	4C
4I	CSO 119 Paunch Plant Storage Facility	New
4J	CSO 105 – Minne Lusa Avenue Storage Facility	3F
4D	MRWWTP Retention Treatment Basin	4D
4K	CSO 118 MRWWTP Storage Facility	New
4E	Cole Creek CSO 204 – 63rd and Ames Storage Tank (If required)	4E

[a] The "2009 LTCP ID" is include for information purposes. It is an indicator where a project was in the schedule in the 2009 LTCP. The values are in Table 7-1 Major CSO Control Phases and Milestones.

TABLE 5-15
Sewer Separation Projects Phases and Milestones

Sewer Separation Phase 2 *Critical Milestones:* Bid Year – Commence bidding of one project: by January 1, 2014 (Met on October 23, 2013)[a] Complete Construction of all projects by September 30, 2017		
ID	**Project**	**2009 LTCP ID[a]**
2B	Bridge Street-103-1, 36th Street	2B
2E	Burt-Izard-108-3, Nicholas & Webster Separation Phase 1	2E
2H	South Interceptor-117-1, Missouri Avenue Phase 1	3A
2I	Minne Lusa-105-1, JCB & Miami Phases 1 & 2 and Adams Park Improvements	4F & 5A7

TABLE 5-15
Sewer Separation Projects Phases and Milestones

Sewer Separation Phase 3

Critical Milestones:

Bid Year – Commence bidding of one project by: December 31, 2014 (Met on July 16, 2014)

Complete Construction of all projects by December 31, 2018

ID	Project	2009 LTCP ID[a]
3C	Burt-Izard-108-3, Nicholas Street Phase 2	3C
3D	Cole Creek 204, Phase 1	3D
3G	Ohern/Monroe-119-6, Gilmore Avenue Phase 1 & 2	3G & 5A8
3I	Martha To Riverview Lift Station Phase 2	New

Sewer Separation Phase 4

Critical Milestones:

Bid Year – Commence bidding of one project: by December 31, 2016

Complete Construction of all projects by June 30, 2022

ID	Project	2009 LTCP ID[a]
4M	Minne Lusa-105-4, 49th & Fowler	5A11
4N	Minne Lusa-105-3, 50th & Sigwart	5A12
4O	Minne Lusa-105-5, 46th & Grand West	6B
4G	Minne Lusa-105-15, Forest Lawn Separation	4G
4P	South Interceptor-117-1, Missouri Avenue Phase 2	3E
4B	Burt-Izard-108-3, Nicholas Street Phase 3	4B
4Q	ML Paxton Corridor Sewer Separation	New
4R	Papillion Creek South 207/208, 42nd & Q	5B4
4S	Cole Creek 204, Phase 2	3H
4T	Burt-Izard-108-3, Nicholas & Webster Separation Phase 2	3B
4L	Minne Lusa-105-2a, 41st & Sprague SE Phase 1	4L

TABLE 5-15
Sewer Separation Projects Phases and Milestones

ID	Project	2009 LTCP ID[a]
Sewer Separation Phase 5 *Critical Milestones:* Bid Year – Commence bidding of one project by: December 31, 2019 Complete Construction of all projects by December 31, 2023		
ID	**Project**	**2009 LTCP ID[a]**
5A	Papillion Creek North-210-2 Inflow Reduction Project	5B6
5B	Cole Creek 204, Phase 3	3H
5C	Cole Creek-203-1 Sewer Separation	5B1
5D	Cole Creek 202, Phase 1	4I
5E	Cole Creek 202, Phase 2	5B8
5F	Papillion Creek North-212-1, Separation	5B5
5G	Papillion Creek North 210-1, Separation	5B9
5H	Papillion Creek North 211-2 Inflow Reduction Project	5B11
Sewer Separation Phase 6 *Critical Milestones:* Bid Year – Commence bidding of one project by: June 30, 2020 Complete Construction of all projects by December 31, 2023		
ID	**Project**	**2009 LTCP ID[a]**
6A	Burt-Izard-107-6, 16th & Grant	5A1
6B	South Interceptor-110-1, Pierce Street	4K
6C	Ohern/Monroe-119-5A, South Barrel Conversion	6D
6D	Ohern/Monroe-119-5B, South Barrel Conversion	6H
6E	Minne Lusa-105-2b, 41st & Sprague NW Phase 1	5A6
6F	Burt-Izard-108-8, 18th & Seward	4J
Sewer Separation Phase 7 *Critical Milestones:* Bid Year – Commence bidding of one project: by June 30, 2022 Complete Construction of all projects by September 30, 2027		
ID	**Project**	**2009 LTCP ID[a]**
7A	South Interceptor-111-1, Hickory Street	5A5
7B	Cole Creek 204, Phase 4	4E
7C	Minne Lusa-105-6, 43rd & Boyd	6G
7D	Cole Creek 204, Phase 5	5B2
7E	Cole Creek Diversions	7C

TABLE 5-15
Sewer Separation Projects Phases and Milestones

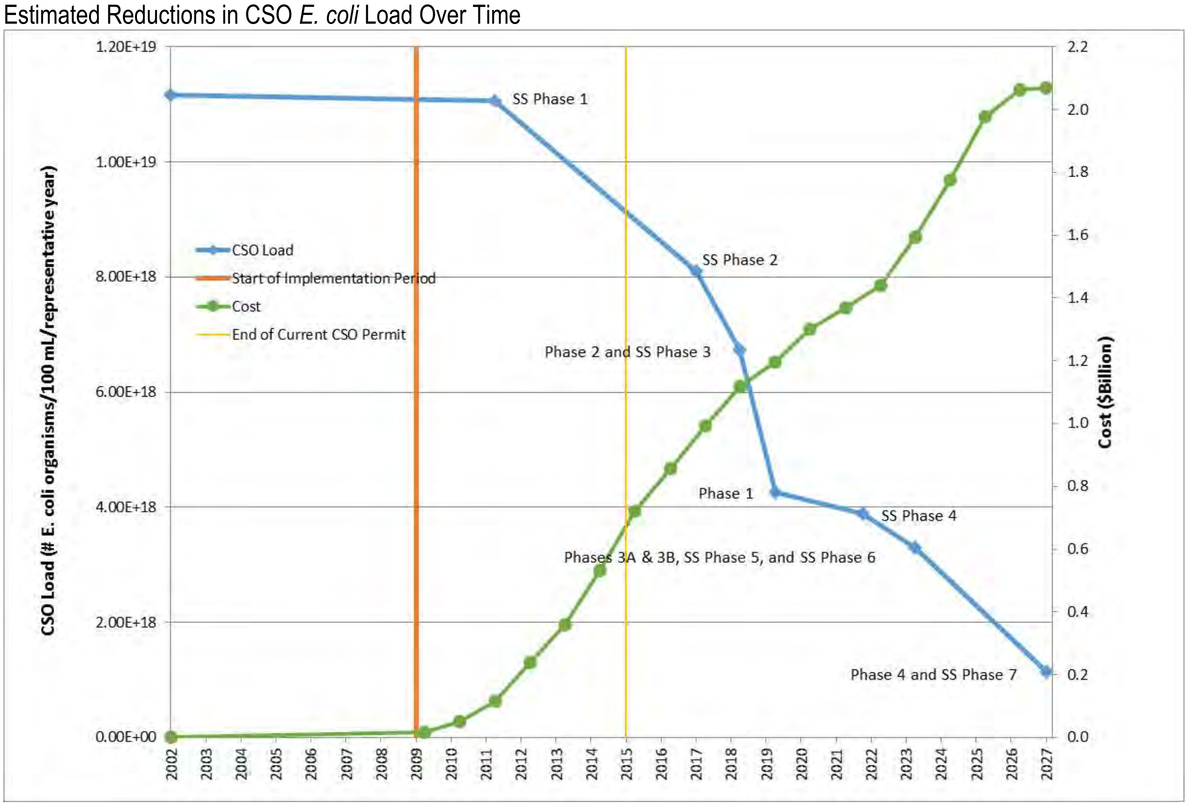
7F	Minne Lusa-105-2a, 41st & Sprague SE Phase 2	5A10
7G	Minne Lusa-105-2b, 41st & Sprague NW Phase 2	6I
7H	Cole Creek 204, Phase 6	5B3
7I	Minne Lusa-105-5, 46th & Grand East	6B

[a] The "2009 LTCP ID" is include for information purposes. It is an indicator where a project was in the schedule in the 2009 LTCP. For example South Interceptor-117-1, Missouri Avenue Phase 1, which is currently under construction, was formerly in Phase 3, in this schedule it is Phase 2. (The letter is only an indicator of its place the original 2009 LTCP list.) The values are in Table 7-2 Sewer Separation Phases and Milestones in the 2009 LTCP.

5.5.4 CSO Reductions Versus Time

Figure 5-10 is a graphical summary of the *E. coli* loading reductions over the 18-year implementation timeframe. It shows that about two-thirds of the reduction in planned *E. coli* levels from the Existing Conditions should have occurred by December 31, 2018 when the MRWWTP Improvements are complete and the Saddle Creek RTB is operational. At that time, approximately half of the total cost of the Program is estimated to be spent.

FIGURE 5-10
Estimated Reductions in CSO *E. coli* Load Over Time



5.6 Factors Potentially Affecting the Schedule

A number of factors could impact the implementation schedule that has been developed as part of the LTCP Update. These factors are similar to the ones that were identified in the 2009 LTCP, and include uncertainty in project funding, affordability of rate increases, fluctuation in project costs, fluctuation in labor and material markets, changes in construction standards and legal requirements, unknown physical conditions in the soils or rock, unforeseen demographic and infrastructure changes, unanticipated limitations in construction capabilities locally, inability of utilities to design or relocate their facilities in a timely manner, changes in NPDES permit requirements, changes in water quality standards, or other unforeseen problems. These factors could affect the schedules of individual projects as well as the City's ability to complete implementation of the overall plan by 2027.

The LTCP Update schedule is based on information currently available to the City, and on experience with implementing the LTCP over the last 5 years. Efforts have been made to evaluate, account for and, as appropriate, mitigate factors that could result in delays in the implementation of the projects. During the course of implementation of the LTCP Update, the City will identify and resolve uncertainties and adjust the schedule accordingly. However, over the next 13 years, there will likely be unanticipated situations that will affect the City's ability to meet the schedule. The City will continue to work closely with NDEQ and EPA to keep them informed of these situations in addition to specific project schedules.

The LTCP Update and schedule are based on current regulations and guidance and a number of assumptions. Regulations and guidance include the Clean Water Act, the 1994 EPA CSO Control Policy, EPA guidance on CSOs and performing water quality standard reviews and revisions, and the State of Nebraska Water Quality Standards. Changes to any of the regulations or guidance or the following assumptions may support a request for modification of the LTCP Update and implementation schedule. Assumptions include the following:

1. NPDES permits issued for the CSS, MRWWTP, PCWWTP, or the separate stormwater system will not contain schedules or requirements that result in significant redirection of City resources.
2. Any future judicial or administrative orders will be consistent with the current Consent Order.
3. The financial capability of the City will remain equal to or better than that indicated in the financial capability assessment in the LTCP Update. Refer to Section 4 of this report for additional discussion related to affordability concerns.
4. The City's bond rating will not be significantly lower than that indicated in the financial capability assessment in the LTCP Update, and the interest rate for bonding will not be higher than that indicated in the financial capability assessment, as documented in Section 4.
5. All approvals and permits can be obtained in reasonable periods. Experience on projects implemented thus far indicates that this can be a challenging area requiring significant effort and diligence.

6. Data and information collected, and studies performed do not result in the need to significantly revise the CSO controls. The projects identified in the LTCP Update were developed at a conceptual/planning level. Specifics such as tunnel alignments, interceptor alignments, and collection sewer alignments, easements and property acquisitions, facility sitings and others have not been completed. More specific facility plans will be based on the collection of additional information and the performance of additional engineering. This includes but is not limited to soil borings, hydraulic design, functional design, system operational design, interaction and interface studies, configuration design, coordination with other utilities, and geotechnical investigations. These are all necessary to develop the LTCP Update in more detail so that preliminary designs can be prepared. Based on the results of the investigations and studies, findings may require revisions to time requirements and project schedules. Subsequent changes in the findings of the 2009 LTCP and the LTCP Update may require additional modifications to the schedule.
7. Acquisition of land and obtaining easements or rights to use land from private landowners, the NDOR, Union Pacific Railroad, BNSF Railway Company, OPPD, and MUD will not cause delays to projects. As with permits, experience on projects thus far indicates that the cost and effort associated with easements and property acquisitions are greater than originally anticipated.
8. Landowners will allow temporary construction access without unreasonable restrictions to perform investigations, surveys, and construction.
9. The technical basis related to construction conditions and technology for construction of the CSO control facilities will not change significantly.
10. The typical timeframe between bid opening of any project and the start of construction will be consistent with assumptions made in schedule development. This timeframe has been lengthened somewhat from what was originally assumed in the 2009 LTCP based on project experience. Delays could be due to challenges to the bid, delay of bid award, delays in utility relocations by others, or other factors.
11. Potential regulations of the state or federal government that impact siting, operation or other functional requirements of the CSO control facilities will not require significant changes to the LTCP.
12. The actual costs of the CSO control projects (based on construction bids or conditions encountered during construction) will not change significantly from the costs assumed at this time, and therefore will not counter the findings of the current financial capability analysis. Higher project costs that have been encountered were discussed in Sections 1.2.4 and 5.2.3. Fortunately, the 2014 LTCP Update cost for the program is consistent with the Rate Model used to set sewer fees; however, some affordability concerns exist, as discussed in Section 4.
13. Technical, legal, and institutional conditions will not require significantly more time than anticipated or planned. This could include requirements of governmental entities related to technical or legal procedures or guidelines that impact the process of completing the design or construction of a project.
14. Development or re-development projects in the combined sewer area will be limited to those currently identified.

15. Revisions to street improvement project schedules will be minimal.
16. All local utilities will work with the City in a cooperative manner and have sufficient staff to provide timely field verification, design, and construction relocation of their facilities (or allow others to do so) for the increased number of annual sewer separation projects.
17. There is sufficient availability of qualified construction contractors to meet the project schedules.
18. The ability of material manufacturers and suppliers to deliver materials in a timely manner does not significantly affect the duration and cost of construction. Increased concrete cost and delivery scheduling has already impacted the cost of projects and the construction schedules of certain projects.
19. Existing sewer infrastructure conditions will remain about the same and there will be no unanticipated failures that cause a redirection of time or resources.
20. No further *force majeure* events, such as the 2011 Flood will take place. This *force majeure* event resulted in a 3-year extension to the CSO Program, as reflected in an Amendment to the City's Consent Order with NDEQ.
21. Affordability discussions with NDEQ will not result in significant changes to project schedules.

5.7 Summary and Conclusions

The information in this section summarized the changes in the 2009 LTCP controls, shows that the changes are in compliance with the EPA CSO Control Policy, and presents a revised schedule that complies with Part V and F of the CSO Permit.

The schedule provided in this section shows the City's intent to complete the CSO controls within the current 18-year implementation period. Periodic review of the schedule to incorporate new data, integrate new technologies that become available, and adjust the plan to fit changing circumstances or requirements will be performed throughout the implementation period.

Section 5.2 provides a comparison of the 2009 LTCP controls and the LTCP Update. This section clearly shows that there have been few modifications to the controls, and most of the modifications that have occurred are not significant.

Section 5.3 shows that the controls in the LTCP Update comply with the EPA CSO Control Policy. The changes in the controls are not significant and will provide the same level of protection to the Missouri River as the 2009 LTCP.

Section 5.5 provides a revised schedule for the LTCP projects and updated charts for compliance. The schedule provided in this section shows the City's intent to complete the CSO controls within the current 18-year implementation period. Periodic review of the schedule to incorporate new data, integrate new available technologies, and adjust the plan to fit changing circumstances or requirements will be performed throughout the implementation period. Figure 5-10 shows that significant reductions in *E. coli* levels will be achieved by the end of the anticipated next permit term in 2020.

Lastly, Section 5.6 provides a list of those items that could result in delays in the schedule.

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6.0 Public Participation Process

6.1 Introduction

Public participation has been a critical element of the City's CSO Program since the development of the 2009 LTCP. This will continue into the future. This section summarizes the efforts undertaken during the last several years to communicate to the public, businesses, and industries.

During the LTCP planning period, the goal of public participation was to involve the public and to obtain support and acceptance of the LTCP from the public. During implementation, the City has worked to provide transparency on the CSO Program to the public, businesses, and industries, both within the City and the entire sewer service area established during LTCP development. The Public Participation Program continues to communicate the impacts of CSO discharges to receiving streams and on water quality, and the federal government's mandate to address them. The City strives to explain the status and progress associated with implementation of the LTCP, minimize adverse impacts to the community, and implement community enhancements or elements of construction that provide amenities within and around a project construction area.

The Public Participation Program continues to communicate the impacts of CSO discharges to receiving streams and on water quality, and the federal government's mandate to address them.

As outlined in the 2009 LTCP, the Public Participation Program was developed to address the following specific goals:

1. To implement communication strategies to ensure that both the challenges and the opportunities of the LTCP are effectively communicated to the maximum number of program stakeholders. This includes continual understanding of who the impacted stakeholders are.
2. To implement strategies that create a continuum of communications. This goal includes maintaining contact and communication with advisory groups present during LTCP development.
3. To promote an understanding of green infrastructure and other stormwater management methods that can be used by the City and individuals to reduce costs and encourage community enhancements.
4. To develop and distribute information and educational materials to program stakeholders.
5. To maintain effective, positive relationships with area media outlets and to educate them about the CSO Program and shape the messages for the stakeholders and ratepayers.
6. To foster an understanding of the CSO Program within minority and emerging community groups and develop a collaborative relationship with neighborhoods.

This section describes how the City has been working with the public to incorporate public input into the implementation of the City's LTCP. It also summarizes public participation activities conducted by and on behalf of the City, to inform and seek feedback on the LTCP Update. Much of the information presented has been provided to NDEQ in annual reports on the CSO Program as required in the City's CSO Permit.

6.2 Public Participation Overview

The City is responsible for developing and implementing the Public Participation Program. To aid in implementation, the City has contracted directly with the Lovgren Marketing Group to act as the Program public participation facilitator. Public participation activities are summarized annually and provided as noted above in the CSO Permit Annual Report due December 31 of each year. The Public Participation effort focuses on two major efforts:

- Continued involvement, education, and acceptance by the public about the need for the CSO Program
- Progress on the specific projects within the LTCP

The following sections provide an overview of the public participation effort activities the City has undertaken since submission of the 2009 LTCP.

6.2.1 Stakeholders

During development of the LTCP, two types of advisory panels were established: the Community Basin Panel (CBP), which drew its members from a broad base of residents and community leaders and 10 Basin Advisory Panels (BAP). More than 125 volunteers participated in these panels and brought a wide spectrum of stakeholder perspectives. The CBP was comprised of 16 individuals from the Greater Omaha metropolitan area that were appointed by the mayor at that time. The objective of the selection was to ensure representation of the communities directly impacted as well as to provide a cross-section of community leaders from environmental groups, watersheds, green initiatives, businesses, neighborhood associations, and utilities. The CBP provided valuable input on each step of the process and a broad perspective for community feedback.

While the CBP and BAPs no longer meet, the City and PMT continue to meet with area residents, attend neighborhood and local business meetings, hold meetings specifically designed to exchange ideas and receive feedback at various times during the design process of each CSO project, and provide information to businesses, residents, and stakeholders affected by construction.

The City has identified several groups that are impacted by the CSO Program and implementation of the projects under the LTCP. These groups include residential ratepayers, commercial ratepayers, industrial users, and other stakeholders impacted by the effects of CSOs on waterways and by implementation of construction. The Public Participation Program continues its effort to be inclusive and involving of each of these groups.

6.2.1.1 Residential Ratepayers

Residential ratepayers are identified as significant stakeholders and efforts to keep them informed and confident in the Program are essential. Costs associated with implementation of the LTCP have a large impact on all ratepayers in the service area. Residential Ratepayers have seen their rates increase significantly to finance the CSO Program. It is important that they be kept informed of the results of their investments and the benefits to water quality. Residents are often also impacted by specific projects, so it is important that they are able to participate and provide input to the planning and design of projects. Once construction starts, communication between the Contractor and residents minimizes the disturbance to the community.

6.2.1.2 Commercial and Industrial Ratepayers

Commercial and industrial ratepayers that discharge wastewater into the City's sewer collection system, particularly 100 or so of the largest users, continue to be identified as significant stakeholders. Specific workshops and meetings to address industrial user concerns have and will continue to be conducted during implementation of the CSO Program.

6.2.1.3 Other Stakeholders

Each LTCP project has a list of interested stakeholders. This includes community leaders and organizations, businesses, neighborhood associations, utilities, and other organizations. In addition, the Missouri River and the Papillion Creek and its tributaries are amenities to the local area residents and visitors. The public participation process, integrated with other existing City processes, continues to keep these groups informed and educated and seeks input and collaboration.

As part of each planned project, a preliminary list of interested stakeholders is identified by the City and PMT. The engineering consultant works with the Public Participation Facilitator to identify a comprehensive stakeholder list. Presentations are often made to specific stakeholders in addition to regular public meetings held during the course of the design and construction work.

Similar to the advisory panels assembled during development of the 2009 LTCP, the following groups continue to be noted as potential and interested stakeholders:

- Businesses
- Community/civic/religious entities
  - Chamber of Commerce
  - Habitat for Humanity
  - Economic Development Groups
  - Churches, Synagogues, and faith-based organizations
  - Red Cross
  - Neighborhood Associations

- Educational/professional groups
  - Creighton University
  - Public Schools
  - Labor Unions
  - Community colleges
- Omaha by Design **–** An initiative dedicated to changing the look of the City using urban design principles and citizen engagement
- Utilities
  - MUD – Provider of natural gas and drinking water
  - OPPD – Provider of electricity
- Environmental organizations
  - Sierra Club
- The City – employees from departments such as the following:
  - Public Works
  - Planning
  - PRPP

6.3 Summary of Public Participation Efforts

The following is a summary of public participation efforts undertaken by the City since submission of the 2009 LTCP.

6.3.1 Procedures

Over the last several years, the City has developed two procedures specific to public involvement. Both of these procedures are discussed in more detail in the following sections.

6.3.1.1 Community Enhancement Procedure

Community enhancements, efforts undertaken by either the City of Omaha or a neighborhood to implement positive green and/or aesthetic changes during the planning and construction of a CSO project, play a key role in the CSO Program. Such enhancements include tree plantings and landscaping, installing or replacing sidewalks, and incorporating public art in an area. These enhancements may be funded through CSO resources (if applicable) or through various grants including Mayor Neighborhood Grants, Omaha Community Foundation Grants, and NET Grants. To be funded through CSO resources, the proposed enhancements must reduce the amount of stormwater that enters the sewer system. Such reductions help to decrease overall Program cost.

In 2011, the PMT developed a four-step Community Enhancement Procedure to help neighborhoods with the preparation and implementation process. As this process was implemented, much was learned. Specifically, the need for continuity among the neighborhood's leadership and access to the appropriate expertise or resources to help determine costs and complete design and construction were identified. In addition, the challenges of writing grants or finding funding sources for project enhancements became very evident among the community and CSO Program. Key components of the new procedure are highlighted below.

- Designate a CSO Program lead for projects with community enhancement potential.
- Form a project design team to identify and share potential community enhancements for a project during the preliminary design public meeting.
- Identify and designate a community lead to champion the project enhancements.
- Conduct a planning/brainstorming workshop with the community lead, Program lead, project design team members, public participation facilitator, and Omaha Public Works and PRPP representatives (if applicable).
- Provide ongoing support to the community lead. Specifically, assist with cost development and grant proposal preparation.

6.3.1.2 Public Information Procedure

After LTCP approval, a Public Information Procedure was developed to ensure consistent communication across all projects in the CSO Program. This document is intended to assist project teams with implementation of public involvement responsibilities that are part of each project within the CSO and RNC Programs. The primary goal of this procedure is to ensure that information presented to the public for each project is consistent in content, detail, form, branding, and delivery.

The procedure outlines the responsibilities of the key public involvement entities including the Public Participation Facilitator, the City, the project team, and the PMT. The procedure includes a Project Implementation Guide which provides more information about specific project public meetings and other general guidelines and procedures for public meetings, plus additional communication approaches. General guidelines for project printing and mailings costs are also included.

Public Participation Methods

To ensure that as many individuals as possible are aware of the CSO Program and the City's efforts to control overflows from its CSS, multiple communication channels continue to be used to reach out to the public. These communication channels include the following.

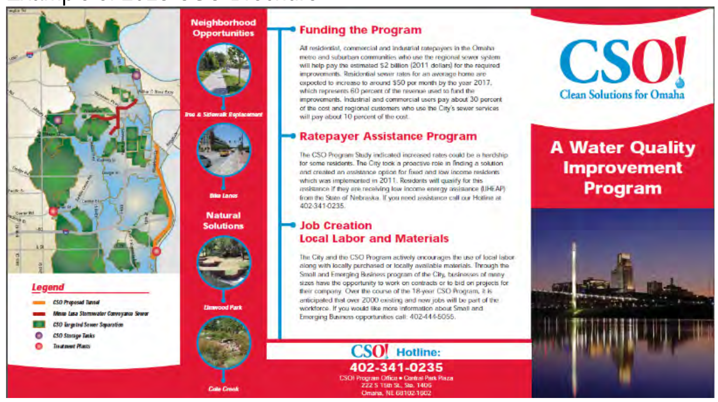
Public Meetings and Mailers - Public meetings and mailers provide a forum for educating the community about the CSO Program, posing alternate solutions for discussion, and demonstrating a desire for transparency and inclusiveness. During the Implementation Phase, Program staff collaborate with community, neighborhood groups, and associations to hold joint public meetings to increase the effectiveness of the Program to increase attendance and reduce redundancy. This collaboration was particularly successful with neighborhood association groups.

Per the Public Information Procedure, public meetings are held at the following phases: after preliminary design, during final design, and prior to construction.

Educational Displays - The use of an education display has continued during implementation of the LTCP. In 2012, a new public display was designed and developed to be shown at public meetings and in public offices and buildings with an emphasis on the solutions being implemented throughout the area, particularly in North and South Omaha where much of the work is taking place.

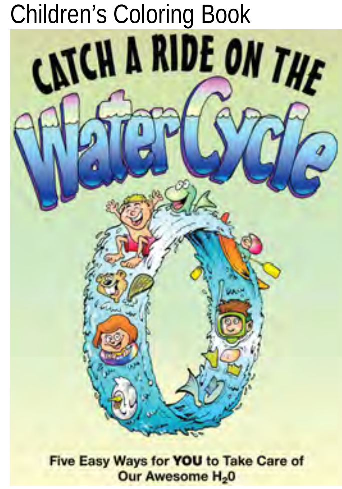
Printed Material - The City continues to use various printed collateral pieces to educate the public. Printed materials are directed at making individuals aware of upcoming meetings, as well as providing valuable information about the CSO Program. This effort has been consistently maintained during the LTCP implementation phase through distribution of brochures, mailers, and handouts. Printed material developed since the 2009 LTCP was approved includes brochures (Figure 6-1), children's coloring books (Figure 6-2), and project construction flyers.

FIGURE 6-1
Example of 2013 CSO Brochure



Presentations - The City has many opportunities to give presentations on aspects of the CSO Program and LTCP projects for a wide variety of audiences including public meetings, briefings, workshops, and guest speaking opportunities at a variety of professional and community organizations. Some presentations are available for viewing on the OmahaCSO.com public website as well.

FIGURE 6-2
Children's Coloring Book

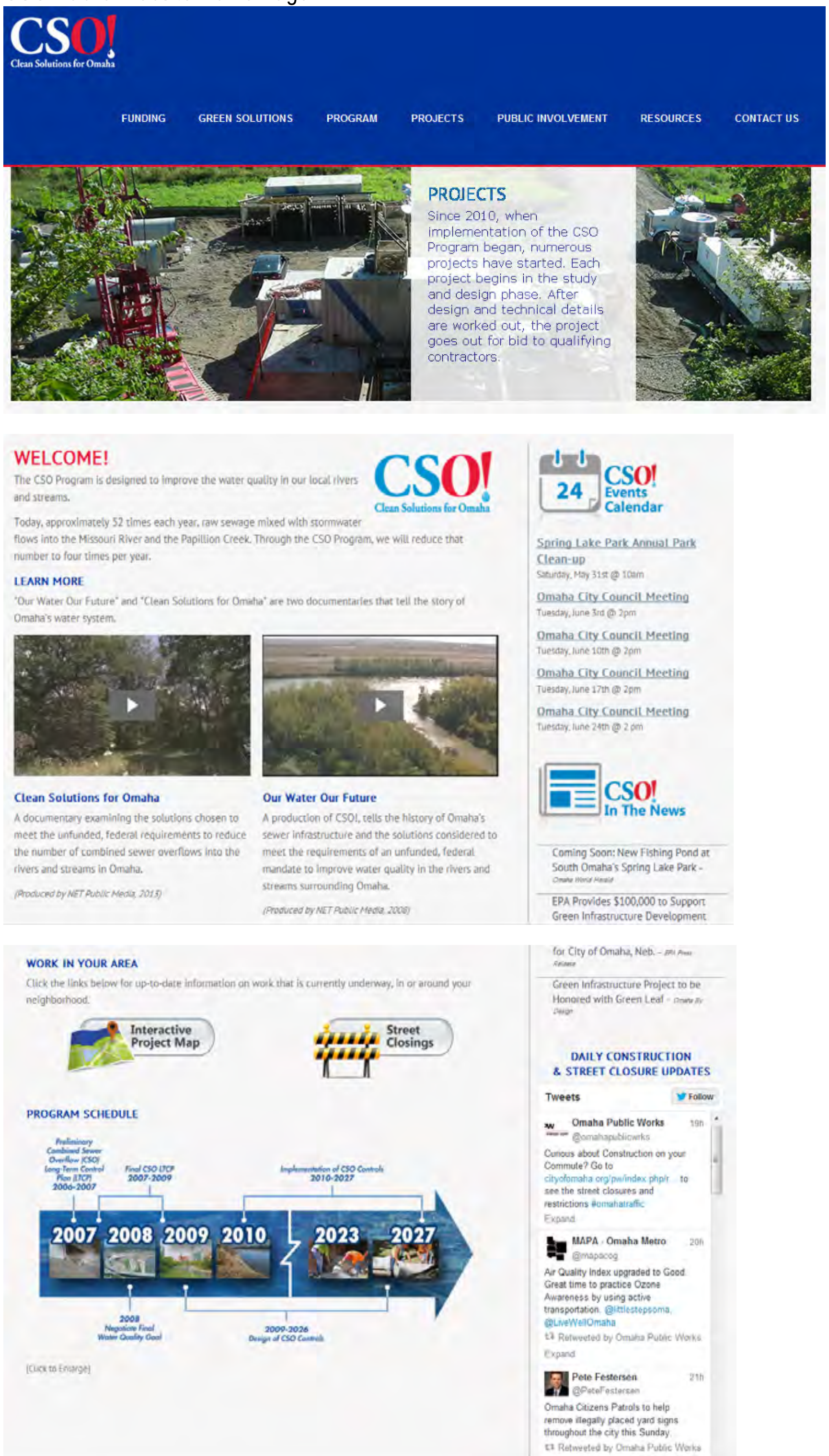


Website - During 2009 LTCP development, a public website was developed (www.omahacso.com) to function as a public communication tool for the CSO Program. Since inception, site content has been continually updated and the overall site design has been modified three times. The first update occurred in February 2010. During this update, an interactive project map with address search functionality was added to the site. During the second update, which occurred in May 2011, several new features were added to the website; most notable was an update to the project map to include facility and other City sewer separation projects. In addition, individual project pages were added to provide the public with information on a project and its status. Future projects, anticipated construction start dates, and short project descriptions were also added.

The latest update to the CSO public website occurred in 2013. Significant additions included: a link to the City of Omaha Public Works Traffic Restrictions/Traffic Map on the Home Page to provide the public with updated street closure information; and new pages providing information on green infrastructure projects that are part of the CSO Program. One of the most significant modifications was the addition of a language translation function to the website. Website language can now be converted to 52 languages other than English.

Content on the CSO public website is updated regularly to provide the public with current information on the CSO Program. Figure 6-3 is a page from the CSO website showing an example of a Home page.

FIGURE 6-3
CSO Public Website Home Page



Hotline - A hotline phone number (402-341-0235) has been available to the public since development of the LTCP. This number has been broadly publicized to citizens as a means to access needed information. It is monitored daily and all calls are returned within 24 hours. The hotline continues to be available and used to report sewer backups and street flooding locations.

Documentary - As discussed in the 2009 LTCP, the City and Nebraska Education Television collaborated in 2007 and 2008 to produce a 1-hour documentary titled *Our Water Our Future.* In 2012, the documentary was updated to include information on LTCP implementation. This updated version, titled *Clean Solutions for Omaha: A Water Quality Investment Program* began airing in 2013 on NETV and is also available on the OmahaCSO.com website.

Media Relations (Print and Broadcast) - In addition to the presentations and brochures discussed previously, the City continues efforts to inform the public through newspapers, TV, and radio. This has included conducting news conferences for major achievements under the CSO Program. Figure 6-4 shows pictures taken of a news conference for the Spring Lake Park NET grant award.

FIGURE 6-4
2010 Spring Lake Park NET New Conference

Youth Outreach - During the implementation phase, efforts were made to educate youth in the Omaha community about the CSO Program. In addition to the children's coloring book, presentations have been made to local schools.

Minority Outreach - As mentioned in the LTCP, approximately 12 percent of the City's population is Hispanic and 13 percent is African American. The Public Participation Program continues to recognize the need to address minority stakeholders with their own communication channels. To enhance inclusion, the collective effort encompassed the following activities:

- A cultural and communications workshop for all CSO Program engineering firms, their public participation facilitators, and City staff.
- Development of bilingual brochures, handouts and meeting materials, displays, advertisements for public meetings, and phone messages.
- The inclusion of translators at major public meetings.

- Bilingual materials posted on the website, in brochure form, and on radio.
- Concerted efforts to reach key leadership and community-wide members through personal contact.

6.4 Public Review of the LTCP Update

Public meetings were held on August 6, 12, and 21, 2014 to obtain public input on the LTCP Update. A 30-day Public Notice of the LTCP update coincided with the August public meetings. The meetings were not well attended and no comments on the LTCP Update were received during these meetings. Questions from the public were mostly associated in the sewer rates.

6.5 Summary and Conclusions

Public participation will continue to be important as the CSO Program is implemented. The public needs to be kept informed of how its fees are being spent, the benefits of the program, details on the ratepayer assistance program, local job creation, construction impacts, opportunities for public input for projects through design and construction, and general information on LTCP implementation progress.

The City will continue to strive to balance three objectives of the program:

- Regulatory Compliance
- Economic Affordability
- Public Acceptance

This will be done through multiple mechanisms including the CSO website, public meetings, information brochures and others. Over the next 5 years it is anticipated the program will expand into new technologies and social media.

7.0 Post-Construction Monitoring Plan and Wet Weather Operations Strategy Update

7.1 Introduction

This purpose of this section is to outline the changes to the City's CSO Monitoring Program and its CSO Wet Weather Operations Plan. This section has been updated to reflect the changes that have occurred over the last 5 years. Part I. Post-construction Compliance Monitoring Program of the City's CSO Permit requires the City to implement its Post-Construction Monitoring Program as proposed in the 2009 LTCP. While there is no specific requirement to update this section, any modifications to the CSO controls would suggest that the monitoring program be evaluated to determine if changes are appropriate.

Section F. Operational Plan of the City's CSO Permit requires that the City update the Wet Weather Operations Plan as CSO controls are constructed and sewers are separated. The permit requires that a protocol for discharge be submitted by September 30, 2015, for CSO 102. The wet weather protocol for discharge through CSO 102 will include operational procedures to maximize wet weather flows through this outfall and provide disinfection and dechlorination.

7.2 Modification to the Post-Construction Monitoring Program

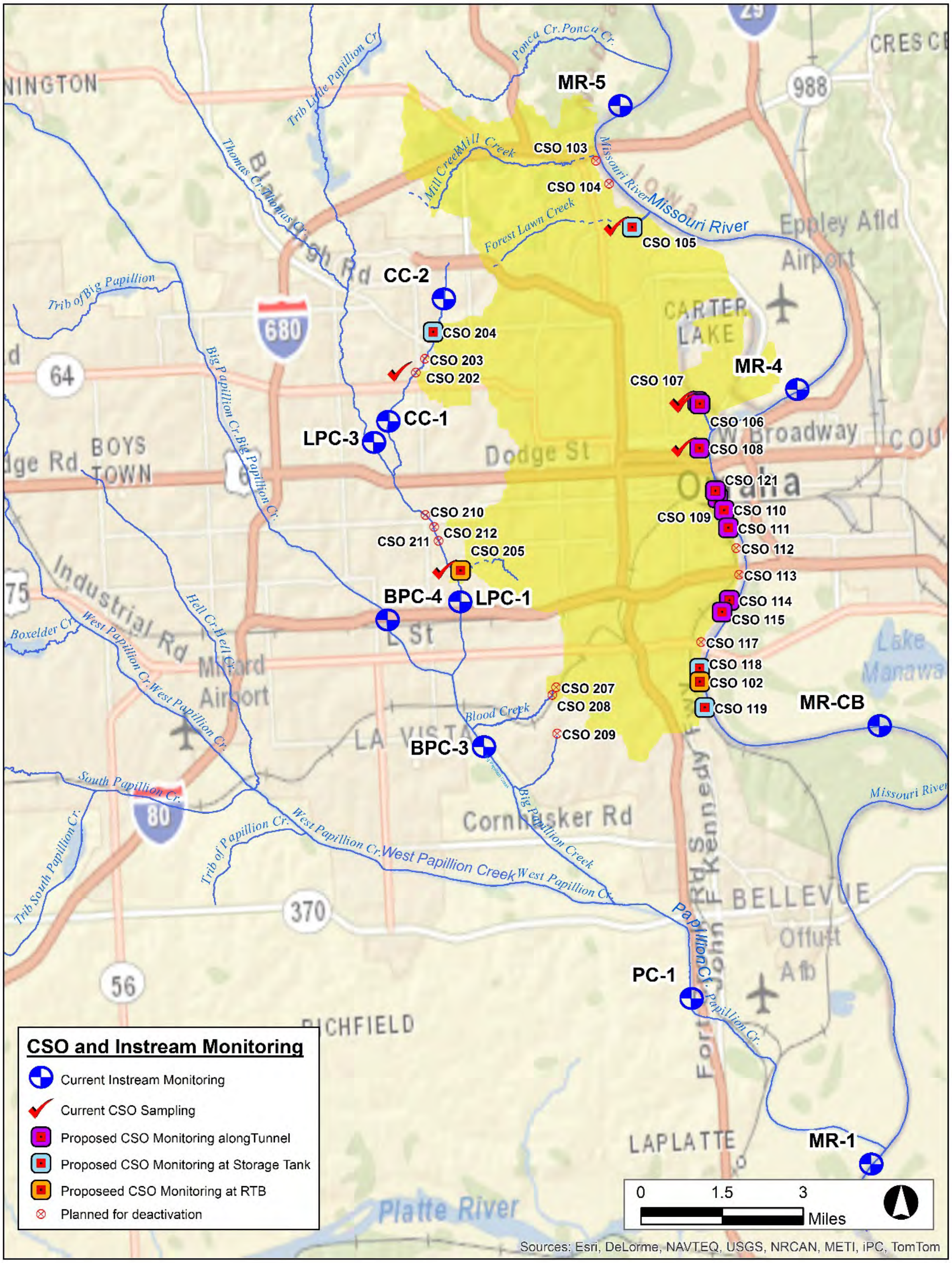
There have been minimal changes to the City's Post-Construction Monitoring Program since the 2009 submittal. That program specified monitoring at various stations along the Missouri River and in Papillion Creek Watershed and Table 7-1 lists the monitoring stations and their locations. Figure 7-1 shows the instream monitoring locations. Figures 7-2 through 7-4 are photographs of monitoring locations and activities.

TABLE 7-1
Instream Monitoring Locations Specified in the Post-Construction Monitoring Program

Monitoring Station Identification	Stream	Location Description	Agency Performing Monitoring
N. P. Dodge Park (MR-5)	Missouri River	Upstream of all CSO points	USGS
Freedom Park (MR-4)	Missouri River	Upstream of the confluence with Papillion Creek	USGS
Near Council Bluffs, IA[1] (MR-CB)	Missouri River	Downstream of the MRWWTP but upstream of the PCWWTP	USGS
Near LaPlatte (MR-1)	Missouri River	Downstream of the confluence with Papillion Creek.	USGS
PC-1	Papillion Creek	Downstream of the confluence with Big Papillion Creek	City Sewer Maintenance Division
BPC-4	Big Papillion Creek	Upstream of the confluence with Little Papillion Creek	City Sewer Maintenance Division
BPC-3	Big Papillion Creek	Downstream of the confluence with Little Papillion Creek	City Quality Control Division
LPC-3	Little Papillion Creek	Upstream of the confluence with Cole Creek	City Quality Control Division
LPC-1	Little Papillion Creek	Downstream of CSO discharges and upstream of confluence with Big Papillion Creek	City Sewer Maintenance Division
CC-2	Cole Creek	Upstream of CSO discharge points	City Quality Control Division
CC-1	Cole Creek	Downstream of CSO discharge points	City Quality Control Division

[1]This is a new monitoring location that was not included in the 2009 LTCP.

FIGURE 7-1
CSO and Instream Monitoring Locations



7.2.1 Instream Water Quality Monitoring

The 2009 LTCP included a draft program for performing instream monitoring of the Missouri River and the Papillion Creek tributaries to obtain an understanding of the impacts from CSO on water quality. The original concept was to have the plan implemented by City staff. During implementation, the City decided to contract with the USGS to perform the sampling of the Missouri River stations.

FIGURE 7-2
Missouri River at Freedom Park Sampling Site (*photo courtesy of the USGS*)

7.2.1.1 USGS Monitoring Program

As noted in Section 2, in 2012 the City contracted with the USGS to monitor the Missouri River upstream and downstream of the City. The City has just renewed the contract with USGS to extend through 2017. Monitoring will continue on a monthly basis at the following locations:

- MR-5: USGS Site Number: 412126095565201 - Missouri River at NP Dodge Park (above the City)
- MR-4: USGS Site Number: 411636095535401 - Missouri River at Freedom Park (below the Airport)
- MR-CB: USGS Site Number: 06610505 - Missouri River near Council Bluffs, IA (below MRWWTP and above the confluence with Papillion Creek , North/East side of the river)
- MR-1: USGS Site Number: 410333095530101 - Missouri River near La Platte (downstream of the PCWWTP and below the confluence with Papillion Creek but above the Platte River)

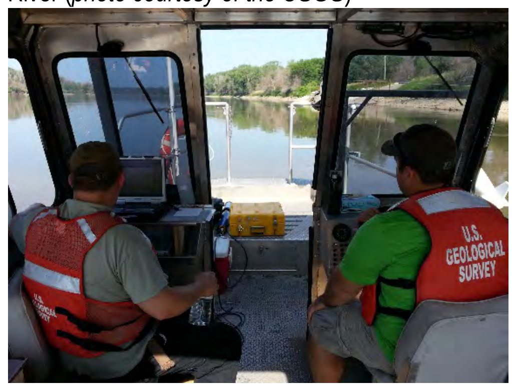
Field parameters monitored include stream discharge, pH, temperature, dissolved oxygen, specific conductance, and turbidity. In addition, samples are analyzed for generic *E. coli* and total coliforms, TSS, total phosphorous, BOD 5-day, TKN, nitrogen, nitrate, ammonia nitrogen, and floating debris. The USGS indicates whether there were wet conditions in Omaha or upstream during the sampling event. With the exception of *E. coli* and total coliforms, samples are a composite of the cross section of the stream.

FIGURE 7-3
Missouri River at the Manawa Ramp (Missouri River at Council Bluffs Site) (*photo courtesy of the USGS*)

In addition to monthly sampling, the USGS obtains continuous data for the Missouri River at three sites: N. P. Dodge Park, Near Council Bluffs (Lake Manawa), and Near LaPlatte for pH, temperature, dissolved oxygen, specific conductance, and turbidity. All data is provided to the City directly as well as published on the USGS website for the sampling site.

The City may request specific studies from the USGS as needed. An example is that the USGS is currently collecting samples from the bank that correspond to the four site locations where they are collecting discrete river samples to develop a relationship between those and the cross sectional stream samples.

FIGURE 7-4
USGS Performing Discharge Monitoring on the Missouri River (*photo courtesy of the USGS*)



7.2.1.2 City Monitoring Program

As noted in the 2009 LTCP, the City of Omaha Quality Control Division and the Sewer Maintenance Division perform monitoring of those sampling points within the Papillion Creek Watershed as indicated in Table 7-1. Some of the points are also required in the MS4 Permit. The City will continue to perform this monitoring.

7.2.2 CSO Post-Construction Outfall Monitoring

In addition to the instream monitoring, it is still expected by NDEQ that CSO controls and outfalls will be monitored by the City. Table 7-2 summarizes the monitoring proposed in the LTCP.

TABLE 7-2
Potential CSO Control Monitoring Locations Under the Post-Construction Monitoring Program

Monitoring Station Identification	CSO Point	Description	Receiving Water	Monitoring
CSO-105/Storage	105	Discharge from storage facility	Missouri River	Flow monitoring of CSO point
CSO Deep Tunnel/RTB	106, 107, 108, 109, 110, 111, 114, 115, 121	Discharge from RTB, Remaining CSO points	Missouri River	Flow monitoring, water quality monitoring of the RTB Flow monitoring of CSO points
CSO-204/Storage	204	Discharge from storage tank	Cole Creek	Flow monitoring of CSO point
CSO-205/RTB	205	Discharge from RTB	Little Papillion Creek	Flow monitoring and water quality monitoring of the RTB Flow monitoring of the CSO point
CSOs 118 and 119/Storage	118, 119	Discharge from storage facilities	Missouri River	Flow monitoring of CSO point

In addition, CSO outfall water quality monitoring is a requirement of the City's CSO Permit for CSOs 102, 105, 106, 107, 108, 202, and 205. Figure 7-1 shows the current CSO sampling sites as well as the proposed post construction locations listed in Table 7-2. It is anticipated that as controls are put in place on these outfalls, the requirement to monitor them will be modified. Such modifications will be addressed outside of the LTCP Update and negotiated as part of permit renewals.

7.3 Wet Weather Operations Plan

There have not been any changes to the Wet Weather Operations Plan from that presented in the 2009 LTCP. The City has just begun operation of the SOIA industrial treatment train at the MRWWTP. No other wet weather facilities have been brought online.

The City has developed possible wet weather operational procedures to ensure adequate chlorination and dechlorination of CSO 102. These are still being refined and will be finalized once construction of the system has been completed. However, the City will not have a complete operational plan by September 30, 2015, as required in the permit. It is the City's intent to provide an update to the strategy by that date.

7.4 Summary and Conclusions

The City has made minimal modifications to its Post-Construction Monitoring Program. The only significant change has been contracting with the USGS to obtain Missouri River samples. This has allowed the City to obtain a better understanding of the river water quality.

Likewise, the City has not made any significant modifications to the Wet Weather Operations Plan. Between 2015 and 2018, significant facilities will be completed and become operational. As the facilities come online, the plan will be updated to reflect the facilities as constructed.

8.0 Future Considerations and Challenges

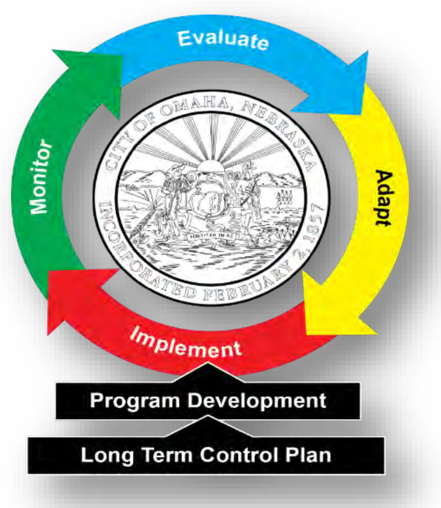
8.1 Introduction

The City continually seeks opportunities to optimize the LTCP implementation to make it more effective in meeting the goals of addressing water quality while also minimizing the cost. The City is facing known challenges in the future such as competing priorities with other environmental programs as well as affordability. With the affordability concerns the City is facing, it is important that the City continue to look at ways to implement CSO projects more efficiently.

Managing CSOs consists of a combination of stormwater management and wastewater practices that control (through treatment or detention) or remove volumes of stormwater from the system. Both are necessary and complementary to achieve cost effective reductions in CSOs. The CSO Program relies on an adaptive management strategy to find the best ways to blend wastewater control and stormwater technologies and practices. The adaptive management strategy was described in the 2009 LTCP and is summarized below. To ensure that the CSO controls proposed are redundant, resilient, and adaptive, both practices need to work together to meet both the goals of the CWA and those of the LTCP.

This section provides information on areas the City anticipates continuing to evaluate or focus on over the next 5 years to further adapt the LTCP.

8.2 Adaptive Management Strategy of the Program



As presented in this LTCP Update, the chosen alternatives for addressing the City's CSOs include a mixture of elements, including the ongoing implementation of systemwide source control practices, sewer separation projects, storage projects, and treatment projects as described in the following sections. These alternatives were chosen because they have the following attributes:

- Improve water quality
- Are cost–effective
- Provide community benefits

To ensure that these goals are met during LTCP implementation, the City has and will continue to use an adaptive management approach. The United States EPA defines adaptive management as "the process by which new information about the health of a watershed is incorporated into the watershed management plan." Adaptive management is an iterative process involving decision making with the intent of reducing uncertainty through system monitoring and information gathering. As information is gathered, the plan will be modified. The City applies this approach to implementing the LTCP and individual CSO controls within the LTCP by following these simple steps:

- Step 1 – Implement
- Step 2 – Monitor
- Step 3 – Evaluate
- Step 4 – Adapt

Adaptive management is an iterative process involving decision making with the intent of reducing uncertainty through system monitoring and information gathering. As information is gathered, the plan will be modified.

Such an approach is critical because the controls are based on the information and understanding of the City's CSS as it currently exists. More information will become available as the controls are implemented, and as additional information is gathered and evaluated. This approach has been used in the implementation of the first 5 years of the program and scheduling of future controls, especially the CSO Deep Tunnel, Missouri River RTB, and several storage tanks. Similarly, the adaptive management approach was incorporated in the LTCP Update. This process will ensure that the most costly CSO controls build on work already completed, have been optimized, and help the City meet water quality goals while also keeping the CSO Program as affordable as possible for ratepayers and providing meaningful community benefits.

8.3 Model Refinements

The CSS model was originally developed to support the evaluation of the CSO NMC and the development of the 2009 LTCP. As such, it was developed as a planning-level tool with a focus on accuracy at the CSO outfalls for estimating CSO magnitude, frequency, and duration. This effort required the gathering of flow monitoring data at CSO diversions at the downstream ends of the basins to calibrate the model.

The City understands the need to adapt the LTCP to ensure that water quality goals are reached in a responsible manner that recognizes the potential hardship to the ratepayers who are funding the improvements. Part of the adaptive management approach is to continually improve the tools used for making decisions, such as the CSS Model, by taking advantage of new technologies, data, and knowledge that become available as Program elements are implemented. The topics discussed in this section represent some of the ways the City is actively working to improve the CSS Model to adapt the Program for better outcomes.

8.3.1 Modeling Stormwater Aspects in the Combined Area

During development of the 2009 LTCP, modeling efforts focused on the combined and sanitary sewer systems. It is becoming increasingly clear that modeling the stormwater system is needed. For example, in the Burt Izard Basin it has become a goal to utilize the existing and planned 108-inch storm pipes to their fullest by implementing sewer separation in a cost-effective manner in neighborhoods near the pipes. The original LTCP concept assumed separation of sewers in a manner that strictly followed the guidelines of the City's Stormwater Manual. It has become evident that targeted sewer separation with a more flexible approach to the design will provide a better long-term balance of CSO control and water quality improvement and will better address customer concerns while managing costs.

To more fully evaluate the expected outcomes of this concept and adapt the size of other planned controls (most importantly, the CSO Deep Tunnel which will provide downstream control in Burt Izard and other basins), it is critical to develop a coupled surface/subsurface model that will more accurately represent exactly which sewer system receives stormwater and how much downstream CSO control will be necessary. This is of particular importance in, but not limited to, those areas of the City where combined sewers with diversions that can send water in different directions remain in service, and where parallel storm and combined sewers will remain in place to serve the same area. The adapted CSS Model will require a finer resolution of subcatchments, and will include inlets so that limitations to draining runoff that really exist in the field will be reflected in the model. A pilot test of the upgraded modeling approach will be developed so that new issues can be explored and the approach refined before a system-wide coupled model is implemented. It is expected that coupled modeling will be necessary for at least the following basins:

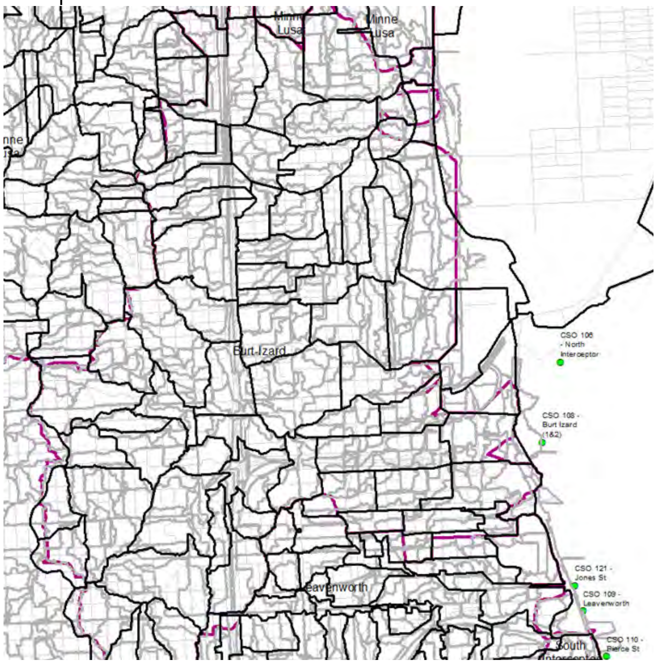
- The Ohern/Monroe Basin, around the combined North Barrel Sewer and the (to be converted) separate storm South Barrel Sewer.
- The Minne Lusa Basin, related to the stormwater system of large-scale detention, equalization, and conveyance facilities and the remaining combined sewer facilities.
- The Saddle Creek Basin, related to local separate stormwater facilities alongside combined sewers with high peak flows that will be treated by the downstream Saddle Creek RTB. Some previous work of this nature was performed in Saddle Creek, but modeling tools have advanced since that time so an update and expansion of the previous work is worth considering.

These CSS Model upgrades will be pursued in a targeted manner to assure that the model will support adaptation decisions while leaving areas that do not need additional detail unchanged.

8.3.2 Adding Model Detail

The CSS Model was originally created to develop and analyze CSO controls, which generally are evaluated using statistics associated with a typical year of rainfall. However, due to the need to perform more modeling of stormwater facilities, it is necessary to simulate larger storm events. Increasing the level of detail in specific areas of the model will increase the accuracy of modeling results for a wider range of storm events. Taking advantage of the City’s recent acquisition of planimetric data providing more detail about pervious and impervious areas, the model will be reconstructed with smaller subcatchments and more (smaller diameter) pipes to increase its overall accuracy and usefulness to answer questions arising from CSO Program implementation. Figure 8-1 shows the current subcatchment boundaries (black) and potential new subcatchment boundaries (grey). It is an example of the type of detail the City will be adding to the model.

FIGURE 8-1
Example of Added Detail in Model Subcatchments



8.4 Green Infrastructure

One of the ways that some communities have reduced the cost of their program is the incorporation of green infrastructure as one of the CSO Program controls. Over the next several years the City is planning on incorporation of green projects into the LTCP.

8.4.1 Green Infrastructure Pilot Program

As noted in Section 3, the City will be implementing a Pilot Program to determine the effectiveness of green infrastructure in reducing the magnitude, duration, and frequency of CSOs as well determining the cost effectiveness of these controls. Many communities around the nation have evaluated green infrastructure to reduce CSO Program costs. The results have been mixed, suggesting that the effectiveness is dependent on factors such as the type of precipitation (slow steady rain versus thunderstorms), community acceptance, and layout of the CSS. The City is planning on moving ahead with the Green Infrastructure Pilot Program to evaluate whether and to what extent selected projects can be used to address overflows.

Construction of projects in this program and monitoring of the impacts of the projects on the CSO system will likely occur over the next 5 years. The results of the Pilot Program will be used to determine if incorporating similar projects would be cost effective and to refine the process and procedures of their implementation. The LTCP may be adapted based on the results of the Pilot Program.

The Pilot Program also will identify potential areas where public/private partnerships may be of benefit. The City will continue to work with others in the establishment of stakeholder relationships that may lead to further reducing the stormwater entering the combined system.

8.4.2 Incorporation of Green Infrastructure into the CSS Model

To evaluate potential green infrastructure opportunities, it is necessary to increase the detail in some areas of the CSS model. New data have become available since the original model development that will greatly aid in this effort. In particular, these data include planimetric information showing outlines of impervious areas in detail in the combined sewer areas and detailed surface elevations resulting from aerial flights and LiDAR technology. The benefits to the CSO Program and related cost-effectiveness of potential projects identified by the City's CSO Green Infrastructure Program will be evaluated using the Program model after updates to include finer detail in the project areas to facilitate comparisons. Once demonstration projects are selected and implemented along with the installation of monitoring equipment, further expansion of the model can be undertaken to include detailed groundwater modeling in targeted areas. These simulation results will be available to help prove or disprove the value of incorporating specific types of green practices so that further investment in such technologies can be made in a wise manner.

8.5 Collection System Optimization

The City continues to seek opportunities to optimize in-system storage and system operations to assure existing facilities are maximized before new facilities are constructed. The City's response to the 2011 Flood incorporated some temporary changes, such as the installation of weir and orifice plates, which were recognized to have the potential for long-term benefits. Recent (2013) analyses to look for ways to shift and possibly detain flows with in-system storage in the Ohern/Monroe Basin are another example of the pursuit of optimized operations. A comprehensive look at optimization opportunities in the Minne Lusa basin was recently undertaken (2014), including changes to existing passive diversions, optimizing use of the existing collection system by reconfiguring flow paths, and targeted placement of equalization storage to decrease peak flow rates.

8.6 System Operations

Within the next five years, the City will place into operation two major wet weather treatment facilities: MRWWTP Improvements and the Saddle Creek RTB. Operational plans will be developed prior to operation of these facilities; however, significant experience will be required to optimize performance and ensure compliance with effluent limits for *E. coli*. In particular, operational experience with the CSO 102 system will be important to learn how to use the designed system to deal with the first flush from the SIFM, which contains high levels of ammonia.

The MRWWTP Improvements work together to:

- Isolate high-strength industrial wastewater, treating it separately and sending it to secondary treatment, thereby eliminating its presence in CSOs.
- Maximize wet weather flows to the plant through primary treatment, sending as much as possible through secondary treatment, and disinfecting the remainder in the CSO 102 chlorine contact basin.
- Efficiently disinfect the flow through the CSO 102 chlorine contact basin. The first flush effects mentioned above will be addressed using an operational protocol involving storage in existing primary clarifiers, chlorine dosages tied to ammonia concentrations, and other factors.

A complicating factor for the MRWWTP will be the need to dewater storage facilities in a manner that does not adversely impact the performance of the plant, but allows the storage facilities to meet challenges such as back-to-back storm events in controlling CSOs. The facilities that will need to be dewatered include wet weather primary clarifiers at the plant; storage tanks at CSOs 105, 118 and 119; the CSO 102 chlorine contact basin; and the RTB associated with the Deep Tunnel. A dewatering plan based on modeling results will be developed to outline appropriate dewatering priorities and procedures. City staff will implement this plan and modify it as needed based on actual experience. Dewatering procedures could potentially reduce the size of tanks at CSOs 118 and 119 by maximizing the use of MRWWTP facilities for dewatering, before and during wet weather events.

Experience will also be important in maximizing the performance of the Saddle Creek RTB. For example, chlorine dosages will be impacted by factors such as influent TSS concentrations, which will vary according to elements such as the time since the last storm, storm intensity, and areal storm variation. The RTB facilities will include components that will allow operators to maximize flow to the PCWWTP by way of the Papillion Creek Interceptor; however, it will be critical to operate these components in a manner that will not adversely impact the PCWWTP or the interceptor system. The manner in which the RTB is dewatered will need to take these factors into account as well.

8.7 Refinements

As the City implements the remaining CSO controls, refinements will be made to those planned controls based on performance of other controls as they are constructed and further evaluation. These refinements will be made in the spirit of the ongoing adaptive management approach that has been followed since the start of implementation. The following are key examples of such refinements:

- Revision of the size of controls based on implementation of projects: Based on the effectiveness of sewer separation and other inflow reduction projects, the sizing of the CSO Deep Tunnel and associated RTB, and storage tanks will be refined. Effectiveness and refinements will be determined from flow monitoring and modeling. The model refinements discussed in Section 8.3 will be an important part of this process. The performance of the Green Infrastructure Pilot Program discussed in Section 8.4 will potentially impact the sizing of controls and will help determine the cost effectiveness of additional green infrastructure.
- Conceptual designs of storage tanks at CSOs 118 and 119: The sizing of these storage tanks will be impacted by the performance of other controls, but will also be impacted by dewatering procedures, as discussed in Section 8.6. As part of other capital improvements at the MRWWTP, consideration may be given to increasing the maximum flow rate to secondary treatment for drivers such as treatment of nutrients. This could enhance the effectiveness of the CSO 102 facilities, making them better able to handle dewatering flows, and potentially reducing the size of the RTB associated with the Deep Tunnel.
- Conceptual design of storage tank at CSO 105: The sizing of this storage tank will also be impacted by the performance of other controls. In addition, it may be possible to reduce the size of the tank by adjusting the weir setting in the CSO 105 diversion structure. This was a key consideration to the No Tunnel Option for the Minne Lusa Basin, described in Section 3. The best location for the CSO 105 storage tank will also need to be determined, considering factors such as soil conditions, site constraints, and property acquisition.
- CSO Deep Tunnel and associated RTB: This LTCP Update has refined the diameter of the CSO Deep Tunnel to 15 feet, and the design flow of the RTB to 22 million

gallons per day (mgd). The optimum sizing of this combination will be further evaluated, and the overall sizing will be impacted by the performance of other controls. In addition, further refinement of the tunnel alignment will be done, based on the results of additional geotechnical investigations, optimum locations for drop shafts, and other considerations.

8.8 Affordability Concerns in the Future

As noted in Section 4, the City is facing affordability concerns in the future with the implementation of the LTCP. In addition, the likelihood exists that modifications will need to be made to the City's two regional wastewater treatment plants to address new water quality concerns associated with meeting new water quality standards for ammonia and future nutrient criteria. The City will work with NDEQ and others to address these concerns. It may be necessary to adapt the schedule for LTCP implementation to factor in these other elements. The City may look toward an integrated permitting approach to deal with the affordability issues.

8.9 Summary and Conclusion

The City has some significant challenges that will need to be addressed over the next 5 years related to the cost of the CSO Program and future regulations. The City structured this LTCP Update, like the 2009 LTCP, so that it can be adapted based on data gathered and lessons learned. This LTCP Update includes several refinements that have come out of adaptive management as discussed in Section 8.7. The City will continue to adapt the Program and has incorporated adaptive management strategies in several elements in the plan including:

1. Scheduling the CSO Deep Tunnel and Storage Tanks in the last phase of the Program after data has been gathered on the effectiveness of the previous controls on improving water quality and reducing CSO volumes.
2. Implementing a Green Infrastructure Pilot Program to determine how this technology can be used to reduce the Program costs while still meeting Program goals.
3. Improving the CSS Model to allow evaluation of optimization approaches where the City uses its existing infrastructure more effectively.

In summary, the City will continue to refine and adapt the CSO Program, providing transparency in the information used as the Program is adapted so that the ratepayers, the regulators, and the elected officials understand that the goals of the Program are being met in a responsible manner.

REGISTERED PROFESSIONAL ENGINEER
THOMAS J. HEINEMANN
9-26-14
E-6144
STATE OF NEBRASKA

Appendix A
Amended Consent Order between NDEQ and the City of Omaha

Dave Heineman
Governor

STATE OF NEBRASKA

DEPARTMENT OF ENVIRONMENTAL QUALITY
Michael J. Linder
Director
Suite 400, The Atrium
1200 'N' Street
P.O. Box 98922
Lincoln, Nebraska 68509-8922
Phone (402) 471-2186
FAX (402) 471-2909
website: www.deq.state.ne.us

DEPARTMENT OF ENVIRONMENTAL QUALITY
STATE OF NEBRASKA

CERTIFICATION

I, Ane McBride, Records Manager for the Nebraska Department of Environmental Quality, do hereby certify that the attached is a true and correct copy of public records filed with the Nebraska Department of Environmental Quality.

Ane C. McBride
Records Manager

Witnessed and sworn to before me this 8th day of August, 2007.

GENERAL NOTARY-State of Nebraska
CATHERINE M. AKIN
My Comm. Exp. June 16, 2008

Catherine M. Akin
Notary Public

(1)

City of Omaha
Mike Fahey, Mayor

RECEIVED
07 JUL -5 PM 1:53
CITY CLERK
OMAHA, NEBRASKA

JUL 17 2007

Public Works Department

Omaha/Douglas Civic Center
1819 Farnam Street, Suite 601
Omaha, Nebraska 68183-0601
(402) 444-5220
Fax (402) 444-5248

Robert G. Stubbe, P.E.
Public Works Director

RECEIVED
AUG 07 2007
Nebraska Department of Environmental Quality
By: ____

Honorable President

and Members of the City Council,

Transmitted herewith is an Ordinance to approve an agreement of the City of Omaha to the Complaint and Compliance Order by Consent providing for settlement and implementation of the Long Term Control Plan for the City of Omaha's Combined Sewer System.

The State of Nebraska Department of Environmental Quality has issued to the City of Omaha an Order of Complaint and Compliance by Consent consistent with applicable law as the most appropriate means of resolving the dispute of the parties and to provide a framework, in the public interest, for the settlement and implementation of the Long Term Control Plan for the City of Omaha's Combined Sewer System.

The Complaint and Compliance Order by Consent (Case No. 2710) is attached.

The Public Works Department requests your consideration and approval of the attached Ordinance.

Respectfully submitted,

Robert G. Stubbe 6-29-07
Robert G. Stubbe, P.E. — Date
Public Works Director

Referred to City Council for Consideration:

7-3-07
Mayor's Office — Date

Approved as to Funding:

Carol A. Ebdon 7/2/07
Carol A. Ebdon — Date
Finance Director

Approved:

Paul D. Kratz 6-29-07
Paul D. Kratz by RJHuman — Date
City Attorney

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ORDINANCE NO. 37809

AN ORDINANCE approving a Complaint and Compliance Order by Consent issued by the State of Nebraska Department of Environmental Quality in regard to the implementation of a Long Term Control Plan for the City of Omaha's Combined Sewer System in accord with the terms and conditions set forth in the Consent Order (Case No. 2710); to authorize the Mayor to execute the Consent Order; and to provide an effective date hereof.

WHEREAS, the complainant, Michael Linder, Director, Nebraska Department of Environmental Quality (referred to herein as NDEQ) has issued a Complaint and Compliance Order by Consent pursuant to Neb. Rev. Stat. §81-1507 (1) (Reissue 1999) and Neb. Rev. Stat. § 81-1504 (7) (Reissue 1999) of the Environmental Protection Act §81-1501 et seq. (Reissue 1999, Cum Supp. 2006); and,

WHEREAS, the respondent, the City of Omaha, is a body corporate and politic organized under the laws of the State of Nebraska in Douglas County, Nebraska; and,

WHEREAS, the Consent Order to be entered into voluntarily by the NDEQ and the City of Omaha pursuant to the Nebraska Environmental Protection Act provides for corrective action for the City of Omaha's Combined Sewer System; and,

WHEREAS, the purpose of this Consent Order is to provide a framework for settlement of the Long Term Control of the City of Omaha's Combined Sewer System, which is in the public interest, consistent with applicable law, and that, the entry of this Consent Order is the most appropriate means of resolving the dispute of the parties.

BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF OMAHA:

Section 1. That the City Council of the City of Omaha hereby approves the agreement of City of Omaha to the Complaint and Compliance Order by Consent, which by this reference is made part hereof, providing for settlement and implementation of the Long Term Control Plan for the City of Omaha's Combined Sewer System and a time line for compliance with the Consent Order including possible penalties for non-compliance with the Consent Order.

Section 2. That the Mayor is authorized to execute the Order of Complaint and Compliance of Consent, which provides the terms and conditions agreed upon, with the Nebraska Department of Environmental Quality.

Section 3. That this Ordinance shall take effect and be in full force upon the date of its passage.

INTRODUCED BY COUNCILMEMBER

[signature]

APPROVED BY:

[signature] 8/2/07
MAYOR OF THE CITY OF OMAHA DATE

PASSED JUL 31 2007 6-0

ATTEST:

[signature] 8/2/07
CITY CLERK OF THE CITY OF OMAHA DATE

APPROVED AS TO FORM:

[signature] 6-29-07
Deputy CITY ATTORNEY DATE

P:\PW\15725pjm.doc

I hereby certify that the foregoing is a true and correct copy of the original document now on file in the City Clerk's Office.

[signature]
Buster Brown, City Clerk, City of Omaha

BEFORE THE NEBRASKA DEPARTMENT OF ENVIRONMENTAL QUALITY

IN THE MATTER OF THE CITY OF OMAHA, Respondent,	Case No. 2710 COMPLAINT AND COMPLIANCE ORDER BY CONSENT

1. This Complaint and Compliance Order by Consent (or Consent Order) is issued pursuant to Neb. Rev. Stat. §81-1507 (1) (Reissue 1999) and Neb. Rev. Stat. 81-1504 (7) (Reissue 1999) of the Environmental Protection Act §81-1501 et seq. (Reissue 1999, Cum Supp. 2006). The complainant is Michael Linder, Director, Nebraska Department of Environmental Quality (referred to herein as NDEQ).

2. The respondent, City of Omaha (the City), is a body corporate and politic organized under the laws of the State of Nebraska in Douglas County, Nebraska.

3. The Consent Order is entered into voluntarily by the complainant and the respondent pursuant to the Nebraska Environmental Protection Act (referred to herein as NEPA") and provides for corrective action as follows herein. The parties agree that settlement of these matters is in the public interest and that entry of this Consent Order is the most appropriate means of resolving the dispute of the parties. The parties further agree that a Consent Order should be issued.

IT IS AGREED AND ORDERED AS FOLLOWS:

4. At all times material herein the respondent City owns and operates a system for wastewater and stormwater treatment. The City's wastewater system collects varieties of wastewater, including domestic sewage, commercial and industrial wastewater, and stormwater. Domestic sewage, commercial and industrial wastewater and during wet weather in some of the older parts of town stormwater is transmitted to one of the City's three wastewater treatment

facilities (WWTF) through the sanitary sewer system, treated to meet standards set by the State and reflected in National Pollutant Discharge Elimination System (NPDES) permits issued by the state, and discharged to waters of the state in Douglas County, and Sarpy County, Nebraska. The discharge of treated wastewater from the WWTFs, provided a variety of conditions are met, is allowed by NPDES permits, one for each WWTF. The NPDES permits for the WWTFs are numbered NE0040096, NE0036358 and NE0112810. Stormwater in some areas of the City's system is collected in pipes dedicated solely to stormwater and is discharged to waters of the state pursuant to an NPDES permit issued to Omaha and known as the MS4 permit, number NE0133698. During wet weather stormwater in other areas, especially older areas of the City, is collected in pipes that were designed to carry at once both stormwater and the other varieties of wastewater. These are commonly called "combined sewers." In times when stormwater flow to these combined sewers is not excessive all the wastewater and stormwater in the combined sewer is carried to the City's WWTFs and treated to meet State standards before discharge to waters of the state. At times of high stormwater flow, however, the volume of stormwater becomes so great in the combined sewers that the large volumes of flow in the system must, so as not to damage the WWTFs and the treatment process and not to back up into dwellings, be diverted away from the WWTFs and discharged without treatment directly into waters of the state. The discharge of untreated combined sewer flow that is diverted away from the WWTFs in conditions of wet weather and high flows is allowed by Omaha's NPDES permit, number NE0133680 issued October 1, 2002 ("CSO Permit").

5. NEPA grants NDEQ the power and duty to act as the state water pollution control agency for all purposes of the federal Clean Water Act, as amended, 33 U.S.C. §§ et seq. (CWA). Neb. Rev. Stat. § 81-1504. (Reissue 1999, Cum Supp. 2006).

6. Section 402 of the CWA, 33 U.S.C. 1342, establishes the NPDES program. Section 402 (q)(1) of the CWA requires that "Each permit, order, or decree issued pursuant to this chapter after December 21, 2000 for a discharge from a municipal combined storm and sanitary sewer shall conform to the Combined Sewer Overflow Control Policy signed by the Administrator on April 11, 1994 . . ." The Combined Sewer Overflow Control Policy was published at 59 Fed. Reg. 18688, April 19, 1994 ("CSO Policy") and calls for measures to minimize CSO impacts to water quality, aquatic biota, and human health.

7. Pursuant to NEPA at Neb. Rev. Stat. §81-1505 (1) (Reissue 1999, Cum Supp. 2006) the Nebraska Environmental Quality Council duly adopted Title 119, Rules and Regulations Pertaining to the Issuance of Permits Under the National Pollutant Discharge Elimination System.

8. NDEQ alleges that the City's CSOs while authorized under the CSO Permit and subject to certain CSO Policy requirements through the CSO Permit are not in compliance with Title 117 - Nebraska Water Quality Standards as implemented through Title 119.

9. The parties agree that for purposes of this Consent Order terms shall have the following meanings:

a. A Combined Sewer Overflow (CSO) is the discharge from a combined sewer system at a point prior to the WWTF. CSOs are point sources subject to NPDES permit requirements including both technology-based and water quality-based requirements of the CWA. CSOs are not subject to secondary treatment requirements applicable to publicly-owned treatment works.

b. Combined Sewer System shall mean the portion of the City's sewer system that conveys domestic, commercial and industrial wastewaters and stormwater runoff through a single-pipe system to Omaha's WWTFs or CSOs.

c. A Long Term Control Plan ("LTCP") is a plan to address CSOs that will ultimately result in compliance with the CWA and NEPA.

10. The City's CSOs are the result of a wastewater system in the older portions of the City that was designed and constructed in ways that make it inevitable that the City will discharge pollutants to waters of the state from CSOs. The CSO Permit in effect covers wet weather discharges of stormwater mingled with sanitary wastewater, yet such discharges should be reduced and eliminated according to the CSO Policy.

11. In order for the City to achieve compliance with the CSO Policy an evolving effort from assessment, through design and infrastructure construction, is necessary. The parties recognize that it will take the City many years to implement the needed measures included in the LTCP and that this Consent Order is the appropriate mechanism for controlling and assuring completion of these measures. The parties also believe that a number of factors could make exact precision in fulfillment of all the requirements herein difficult to achieve. Among these factors are uncertainty as to how component projects within the LTCP can be funded in the future, fluctuation in costs of the component projects, including labor and material market changes, potential changes in construction standards and legal requirements, unknown physical conditions of soil in the areas where construction is expected to occur, potential unforeseen demographic and infrastructure changes in areas affected by the component projects, unanticipated limitations in engineering or construction capacities in the area, changes in NPDES requirements and Nebraska Water Quality Standards, or other unforeseen problems. The parties pledge their best

efforts to overcome these and other difficulties to implement the LTCP in accordance with this Consent Order. All plans, measures, reports, construction, maintenance, operational requirements and other obligations in this Consent Order or resulting from the activities required by this Consent Order shall have the objective of allowing the City of Omaha to achieve LTCP implementation, excluding post-construction monitoring, by October 1, 2024, and, ultimately, allowing full compliance with the CWA, the CSO Policy, applicable state laws, and the terms and conditions of Omaha's NPDES permits, as the same may be reissued or modified from time to time.

12. The City denies the allegations in paragraph 8 of this Complaint and Consent Order, and by undertaking the obligations set forth herein does not admit any liability, negligence or fault. The City while not admitting the allegations of paragraph 8, nevertheless agrees to the form and content of this Consent Decree for the purposes of settlement.

IT IS FURTHER AGREED AND ORDERED:

13. Force majeure provisions applicable to the parties and this Consent Decree are provided in paragraphs 14 through 21 herein.

14. Omaha shall perform the requirements of this Consent Order within the time limits set forth herein unless the performance is prevented or delayed by events which constitute a force majeure.

15. A force majeure event is defined as any event arising from causes not reasonably foreseeable and beyond the control of the City or its consultants, engineers, or contractors which could not be overcome by due diligence and which delays or prevents performance as required by this Consent Order.

16. Force majeure events do not include unanticipated or increased costs of performance, changed economic or financial conditions, or failure of a contractor to perform or failure of a supplier to deliver unless such failure is, itself, the result of force majeure.

17. If any event occurs that causes or may cause the City to violate any provision of this Consent Order or to delay achievement of the LTCP within the timeframe established herein or delay achievement of any component project within the respective component project implementation time, the City shall notify the NDEQ by telephone within ten (l0) business days and in writing within (15) fifteen business days after it becomes aware of events which it knows or should reasonably have known may constitute a force majeure. The City's notice shall provide an estimate of the anticipated length of the delay, including any necessary period of time for demobilization and remobilization of contractors or equipment; a description of the cause for the delay, and a description of the measures taken or to be taken to minimize delay, including a timetable for implementing these measures. Notification to NDEQ by telephone and in writing shall be directed to Donna Garden, or such other person as NDEQ shall subsequently designate in writing. In the event that Donna Garden or subsequent designee is unavailable at the time of any attempt to notify, then notification shall be to another NDEQ employee who shall also be informed specifically that the notification is dictated by this Consent Order in Case No. 2710.

18. Failure to comply with the notice provision shall be grounds for NDEQ to deny granting an extension of time to the City.

19. If the City reasonably demonstrates to NDEQ that the delay has been or will be caused by a force majeure event, NDEQ will consent to an extension of the time for performance for that element of the Consent Order for a period not to exceed the delay resulting from such

circumstances. The City shall not be liable for penalties or any other relief for any period of delay resulting from a force majeure event.

20. If a dispute arises over the occurrence or impact of a force majeure event and cannot be resolved, NDEQ reserves the right to seek enforcement of this Consent Order under Neb. Rev. Stat. §81-1508 and §81-1508.02 (Reissue 1999). In any such dispute, the City shall have the burden of proof that a violation of the Consent Order was caused by a force majeure event. The City reserves the right to exercise and assert any and all defenses to such enforcement action, including, but not limited to the defense of force majeure.

IT IS FURTHER AGREED AND ORDERED:

21. This Consent Order shall not prevent NDEQ from issuing, reissuing, renewing, modifying, revoking, suspending, denying, terminating, or reopening any NPDES permit to the City, including the necessary modifications to the City's NPDES permits for WWTFs and CSOs to maintain consistency with Nebraska law, NDEQ regulations, the implementation schedule called for herein, and the CSO Policy. The City shall not use this Consent Order as a defense to these permit actions.

22. Failure by the City to comply with this Consent Order shall be grounds for NDEQ to seek appropriate administrative or judicial enforcement of this Consent Order. The City reserves the right to exercise and assert any and all defenses to such enforcement action.

23. This Consent Order may be modified and amended in writing by mutual agreement of the City and NDEQ to address changes in circumstances, events such as those described in paragraph 11, changes in law and regulations, or in response to any facts or circumstances relevant to the City's performance under this Consent Order. NDEQ and the City shall negotiate in good faith with respect to use of this provision. Any modifications of the

obligations of the Parties under this Consent Order shall be effective when in writing executed by the parties and only upon approval of the Director of NDEQ.

24. Notwithstanding NDEQ's review of any plans submitted to NDEQ pursuant to this Consent Order, the City shall remain solely responsible for compliance with the CWA, NEPA, and the rules and regulations promulgated thereto. This Consent Order is not and shall not be construed as a permit, nor a modification of any existing NPDES permit, nor shall it in any way relieve the City of its obligations to obtain permits for its WWTFs and related operations or facilities and to comply with the requirements of any NPDES permit or with any other applicable state or federal law or regulation. The Parties intend that the schedules called forth herein will be consistent with any schedules required pursuant to any NPDES permit issued to the City. Any new permit, or modification of existing permits, shall be complied with in accordance with applicable state or federal laws and regulations.

25. The City, upon completion of all of its obligations hereunder, is entitled to termination of this Consent Order.

26. The NDEQ has jurisdiction of the parties and the subject matter of this action. This complaint filed herein constitutes a justifiable cause of action against the City of Omaha under the Environmental Protection Act, Neb. Rev. Stat. §81-1501 et seq. (Reissue 1999, Cum Supp. 2006).

27. THEREFORE IT IS ORDERED AND AGREED as follows: On or before October 1, 2009, the City of Omaha shall produce and submit to NDEQ for review and approval a final LTCP, including a written schedule of the sequence in which LTCP component projects will be undertaken and the time frame for each component project. The LTCP plan shall be consistent with the CSO Policy, the CSO Permit, the CWA, NEPA and implementing regulations

and shall include sufficient justification and explanation of its component projects for NDEQ to review. The schedule for the order of accomplishment of LTCP component projects shall identify the component projects by location, the engineering or operational means of accomplishment, and the time frames within which the component projects will be commenced and completed. The schedule shall provide for implementation of the LTCP except post-construction monitoring as soon as practicable and in any event by October 1, 2024.

28. THEREFORE IT IS ORDERED AND AGREED that, upon approval of the LTCP and schedule by NDEQ, the City shall implement the LTCP according to the schedule on or before October 1, 2024.

29. THEREFORE IT IS ORDERED AND AGREED that within 30 days following October 1, 2011, and within 90 days following each yearly anniversary thereafter until termination of this Consent Order, the City shall submit written status reports to the Department setting for the following:

a. A statement identifying each component project time frame in the period preceding the initial, or thereafter, the most recent previous report, calling for commencement, completion, implementation or some other action to be taken, and whether and to what extent such action was taken by the City within the respective component project time frame.

b. A general description of the work performed pursuant to the LTCP and component project time frame schedule for the period covered by the report and whether it conformed to the LTCP and time frame schedule.

c. A statement of any future planned or expected deviations from the LTCP and component project time frame schedule and the reasons for such deviations.

30. NOTICE OF OPPORTUNITY TO REQUEST A HEARING AND WAIVER OF HEARING. Pursuant to Neb. Rev. Stat. § 81-1507 (Reissue 1999) a Respondent may apply for a hearing to contest the Complaint and Compliance Order and by making a request for such hearing to the Director no later than 30 days after service hereof. Nebraska Department of Environmental Quality, Rules of Practice and Procedure, Title 115, Chapter 7, relates to the initiation and procedure of such hearings. The City hereby waives its right to a hearing to contest any matters contained in this Consent Order. The waiver does not extend to any hearing to determine compliance with this Order.

31. ADVISEMENT OF POSSIBLE PENALTIES. The Respondent, City of Omaha, is advised that pursuant to Neb. Rev. Stat. § 81-1508.02 (Reissue 1999) any failure to comply with, or violation of, the foregoing Consent Order is grounds for imposition of a civil penalty in an amount not to exceed ten thousand dollars ($10,000) per day, with each day of violation constituting a separate offense. The issuance of this Order does not preclude NDEQ from pursuing enforcement action in court for appropriate relief or for penalties.

IT IS SO ORDERED AND AGREED BY:

August 8 2007
Date

Michael J. Linder, Director Nebraska
Department of Environmental Quality

AND AGREED BY:

August 2, 2007
Date

Mike Fahey
Michael Fahey, Mayor
City of Omaha

ATTEST:

8/2/07
Buster Brown, City Clerk

DB02/801032 0006/7551143.4
DB02/801032.0006/7551143.4/

BEFORE THE NEBRASKA DEPARTMENT OF ENVIRONMENTAL QUALITY

IN THE MATTER OF THE CITY OF OMAHA, Respondent,	Case No. 2710 AMENDED COMPLIANCE ORDER

On May 8, 2012, the City of Omaha, the Respondent herein, submitted to the Nebraska Department of Environmental Quality (NDEQ), the Complainant, the City's request for a three year extension to the final implementation date of the CSO Long Term Control Plan (LTCP) from October 1, 2024, to October, 2027. The City claimed Force Majeure under paragraph 15 of the August 8, 2007, Complaint, and Compliance Order by Consent, as the grounds for the extension. The force majeure event in this instance was the 2011 Missouri River Flood.

The NDEQ finds that the flood of 2011 was a force majeure event. It was a flood of exceptional magnitude. It overwhelmed flood precautions taken by diligent and responsible government authorities for hundreds of miles along the Missouri River, including the boundary between Nebraska and Iowa. The City notified NDEQ in writing of its intent to invoke force majeure on June 3, 2011. The City's efforts at design and construction were impeded by the flood.

IT IS THEREFORE ORDERED that paragraphs 27 and 28 of the August 8, 2007, Order are amended as follows:

A. The last sentence of paragraph 27 shall provide: The schedule shall provide for implementation of the LTCP except post-construction monitoring as soon as practicable and in any event by October 1, 2027.

B. Paragraph 28 shall provide: Therefore it is ordered and agreed that, upon approval of the LTCP and schedule by NDEQ, the City shall implement the LTCP according to the schedule on or before October 1, 2027.

IT IS FURTHER ORDERED that the LTCP of 2009 shall be revised and submitted to NDEQ on or before October 1, 2014; the amended LTCP shall address all force majeure related delays. The revision shall be subject to, and contingent upon, approval by NDEQ. Upon approval by NDEQ the LTCP shall be performed by the City according to its terms and schedule.

IT IS FURTHER ORDERED that the remainder of the Order of August 8, 2007, is ratified and confirmed, and the City shall comply with the terms of the Order as amended herein.

IT IS SO ORDERED:

May 30 2012
Date

By: [signature]
Michael J. Linder, Director, Nebraska
Department of Environmental Quality

AFFIDAVIT

STATE OF NEBRASKA | *SS*
COUNTY OF LANCASTER |

The undersigned oath deposes and says that on the 31st day of May, 2012, he caused an exact copy of the attached Amended Compliance Order, to be served by mailing the same in the regular United States Mail, first class, postage prepaid, certified with return receipt requested, addressed as follows:

Jim Suttle, Mayor
City of Omaha
1819 Farnam Street, Suite 300
Omaha, Nebraska 68183

and by United States mail, first class, postage prepaid on the following:

Paul Kratz
City Attorney
1819 Farnam Street, Suite 804
Omaha, Nebraska 68183

Marty Grate
City of Omaha
5600 South 10th Street
Omaha, Nebraska 68107

Timothy J. Doyle, affiant

Subscribed and sworn to before me, a Notary Public, on the 31st day of May, 2012.

GENERAL NOTARY-State of Nebraska
KERRIE CARPENTER
My Comm. Exp. Feb. 19, 2016

Notary Public

Appendix B
Green Infrastructure Guidance for Projects

Green Solutions in Facility Design Guidance Document

Purpose of this Document

This Guidance Document is being developed for the City of Omaha as a part of the Long Term Control Plan (LTCP) and is intended to provide guidance relating to the implementation of Green Solutions in facility designs. The type of facilities for which this approach may apply includes the major CSO Controls. This includes treatment plants, lift stations, storage tanks, tunnel shafts, or other projects for which site development may be required. A separate guidance document has been developed for sewer separation projects.

The incorporation of Green Solutions into facility designs is the responsibility of the designer. It is hoped that these measures will serve to limit the impact of new facilities on stormwater runoff and water quality and replicate the site's natural response to rainfall events. All reasonable efforts should be employed to identify appropriate Green Solution technologies at the earliest stages of conceptual design. If deemed viable, these measures should be developed along with other elements of the site and facility design.

The purpose of this guidance document is to present opportunities for implementation of Green Solution best management practices, stimulate the ingenuity and creativity of engineers and planners, and identify reference sources to support design and implementation of Green Solutions. The recommendations and guidance presented are intended to provide a general overview of the intent and types of Green Solutions technologies available. It is the designer's responsibility to assess the technologies and identify those most appropriate at the site.

General Introduction

The Green Solutions Program is an element of the City's effort to address Combined Sewer Overflows (CSO) in environmentally and financially responsible ways. The Green Solutions program incorporates natural environmental controls that are largely passive. Capitalizing on these Green Solutions measures, the elements of the facility construction projects may or may not have an impact on downstream infrastructure, but they will improve runoff water quality and add to the overall sustainability of the program.

The Project Management Team (PMT) for the CSO Program has a strong interest in the successful implementation of Green Solutions. As such, periodic interaction between the PMT and the designers will be an important part of the implementation process. These periodic meetings are anticipated to begin during the scoping phase and extend throughout the project duration.

Objectives of the Green Solutions Program

Green Solutions, at their most fundamental level, are intended to replicate the hydrologic response of natural systems. That is, the rainfall/runoff response mimics that which could be expected before man's intervention. Historically rainfall was left to naturally pond and infiltrate into the ground, recharging groundwater and filtering any pollutants that may have been mobilized. Only large storms created significant surface runoff.

Replicating these runoff characteristics allows natural runoff reduction and treatment processes to be employed. The result is more stable base flows, fewer runoff producing storms, and fewer pollutants entering receiving waters. These Green Solution technologies also further efforts to conform to the City's Municipal Separate Storm Sewer System (MS4) program requirements.

In general, the Green Solutions technologies that are to be incorporated will address the more frequent rainfall events and are expected to have results that replicate the site's natural response to runoff. As a target, designs should focus on the control of the first 0.5" of runoff. This threshold conforms to the City's stormwater quality guidance.

Overall Incorporation of Green Solutions Technology

When properly done, Green Solutions maximize infiltration, reduce peak runoff, reduce the frequency of runoff events, and develop a more sustainable base flow condition. This approach implements engineered small-scale hydrologic controls to replicate the pre-development hydrologic regime of watersheds through infiltrating, filtering, storing, evaporating, and detaining runoff.

The general process to be employed relies on steps that are common to any site development process and includes:

- Planning
- Site Layout
- Infrastructure Selection

Planning is a part of every site development process and requires a clear understanding of the regulatory constraints imposed on a site and, more importantly, the functional objectives of the project. Green Solutions are intended to support the underlying project but may require that some previously accepted approaches be reconsidered. While it is easier to envision alternatives to conventional site planning for "Greenfield" developments, the concepts apply to redevelopment sites as well. For the purposes of this Guidance Document, equal consideration of these elements should be given for areas of both new development and redevelopment.

The layout of the site generally has enough flexibility that the functional objectives can be met with a variety of configurations. Simple changes at this stage can have a profound impact on the runoff characteristics and can reduce the potential runoff considerably.

Finally, through careful selection of infrastructure elements, additional benefits can be realized without any compromise of facility function. These elements often come with some additional capital investment but sometimes result in a commensurate reduction in the necessary investment for other parts of the drainage system.

Green Solutions can be applied in most conditions; although, some sites may have conditions that are less favorable for Green Solution technologies. In these cases, planning and site layout alone may not be sufficient to fully realize the benefits of Green Solutions. When these site conditions are encountered, it may be necessary to introduce a more engineered approach in order to successfully implement Green Solutions. The following is a list of site conditions that may require a more engineered approach in order to successfully implement Green Solution technologies.

- Low permeability soil conditions
- Past contamination
- Steep topography
- Water rights regulations
- Safety concerns
- Proximity to infrastructure
- Cost and maintenance
- Limited construction areas and existing construction and easement constraints.

The issues may present barriers for Green Solutions although the opportunities still exist to implement Green Solutions through creative and resourceful engineering and planning. Sites with these conditions should not be dismissed from consideration of Green Solutions without appropriate evaluation.

The City of Omaha actively encourages the use of Green Solution technologies in site planning for all developments, including facilities such as those contemplated as part of the LCTP. The City published the *Omaha Regional Stormwater Design Manual* (Manual) in 2006 which includes extensive guidance on the application and implementation of Green Solution technologies as part of a comprehensive stormwater management plan for a site. It is the City's intention that all developments comply with the requirements of the Manual as well as with relevant sections of the Omaha Municipal Code. In doing so, the requirements of the MS4 permit program will also be met.

The City's approach to assuring that appropriate measures are included in development proposals is through oversight rather than prescription. That is, no absolute approaches are prescribed; rather, general guidance is provided and the developers and their engineers are asked to demonstrate through the application of their Stormwater Management Plan that compliance has been achieved. This puts the burden of ingenuity on the engineer and allows for creativity in finding and demonstrating the effectiveness of solutions.

This document is intended to help introduce Green Solution technologies to the facility designers and to provide resources that can help them determine the appropriate application, quantify the benefits of application and present a compelling case for their inclusion on facility designs. With appropriate documentation and coordination with the City's reviewing agencies, the facility's Stormwater Management Plan can secure the necessary Plan Approval even when departing from more traditional stormwater management approaches.

Planning

The goal of incorporating Green Solutions into site planning is to allow for full development of a property while maintaining the essential site hydrologic functions. This goal is accomplished in a series of incremental steps that include first clearly understanding the functional objectives. These objectives that support the broader goals of the LTCP should never be compromised when considering Green Solutions.

In addition, all legal and regulatory constraints must continue to be satisfied. In some cases, it may be desirable to try and obtain waivers in order to fully realize the benefits of Green Solutions. For example, specific parking space requirements may be imposed by zoning or subdivision regulations. An approach that might further the Green Solutions objectives could include providing a percentage of the parking on a grassed surface rather than on a conventionally paved surface. As with all departures from those elements of the planning and design process that are prescriptive (such as pavement widths) submitting the proposed deviations as part of the Stormwater Management Plan allows the City to consider the relative benefits as part of the Plan Approval process. The PMT, as part of their role in helping to oversee compliance with the LTCP, is in a position to support viable and beneficial departures from the prevailing development regulations. If, after meeting with the project designers, the PMT believes the proposed modifications are warranted, they can support the waiver claims and carry the request forward on the designer’s behalf.

Creativity in the planning process should consider the regulatory constraints, the functional objectives of the project and superimpose Green Solutions measures as part of the basic site plan. The planning objective should be to meet the regulatory and functional requirements while minimizing the hydrologic changes with the use of an at-source control approach, in contrast to the more commonly used end-of-pipe control approach. The end result will be to more closely mimic the watershed’s historic hydrologic functions through infiltration, storage, groundwater recharge, and evapotranspiration rather than runoff. With Green Solutions, every urban landscape and infrastructure feature (roofs, streets, parking, sidewalks, and green space) can be designed to be multifunctional, incorporating detention, retention, filtration, or runoff use. The ingenuity of the designer, when applied at appropriate stages throughout the planning and design process, will drive the selection of the type and character of the Green Solutions measures.

Successfully planning for controls requires they be incorporated early in the site development process. Green Solutions should be incorporated at the project conception to allow for an optimum site design. The result of this preliminary planning stage should be reviewed throughout the project design process to ensure that the intent of the project is being met.

Site layout

Site design is a key element in implementation of Green Solutions. Several elements need to be identified early in the site layout process. Unlike conventional pipe systems that hide water beneath the surface and work independently of the topography; drainage systems for Green Solutions are adapted to natural topographic constraints, maintain lot yield, maintain pre-development hydrology, and provide for aesthetically pleasing and less expensive stormwater management controls. When developing a site layout planners and engineers should consider the following steps in the site layout process:

- Identify applicable zoning, land use, subdivision and other local regulations
- Reduce/minimize total site impervious areas
- Minimize directly connected impervious areas
- Modify/increase drainage flow path lengths
- Use drainage/hydrology as a design element

Minimize disturbance

One key way to maintain the historic hydrology is to minimize the amount of disturbance on the site and retain existing vegetation where possible. Limiting the areas to be cleared and grubbed, stabilizing disturbed areas immediately upon completion of the work, confining the limits of construction, and phasing of the project to limit the amount of time areas are disturbed can all be effective ways to reduce development impact.

Minimize imperviousness

A major concept behind developing a site with Green Solutions is the minimization of impervious surfaces. The reduction of impervious surface will reduce the overall amount of runoff as well as decrease the amount of pollutants carried in the runoff. Some approaches that minimize impervious areas include:

- Reduced building footprints
- Smaller roadway cross-sections
- Reduced parking areas or hybrid lots that may have multiple uses
- Porous parking areas and roadways

By reducing the size and type of these newly created impervious surfaces there can be significant decrease in the amount of runoff from a site. Specific best management practices are available in several design manuals; the following is a list of some technical guides that offer some best management practices as well as guidance for minimizing impervious areas.

- *"Omaha Regional Stormwater Design Manual"* (City of Omaha; http://www.papiopartnership.org/pdf/Manual.pdf)
- *"Low Impact Development Design Strategies: An Integrated Design Approach"* (Prince George's County, Maryland - Department of Environmental Resources; http://www.epa.gov/OWOW/nps/lidnatl.pdf)
- *" Stormwater Best Management Practice Handbook: New Development and Redevelopment"* (California Stormwater Quality Association; http://www.cabmphandbooks.com/documents/Development/DevelopmentHandbook.pdf)
- *"Better Site Design: A Handbook for Changing Development Rules in Your Community"* (Center for Watershed Protection; http://www.cwp.org/Store/bsd.htm)

Promote infiltration

Infiltration is ideal for management and conservation of runoff because it filters pollutants through the soils and restores the natural flows to groundwater and downstream water bodies. When incorporating Green Solutions the goal is to maximize the amount of infiltration on the site. This can be accomplished many ways, including:

- Incorporate grading techniques that flatten slopes to reduce runoff and impound stormwater
- Slow down stormwater runoff to allow for infiltration
- Subsurface infiltration galleries using crushed rock or other permeable media
- Direct surface drains to discharge to open pervious areas

The design intent of promoting infiltration is to reduce the runoff volume and capture pollutants from a developed site. Specific best management practices are available in several design manuals; the following is a list of some technical guides that offer best management practices as well as guidance for promoting infiltration. These are included as references. It is still the engineer's responsibility to quantify the benefits of these practices and to make sure that appropriate documentation is presented as part of the Stormwater Management Plan that is submitted to the City for approval.

- *"Omaha Regional Stormwater Design Manual"* (City of Omaha; http://www.papiopartnership.org/pdf/Manual.pdf)
- *" Stormwater Best Management Practice Handbook: New Development and Redevelopment"* (California Stormwater Quality Association; http://www.cabmphandbooks.com/documents/Development/DevelopmentHandbook.pdf)
- *"Better Site Design: A Handbook for Changing Development Rules in Your Community"* (Center for Watershed Protection; http://www.cwp.org/Store/bsd.htm)

Disconnected imperviousness

A common component of Green Solutions involves the disconnection of a direct path for runoff from impervious areas to reach the drainage system. The goal of disconnecting impervious surfaces is to allow runoff from the site's impervious surfaces to travel across a pervious surface long enough to promote infiltration and trap sediment. These flows may be concentrated or distributed sources based on the site design. The following are some commonly used Green Solutions technologies to disconnect impervious areas.

- Rain barrels and cisterns that store runoff from impervious surfaces
- Detached sidewalks where runoff flows across a vegetated buffer before it enters the curb and gutter system
- Rain gardens that receive runoff from building downspouts or other impervious surfaces
- Level spreaders that intercept runoff from impervious areas and slow down and evenly spread flow before it reaches the drainage system
- Infiltration swales that serve as both conveyance system elements and infiltration and filtration elements

Several technical design guides have been developed that address disconnecting impervious surfaces.

- *"Omaha Regional Stormwater Design Manual"* (City of Omaha; http://www.papiopartnership.org/pdf/Manual.pdf)

- *"Stormwater Regulations Fact Sheet #4: Disconnecting Your Impervious Areas"* (Philadelphia Water Department, Watershed Information Center; www.phillyriverinfo.org/WICLibrary/SWFS4_April2008.pdf)
- *" Stormwater Best Management Practice Handbook: New Development and Redevelopment"* (California Stormwater Quality Association; http://www.cabmphandbooks.com/documents/Development/DevelopmentHandbook.pdf)

Buffers

Buffers help reduce the impact of runoff by trapping sediment and sediment-bound pollutants, encouraging infiltration, and slowing and dispersing stormwater flows over a wide area. Buffers are typically strips of vegetation, either planted or natural, around sensitive area, such as waterbodies, wetlands, woodlands, or highly erodible soils. There are numerous examples of common buffers, including:

- Grass medians that can collect street runoff for storage or before release to the storm drain system
- Detached sidewalks where runoff flows across a vegetated buffer before it enters the curb and gutter system
- Vegetation preservation to take advantage of existing infiltration and filtration characteristics of the site
- Riparian/forested buffers that provide natural protection along stream corridors

Many municipalities have incorporated buffers into their development criteria. Several technical guides have been developed regarding the placement and size of buffers.

- *"Omaha Regional Stormwater Design Manual"* (City of Omaha; http://www.papiopartnership.org/pdf/Manual.pdf)
- *"Low Impact Development Design Strategies: An Integrated Design Approach"* (Prince George's County, Maryland - Department of Environmental Resources; http://www.epa.gov/OWOW/nps/lidnatl.pdf)
- *"Better Site Design: A Handbook for Changing Development Rules in Your Community"* (Center for Watershed Protection; http://www.cwp.org/Store/bsd.htm)
- *" Stormwater Best Management Practice Handbook: New Development and Redevelopment"* (California Stormwater Quality Association; http://www.cabmphandbooks.com/documents/Development/DevelopmentHandbook.pdf)

Parking lot and roadway alignments

Parking lots and roadways typically account for approximately 60% - 70% of the impervious surface on a developed site. More than any other single element parking lots and roadways have major impact on stormwater quality. The following are examples of practices that can be utilized to limit the impervious surface of parking and roadway alignments.

- Reduce impervious parking surfaces by having infrequently used parking areas on porous surfaces

- Porous parking and roadway surfaces that use modular block pavers, porous asphalt, porous concrete, or a vegetated surface
- Construction of roadway surfaces using porous materials
- Consider narrower street sections to reduce imperviousness but assure that safety and emergency vehicle access concerns are addressed

Several technical guides for parking lot and roadway alignments have been developed aid to design and address common concerns. The following are some common guidance documents for implementing alternative parking and roadway alignments.

- *"Porous Pavement Phase I Design and Operational Criteria"* (Environmental Protection Agency: Urban Watershed Management Research; http://www.epa.gov/ednnrmrl/publications/reports/epa600280135/epa600280135.htm)
- *"Structural Design of Permeable Pavements Worksheet"* (Pervious Pavement Design; http://www.perviouspavement.org/PDFs/A%20NCSU%20Structural%20Design%20-%20Permeable%20Pavements.pdf)
- *"Infiltration Opportunities in Parking Lot Designs Reduce Runoff and Pollutants"* (Southwest Florida Water Management District; http://www.stormwaterauthority.org/assets/202BAquarium.pdf)
- *" Stormwater Best Management Practice Handbook: New Development and Redevelopment"* (California Stormwater Quality Association; http://www.cabmphandbooks.com/documents/Development/DevelopmentHandbook.pdf)

Infrastructure Selection

Implementing Green Solutions requires the planner and engineer to select infrastructure based on specific site conditions. The site conditions such as soil conditions, topography, and other constraints will determine the most appropriate approach. Regardless of the approach used, any plan must be consistent with Omaha's Municipal Code, the Manual, the City's MS4 permit obligations and other state and federal requirements. Nevertheless, regulatory requirements and the goals of Green Solutions can often be met by incorporating one or more of the following basic elements, either alone or in combination:

- Infiltration ponds, basins, swales, and subsurface systems
- Retention and detention basins, constructed wetlands, and buffers
- Biofilters, filter strips, vegetated slopes and channels, and plantings
- Structural controls such as diversion berms and ditches, secondary containment facilities, curb cuts, and slope drains

Several design manuals have been developed to demonstrate the different options available when choosing infrastructure. The following technical guidance documents identify a variety of infrastructure.

- *"Stormwater Best Management Practice Handbook: New Development and Redevelopment"* (California Stormwater Quality Association; http://www.cabmphandbooks.com/documents/Development/DevelopmentHandbook.pdf)

- *"Best Management Practices for Sediment Control and Water Clarity Enhancement"* (Chesapeake Bay Program, A Watershed Partnership; http://www.chesapeakebay.net/content/publications/cbp_13369.pdf)
- *"Minnesota Stormwater Manual, Nonpoint Source Water Pollution Control Measures"* Minnesota Pollution control Agency; http://www.pca.state.mn.us/publications/wq-strm9-01.pdf)

Ponding and vegetation

Ponding and vegetation can be designed to replicate the historic surface roughness and create local depressions to promote infiltration. There are many Green Solution technologies available that utilize ponding and vegetation.

- Rain gardens create small depressions where runoff can collect and be effectively used to irrigate landscape elements
- Constructed wetlands that capture runoff and remove pollutants before infiltration or overflow
- Porous landscape detention that serves to both store and infiltrate runoff

Several technical design guides have been developed; the following are some guidance documents for designing systems that incorporate ponding and vegetation.

- *"Omaha Regional Stormwater Design Manual"* (City of Omaha; http://www.papiopartnership.org/pdf/Manual.pdf)
- *"Low Impact Development Design Strategies: An Integrated Design Approach"* (Prince George's County, Maryland - Department of Environmental Resources; http://www.epa.gov/OWOW/nps/lidnatl.pdf)
- *"Better Site Design: A Handbook for Changing Development Rules in Your Community"* (Center for Watershed Protection; http://www.cwp.org/Store/bsd.htm)
- *" Stormwater Best Management Practice Handbook: New Development and Redevelopment"* (California Stormwater Quality Association; http://www.cabmphandbooks.com/documents/Development/DevelopmentHandbook.pdf)

Pavements and impervious surfaces

Most of the pavements and impervious surfaces in developed areas are for common roads and parking lots. They play a major role in generating and transporting increased stormwater runoff and contaminant loads to receiving waters. Use of alternative surfaces can also eliminate problems associated with standing water, provide for groundwater recharge, facilitate pollutant removal, and still provide an aesthetically appealing site. The following are some examples of alternative surfaces, although several others exist.

- Porous asphalt or concrete that has some infiltration capacity and reduces the effective imperviousness
- Permeable Block Pavers that promote infiltration along joints between paver blocks
- Grass Pavers that have large voids to promote growth of vegetation and provide a stabilized infiltration surface

- Plastic Turf Reinforcing Grids that have large voids to promote growth of vegetation and provide a stabilized infiltration surface
- Crusher Fine Surfaces that are durable and stable but maintain permeability to promote infiltration

Several design manuals have been developed to demonstrate the different options available when designing pavements and impervious surfaces. The following list is a summary of technical guidance documents.

- *"Porous Pavement Phase I Design and Operational Criteria"* (Environmental Protection Agency: Urban Watershed Management Research; http://www.epa.gov/ednnrmrl/publications/reports/epa600280135/epa600280135.htm)
- *"Structural Design of Permeable Pavements Worksheet"* (Pervious Pavement Design; http://www.perviouspavement.org/PDFs/A%20NCSU%20Structural%20Design%20-%20Permeable%20Pavements.pdf)
- *"Infiltration Opportunities in Parking Lot Designs Reduce Runoff and Pollutants"* (Southwest Florida Water Management District; http://www.stormwaterauthority.org/assets/202BAquarium.pdf)
- *" Stormwater Best Management Practice Handbook: New Development and Redevelopment"* (California Stormwater Quality Association; http://www.cabmphandbooks.com/documents/Development/DevelopmentHandbook.pdf)

Conveyance elements

In some cases planners and engineers will need to convey storm flows rather than try and control them at their source. Conveyance, when properly designed, can provide additional infiltration and attenuation benefits. The following are some examples of how conveyance elements can be used to provide some treatment benefits:

- Bioswales that are carefully vegetated and designed to promote vegetative uptake of pollutants and promote infiltration
- Infiltration Trenches that are mostly coarse grained sands and gravels where infiltration of runoff is achieved
- Vegetated Swales that slow the response of the watershed, lengthening the overall time of basin response and subsequently reducing the peak rate of runoff

The following list presents several design manuals have been developed to demonstrate how conveyance elements can be incorporated.

- *"Omaha Regional Stormwater Design Manual"* (City of Omaha; http://www.papiopartnership.org/pdf/Manual.pdf)
- *"Low Impact Development Design Strategies: An Integrated Design Approach"* (Prince George's County, Maryland - Department of Environmental Resources; http://www.epa.gov/OWOW/nps/lidnatl.pdf)
- *"Better Site Design: A Handbook for Changing Development Rules in Your Community"* (Center for Watershed Protection; http://www.cwp.org/Store/bsd.htm)

- *" Stormwater Best Management Practice Handbook: New Development and Redevelopment"* (California Stormwater Quality Association; http://www.cabmphandbooks.com/documents/Development/DevelopmentHandbook.pdf)

Summary

Green Solution technologies are intended to help designers develop sites that mimic the historic hydrology through the use of naturally occurring processes such as, infiltration, interception, depression storage, and filtration. This guide has been developed to highlight different aspects of Green Solutions that need to be incorporated into the planning and design of site specific improvements. Planners and engineers should consider using these elements to maximize the benefits of Green Solutions. Several technical guides have been referenced that can provide more specific design guidance. Planners and designers will need to keep in mind that, while Green Solutions technologies are generally enthusiastically embraced, it will be necessary to review the local regulations to assure that the appropriate Green Solution technology is being used and that all prevailing guidelines, criteria and regulations are being followed.

Omaha Green Solutions Site Suitability Assessment and BMP Selection Process Guidance Document

Purpose of this Document

The purpose of this document is to provide an evaluation process to be followed to determine if Green Solutions can be effectively incorporated into sewer separation projects. This document is not meant to be a recipe for this incorporation. Rather, it is intended to provide general guidance and point out important elements that need to be considered. It is anticipated that those firms selected for these projects will continue to provide the appropriate levels of ingenuity and technical skills to conduct the project specific technical evaluations.

General Introduction

The Green Solutions Program is an element of the City's effort to address Combined Sewer Overflows in environmentally and financially responsible ways. The City of Omaha has adopted broad sustainability goals as part of the implementation of the Combined Sewer Overflow (CSO) Control Program. It is the City's intention to incorporate the concepts embodied by the goals into projects implemented as part of the Long Term Control Plan (LTCP). A Vision Statement has been established.

> ***The City of Omaha CSO Control Program will apply the principles of sustainability in a fiscally responsible manner to add meaningful and lasting social, environmental, and economic benefits to the implementation of the LTCP and serve as a model for the application of sustainability in the design, construction, and operation of infrastructure.***

Seven specific goals were developed to support the implementation of the vision statement. Three of these can be applied to infrastructure improvement projects with specific goals as follows.

- Incorporate resource efficiency (e.g., energy efficiency, reduced construction waste, reduced hazardous waste generation, recycling of concrete and asphalt) into project design, construction and operation to reduce energy and material use, reduce waste and provide economic benefit to rate-payers.
- Identify and implement opportunities for design practices that encourage innovative thinking to produce multiple benefits, such as enhance environmental protection, contribution to the control of CSO's and economic benefit to rate-payers.
- Identify and implement natural system enhancements that contribute to the control of CSO's, improve water quality and/or create valuable community enhancements.

The Green Solutions program furthers these sustainability goals by incorporating natural environmental controls that are largely passive. In addition, by capitalizing on these Green Solutions measures, the elements of the sewer separation projects may be smaller and consume less financial and environmental resources, furthering the sustainability objectives.

Objectives of the Green Solutions Program

The purpose of encouraging the consideration of Green Solutions technologies into design projects that further the objectives of the CSO Program is to embrace and implement the sustainability objectives. In addition, these serve other, more tangible benefits that support the fiduciary objectives of the Program.

Green Solutions, at their most fundamental level, are intended to replicate the hydrologic response of natural systems. That is, the rainfall/runoff response mimics that which could be expected before man's intervention. Historic rainfall was left to naturally pond and infiltrate into the ground, recharging groundwater and filtering any pollutants that may have been mobilized. Only large storms created significant surface runoff.

Replicating these runoff characteristics allows natural runoff reduction and treatment processes to be employed. The result is more stable base flows, fewer runoff producing storms, and fewer pollutants entering receiving waters. More directly applicable to the CSO Program, these kinds of measures will reduce the overall runoff and result in smaller downstream infrastructure and fewer sanitary sewer overflows. As a result, the hope is to improve downstream water quality and reduce the capital investment necessary to control overflows.

The integration of Green Solutions into the design of sewer separation projects has the potential to offer benefits to the City of Omaha. First, any measures that support the objectives of the LTCP are inherently valuable. Reducing runoff directly reduces the potential for overflows. However, the opportunity to realize a capital cost savings exists if Green Solution technologies can be incorporated into infrastructure design projects. The cost to realize the upstream runoff reductions may be offset by reductions in downstream infrastructure investments, resulting in an overall project cost savings.

While Green Solution technologies have value as a part of control projects, there is the potential to maximize their benefit by making sure the projects conform to the City's municipal separate sewer system (MS4) program requirement. Incorporating the objectives of the MS4 program and draping those over the ones identified in the LTCP will maximize the overall benefit to the City of Omaha.

Green Solutions Guidance

In an effort to reduce the number of combined sewer system overflows during rain events, the "Green Solutions Guidance Document" was developed for Consultants to identify opportunities to implement Green Solutions as a part of the LTCP. While the guidance was developed specifically for the reduction of sewer overflows, the benefits of green solutions can also be seen in reduced infrastructure size and the increased water quality of stormwater runoff.

As a part of the guidance document a process was developed for the evaluation and selection of green solutions for incorporation into the CSO projects. The process that was developed for the green solutions evaluation is shown in that document as Figure 3 and is repeated below as Figure 1 of this document.

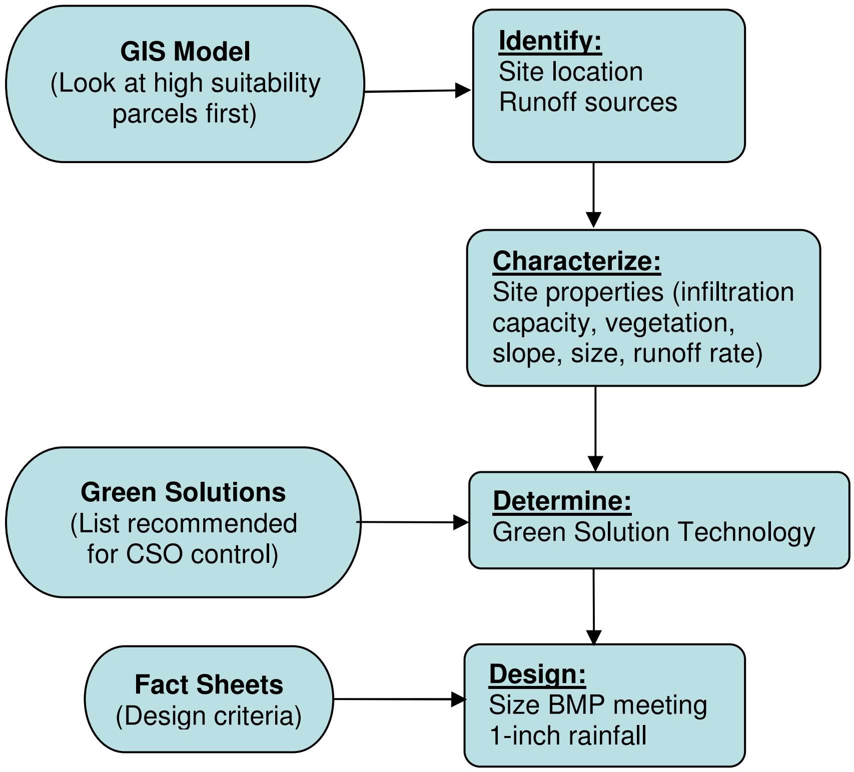


Figure 1: Green Solutions Technology Selection Methodology

The process shown in Figure 1 is a simple methodology that enables designers to identify opportunities for green solutions based on a series of criteria. This process was utilized by basin consultants to identify high potential sites for Green Solutions as a part of the LTCP. A detailed description of the selection process is included in the "Green Solutions Guidance Manual", which has been included in Appendix O of the LTCP. This same process has been expanded to develop guidance for designers of sewer separation projects to help ensure that green solutions are implemented when possible and beneficial. The expanded approach is described in detail in later sections of this document and is shown in an expanded flow chart that is attached to this document.

Multiple Best Management Practices (BMPs) were considered as a part of the LTCP effort for inclusion of Green Solutions. These BMPs are also listed in the "Green Solutions Guidance Manual" and fact sheets for the BMPs were included in that manual for reference.

Integration with Project Management Team

As previously mentioned the CSO Program Management Team (PMT) is developing sustainability guidelines for the CSO Control Program. Every effort should be made to identify and incorporate viable stormwater reduction options into the sewer separation projects. It is expected that there will be specific constraints and challenges unique to each separation project that may reduce or eliminate the ability to implement permanent BMPs to reduce stormwater runoff. In those instances it is important that the PMT are closely involved with the decision making process. The incorporation of Green Solutions is a priority and the bias should be toward incorporating Green Solutions into sewer separation projects.

The process was developed such that a good faith effort to incorporate Green Solutions is a part of every sewer separation project and is considered from the outset of the project. The process requires that the designer show that there are physical, engineering, or financial justifications for non-inclusion of Green Solutions. Although reasons may exist for non-inclusion, ultimately the City and PMT must agree that the benefits from Green Solutions do not out weigh the challenges. There are also overriding goals that encompass more than just the sewer separation projects that need to be considered, such as the City's MS4 requirements. Other goals that should be considered are those required for broader community objectives that must be determined by the City and the PMT.

It is important that the process is thoroughly documented to maintain transparency as well as to ensure that all efforts were made to incorporate Green Solutions. Documentation of the processes followed and decisions that are made with supporting evaluations must be maintained for the project to show a clear cause for non-inclusion. The documentation process should include, at a minimum, a summary report of the designer's findings and supporting documentation that resulted in the recommendation for non-inclusion, as well as the basis for the recommendations. The designer should clearly identify the benefits of incorporating Green Solutions into the project and discuss those with the PMT. Ultimately the City and PMT will need to approve any decision to include or not to include Green Solutions into a sewer separation project.

Use of LTCP Identified High Suitability Areas

The primary option for inclusion of Green Solutions into sewer separation projects are those sites that have been evaluated in the LTCP. These sites include the following:

- Adams Park – Minne Lusa Basin
- Forest Lawn – Minne Lusa Basin
- Miller Park – Minne Lusa Basin
- Bemis Park – Burt-Izard Basin
- Dewey Park – Burt-Izard Basin
- Gifford Park – Burt-Izard Basin
- Leavenworth Park – Burt-Izard Basin
- Bohemian Cemetery – Saddle Creek Basin
- Norris Middle School – Saddle Creek Basin
- Deer Hollow Park South – South Interceptor Basin
- Spring Lake Park – South Interceptor Basin
- Dorothy Patach Natural Environmental Area – Ohern/Monroe Basin
- Upland Park – Ohern/Monroe Basin
- 38th and Frances – Ohern/Monroe Basin

– Hanscom Park – Leavenworth Basin

These sites have been previously screened as providing potential benefit to the CSO program. Additional evaluation is needed to confirm their viability. If a sewer separation project occurs near one of the pre-screened sites, it is highly recommended that the project further evaluate the recommended green solution as a part of the project. Specific information for the recommended Green Solutions can be obtained from the Basin Consultant's technical memorandum through the PMT.

Green Solutions Implementation

Regardless of the conclusions reached in the LTCP assessment of Green Solutions, it is the intention of this integration process to encourage the consideration of other sites for possible inclusion into a sewer separation project. As is shown in the attached flow chart (Figure 2), assessment of possible Green Solution integration must be conducted during each project. The intent of this assessment is to determine if suitable sites exist when assessed using a more site specific evaluation process. In general terms, the assessment will follow the same basic procedure employed in the Green Solutions Guidance Document.

Local site assessment

As the process flow chart indicates, a local site assessment process is to be employed. The intent of this assessment is to employ a more site specific evaluation process in the hopes of identifying specific measures that can be employed as part of a sewer separation project. In general terms, the assessment will follow the same basic procedure employed in the Green Solutions Guidance Document.

The intent of this level of assessment is for screening purposes. That is, does a qualitative assessment suggest that there will be some substantive reduction in flow rate that will result in reduced downstream infrastructure or a reduced risk of sewer overflows? If so, then more refined investigations will be conducted to quantify the benefit and ascertain the potential economic impact. The following sections provide more explanation on how this should be done.

Refine site suitability screening from Guidance Document

The site suitability screening process developed in the Guidance Document still applies at the more site specific levels envisioned here. All of the general criteria used to determine the high suitability sites should continue to be applied. The objective is to review sites in the tributary watershed to determine if any have promise for implementation of Green Solutions.

Site location

Site location criteria will generally focus on sites that may be suitable for BMP implementation by virtue of their proximity to runoff sources, their ability to capture and control large areas or the fact that they may present attractive ownership potential.

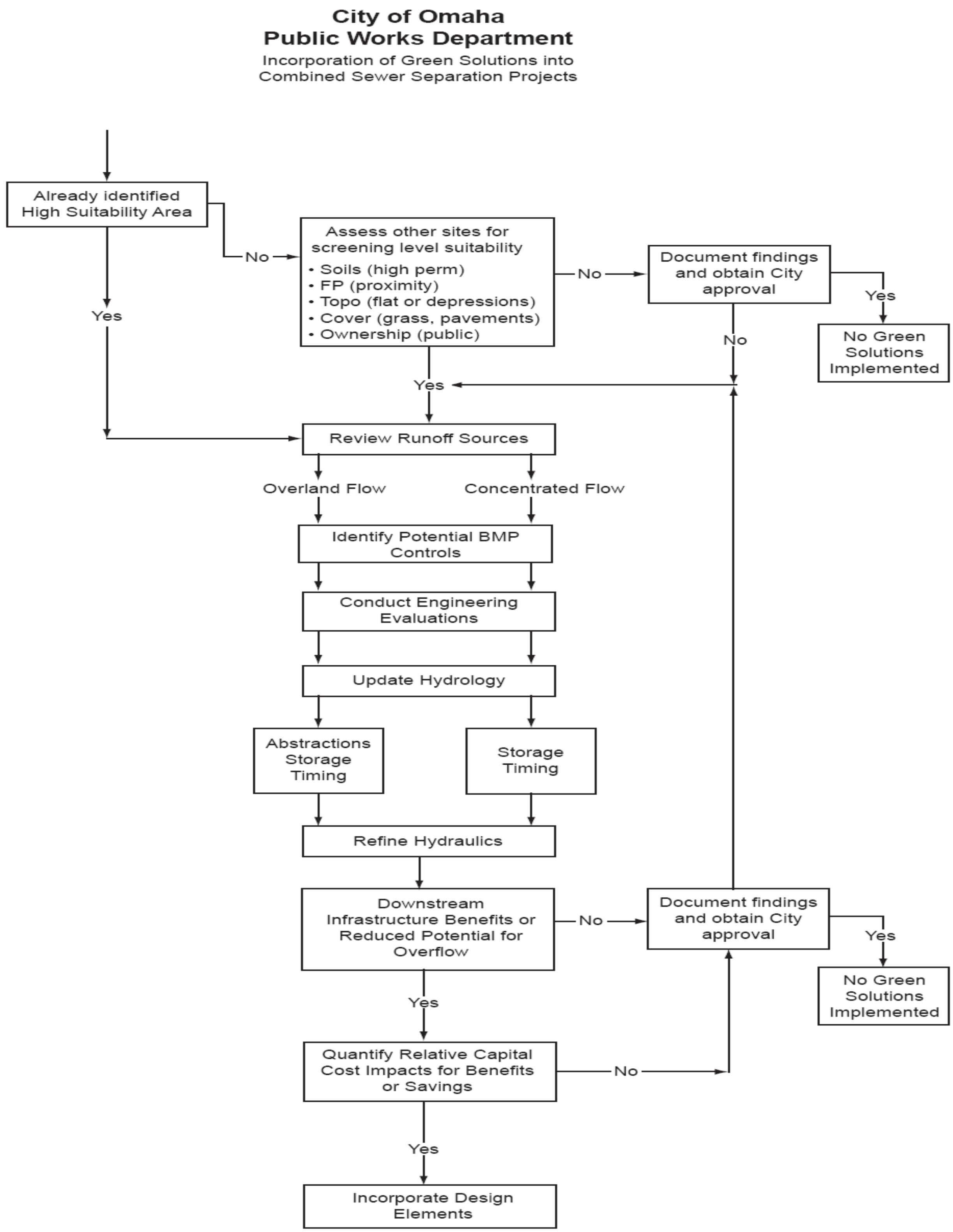


Figure 2: Green Solutions Implementation Flow Chart

The ability of a site to control a significant tributary area means that runoff reductions will result in a potential to reduce the size and extent of downstream infrastructure. Very small basins (such as single lots) may be suitable for some local controls but aren't likely to have a material runoff reduction. However, areas where a majority of the basin tributary to the infrastructure being designed can be controlled may be very suitable. These should be identified for further consideration.

The ownership of the site will have a significant influence on the site suitability. Since most of the combined sewer service area is developed, large tracts of open space or publically owned land may not exist. However, other public tracts, or quasi-public land (such as school sites) may provide opportunity for convenient implementation. When such lands are located in areas where a significant portion of the basin runoff can be controlled they are likely to warrant further investigation and should be designated for further consideration.

Topography

Sites that have historically had low runoff characteristics are worthy of investigation. These include areas that are flat or have numerous surface depressions. These areas promote infiltration and are natural controls for runoff. These sites can often be modified to enhance the natural retention and infiltration functions. As such, these are high suitability sites that should be designated for further consideration.

In addition to the ability to enhance these sites to promote the retention and infiltration functions, flat or gently sloping sites lend themselves to easy construction. It is often possible to construct infrastructure such as storage ponds or enhanced infiltration areas on these sites and reap the combined benefits of infiltration and storage. The storage can materially reduce downstream peak flows and may be useful in reducing downstream infrastructure or overflow potential.

Land Cover

Land cover presents an interesting consideration for Green Solution implementation. In general, areas of dense natural cover such as forests or very lush grasslands already perform the natural control measures very well. There is little opportunity to substantially improve the retention and infiltration characteristics of these sites and leaving them in their natural state probably represents the most highly effective land use.

However, few such sites are likely to exist in the combined sewer service area. However, other sites that have less favorable runoff conditions such as those with high levels of impervious or those with poor natural ground cover offer great promise. These can be enhanced to promote infiltration and reduce runoff. Paved areas that can be converted to more pervious surfaces provide an inherent benefit of increased infiltration and are often relatively flat and can therefore be adapted to include storage. Large tracts of poorly vegetated grasslands often have similar potential for storage, although the potential increase in infiltration, while it can be improved, may not be as dramatic as that of pavement conversion.

Soils

Areas of high permeability soils have the highest site suitability for Green Solution implementation. These sites have natural infiltration properties that allow the natural processes to be replicated most easily. If these sites have some surface cover, then application of Green Solutions will have an immediate and potentially dramatic benefit. Unfortunately, areas of high permeability soils are relatively limited within the combined sewer service area.

However, even when high permeability soils are not present, the possibility of applying Green Solutions is still possible through the use of an engineered media. These media essentially recreate some of the natural storage and infiltration characteristics of more permeable soils. These engineered media are generally porous soils and include both infiltration and have a storage reservoir. Often, a small outlet drain is provided when the native soils around the facility lack capacity to drain the media. The advantage of the engineered media is that it reduces the constraints that soil type may have on site suitability assessments.

Suitability Assessment

This site suitability assessment is intended to serve as the most preliminary screening. While these factors are important in determining the effectiveness of a Green Solutions application, lack of suitable conditions may not preclude application. However, the intention is to demonstrate the viability or to ascertain that a given site is categorically unsuited for such an application.

In most cases, the site suitability assessment will not render an absolute determination. Not all issues need to be resolved at this stage, but any issues that can not be overcome should be identified and those should serve as the basis for site rejection. In such a case, the decision to eliminate a specific suite of sites should be discussed with the PMT prior to abandoning integration efforts.

The data required to perform the site suitability analysis is readily available from the PMT in GIS format. This data include two-foot contour mapping, property ownership, soils data, aerial photography, and existing sewer location and sizes.

Review runoff sources

As was mentioned in the site suitability assessment, the amount and character of runoff has a significant impact on the application of Green Solutions. The amount is generally a function of the size of the tributary basin. In most cases, there is a direct correlation between size of watershed and flow rate. Since BMPs can only influence the water that reaches them, the size of the basin, and more particularly the fraction of the watershed that reaches the BMP, has a material impact on the potential benefit.

Size of tributary basin

The size of the tributary basin area reaching the project site must be determined. It is also important to understand the size of the entire area tributary to the project outfall location. The higher the percentage of area tributary to the project site the greater potential impact the Green Solution implementation will have. However, any tributary area will have some benefit and low percentages should not be summarily excluded.

A small tributary area suggests (lot size areas) that very localized BMPs may be appropriate. These can yield good results when the hydraulic loading is small. As such, these watersheds may still be viable but their impact on downstream infrastructure is fairly small. In most cases an economic evaluation would determine these to be infeasible. Consultation with the PMT may show that there are overriding considerations that suggest these sites remain under consideration.

Large watersheds that capture only a small fraction of the tributary area of the ultimate outfall have the potential to yield great benefit, but perhaps only in the area of the BMP. Facilities that control fairly large areas can be effective at reducing the discharge and improving water quality. However, when discharging into a system draining an equal sized basin, the benefits may not be seen due to hydrologic effects. In this case, a more refined evaluation should be undertaken that will ascertain the benefits to the broader system. In cases where the tributary incorporating the project location is a very small percentage, the downstream system may overwhelm any potential benefits. In these cases the further evaluation may not be necessary.

For larger watersheds where the facility might control a substantial part of the tributary basin, the potential benefits of the Green Solution implementation may be considerable. In these cases, a reduction in discharge into the system will have direct benefits on the downstream infrastructure requirements. These are the most viable of options and should be considered for further evaluation.

Determine character of runoff to project area

After having assessed the relative tributary area, the way flow reaches the site has the next greatest impact on the viability of implementation. The intent is to understand this character and to implement BMPs that are best suited to meet the specific conditions of the site. The character of runoff effects the selection, sizing and effectiveness of a specific Green Solution BMP. Care must be taken to carefully consider the nature of runoff in order for any BMPs to be effectively integrated into a specific design project. This characterization should determine if flow is concentrated or overland.

Overland flow is distributed across a broad area and is shallow and well distributed and generally found higher in the watershed. The headwaters of most natural watersheds, and some developed watersheds, display these characteristics. Concentrated flows are just that, flow that has collected and is more confined. In the case of natural systems, this is often where gully or rill erosion occurs or when a natural channel is evident. In more developed systems this may be where collection channels or swales have been constructed to divert water from its natural flow path.

The description of flow characteristics that follows is intended to help the designer define the flow character and to provide qualitative guidelines that can be used to assess viability. If flow conditions and the other factors of tributary size and local site conditions permit, then Green Solutions BMPs should continue to be a part of overall project planning.

Overland Flow

Overland flow is sometimes characterized as shallow distributed flow. This is common in large undeveloped areas or across large, smooth paved areas. In some cases, other developed sites without any drainage collection system (parks or large open space areas) may also exhibit such characteristics.

The integration of Green Solutions in these areas needs to be carefully considered. Flow rates are likely to be low because these conditions are frequently high in the watershed. These lower flow rates help with the hydraulic loading but also make the effectiveness of measures somewhat lower. It may be necessary to identify and incorporate a collection system into the assessment to be able to fully leverage the use of some particular BMP measures. In cases where a collection system is infeasible or undesirable, a distributed system of BMPs may be necessary. Again, these can be very effective but their evaluation is complicated.

In general, distributed or overland flow lends itself to smaller localized applications of BMPs. This is certainly consistent with the overall intent of the Green Solutions and should be considered a positive. If the area that can be controlled is a significant portion of the watershed, then these should almost always be retained for further consideration. If there is a smaller percentage of control from the local watershed, it may be advisable to consider eliminating this area from a more detailed analysis as the resulting control is likely to be minimal.

Concentrated Flow

Concentrated flow differs from overland flow in that the flow is generally in some sort of conveyance system. These are most commonly areas of more intense development where there are improved drainage collection and conveyance systems. It is not uncommon for these to be larger basins with defined drainageways.

Control of flows from areas of concentrated flow using Green Solutions approaches can be very effective. Larger systems have better established design parameters and have proven to be more consistently effective. Often, it is because these systems are publically owned and maintained and adequate monitoring is in place to measure effectiveness. As are results, the operational performance has been well documented. In some cases, these are also more cost effective because there are economies of scale that help to maximize the return on the capital investment.

While these are effective, integration options may be more limited. Most of these larger installations rely on storage as a primary management technique and therefore demand significant space. This limits the number of available sites. The large scale of many of these facilities also means that controls are being implemented farther from the source. The hydraulic loading often impacts the potential effectiveness in both control of runoff quantity and the reduction of pollutants in the flow.

These constraints notwithstanding, the use of Green Solutions controls for concentrated flow can be very effective and should be considered wherever site availability exists. The ability to control large portions of the watershed and to reduce flow rates considerably mean there is a high probability that there will be a tangible return on the capital investment.

Local On-site flows

Local on-site flow is perhaps the most easily controlled source but one that has limited potential for Green Solutions application. These controls must be implemented on a very localized basis and demand the coordination between many different property owners. As a result, it is difficult to get a consistent adoption of the control measures and therefore there is little chance that effective long term benefits will accrue.

In spite of these limitations, the fact that these measures are highly visible and well known to the public provides a great opportunity to demonstrate the City's commitment to Green Solutions. The sense of broad participation has great value and may represent a tangible outcome from the effort. Nevertheless, it is difficult to envision a scenario where there is sufficient participation to have an economic impact on any infrastructure improvement project. As such, these should be encouraged but not necessarily expect to fund them through any of the Control Measures.

Identify Potential BMP Controls

Once potential sites have been screened and the character of runoff has been determined, it is possible to begin to evaluate potential BMP control measures. These measures are presented in some detail in the Green Solutions Guidance document as well as other manuals available from the City.   A list of recommended documents is provided below.

Omaha Regional Stormwater Design Manual,
http://www.cityofomaha.org/pw/images/stories/pdfs/Stormwatermanual.pdf

City of Omaha Post Construction Stormwater Management Planning Guidance
http://www.omahastormwater.org/images/stories/Development/PCSMP%20Guidance%20Document%20FINAL%207-23-09.pdf

Manual of Best Management Practices For Stormwater Quality
http://www.marc.org/Environment/Water/bmps.htm

Urban Storm Drainage Criteria Manual – Volume 3
http://www.udfcd.org/downloads/down_critmanual_volIII.htm

The site and character of the runoff both impact the viability of a particular BMP. Each combination must be explored in some detail to determine appropriate BMPs using the guidance provided. The intent would be to identify the full suite of available and viable options and to screen them to look at only a few of the most attractive controls. The criteria would vary by project and site but may be strictly hydraulic or hydrologic benefit or may be as varied as ability to integrate into the surrounding community.

Here, some discussion with the PMT is necessary to assure that viable options are not prematurely discarded and that options that may be infeasible for reasons other than technical are excluded. A short summary of the initial screening process is valuable to communicate the basis for any recommendations. The following sections provide some suggested control measures that might be employed for various flow types. These measures are not intended to be an exhaustive listing of possible options; rather they reflect some of the more common categories of controls. There are numerous variations and details within each category that should be explored in more detail if the overall approach appears viable.

Control of Overland Flows

Overland flow controls will generally be distributed across portions of the watershed to effectively capture the distributed flows. As a result, they are likely to more effectively control small local areas and handle smaller watershed. While the absolute impact of each installation may be limited, they have a smaller footprint and have proven to be very effective at replicating the drainage and infiltration characteristics that existed prior to development. As such, when multiple applications are used within a watershed they may produce results that are similar to larger, more regional facilities.

Many of these control measures rely on infiltration as their primary control measure. The distributed nature of the flow allows the runoff to come into contact with large areas of ground and promotes the infiltration of excess precipitation. The broad area of contact also slows flows and changes the timing of runoff, again more closely reflecting conditions prior to any development. The mechanism for control is to capture rainfall at the source and promote its infiltration into the groundwater. This is very similar to rain falling on the natural watershed.

A secondary mechanism for these control measures is detention. This is generally limited to larger applications where flow may still be overland but a larger tributary area contributes. In most cases, the detention function is secondary to the infiltration and often is of limited capacity. These types of facilities are very useful for low depth, frequent rainfall events but may only have limited impact on large, flood producing events.

Typical types of applications can be found in Table 3 of the Guidance Document. This provides a good summary of the available options and how they work. Also, Attachment 4 provides implementation information that can be used to supplement the summary provided in Table 3. Some typical measures that are relatively effective for overland flow applications include the following:

(1) Pervious Pavement

  (a) Infiltration of runoff

  (b) Return flow to groundwater

  (c) Provides reduced runoff and captures runoff pollutants

(2) Infiltration Basin/Trench

  (a) Both storage and infiltration of runoff

  (b) Reduces and stores pollutants

(3) Wetlands

  (a) Provides storage of runoff

    (i) Some nominal infiltration losses

(b) Promotes uptake of pollutants in addition to pollutant storage

(4) Filter Strips

(a) Provides filtration

(i) Some nominal infiltration losses

(b) Little reduction in flow but potential uptake or settlement of pollutants

(5) Disconnected Imperviousness and other Low Impact Development (LID) measures

(a) Promotes infiltration

(b) Promotes reduction in pollutants

(c) Can be used in combination with other measures

Control of Concentrated Flows

Concentrated flow controls will generally be used downstream in a watershed and have the benefit of providing more system wide controls. They are frequently used in larger watersheds where flow has concentrated and is easily collected. In some cases, these control measures may be linear in nature, reflecting the nature of the flow conveyance systems delivering the flow. It is not uncommon for these measures to be fairly large with a footprint that demands consideration of right of way needs.

Many of these control measures rely on storage as their primary control. They are able to capture the full flow across much of the hydrograph and reduce the volume of discharge by storing excess runoff. These facilities tend to mimic nature somewhat by representing the impact that shallow groundwater may have had on natural basin response. Flow is slowly metered back into the system when downstream capacity is available. These systems must be sensitive to the downstream conveyance system capacity so as not to exacerbate existing flooding issues. In some cases, it is possible to avert capacity issues by releasing to groundwater but often natural infiltration capacities limit the viability of this option.

A secondary mechanism for these control measures is infiltration. This is generally limited to larger applications where flow may be stored for some time. Infiltration will reduce the total volume of water that needs to be released to a surface outfall system. In some rare cases, it is possible to completely eliminate a surface outfall. When infiltration is the primary outfall, significant improvements to surface water quality will be seen. Pollutants are retained in the soil mass and prevented from entering the downstream drainageway. It is not common for these discharges to groundwater to materially impact groundwater quality but it may be advisable to consider such potential impacts.

Typical types of applications can be found in Table 3 of the Guidance Document. This provides a good summary of the available options and how they work. Also, Attachment 4 provides implementation information that can be used to supplement the summary provided in Table 3. Some typical measures that are relatively effective for concentrated flow applications include the following:

(1) Infiltration Basin/Trench

    (a) Both storage and infiltration of runoff
    (b) Reduces and stores pollutants
(2) Wetlands
    (a) Provides storage of runoff
        (i) Some nominal infiltration losses
    (b) Promotes uptake of pollutants in addition to pollutant storage
(3) Wet or Dry Detention Basins
    (a) storage of runoff
    (b) Return outflow to surface streams
        (i) Some potential infiltration to groundwater
    (c) Provides reduced runoff and captures runoff pollutants
(4) Swales
    (a) Provides filtration
        (i) Some nominal infiltration losses
    (b) Little reduction in flow but potential uptake or settlement of pollutants
    (c) Extends time of concentration reducing peak runoff
(5) Catch Basin Modifications
    (a) Promotes infiltration
        (i) Promotes reduction in pollutants
    (b) Highly suitable to linear projects
        (i) Can be used in combination with other measures

Technical Analysis

Determining the benefits of Green Solutions technologies builds on the basic evaluations performed on the project. The intent is to quantify the hydrologic and hydraulic impacts of implementation. Reductions in flow rate or in the necessary hydraulic capacity may result in reduced costs or some of the other benefits already described.

The following sections present the various impacts of Green Solutions and provide direction on how these impacts can be quantified. In most cases, the hydrologic and hydraulic evaluations are similar to those used in the baseline hydrology and hydraulics. Different parameters will be used to represent the various technologies.

General guidelines

The analysis is not intended to fully resolve details that will be necessary for final design. Rather, this evaluation is intended to determine if Green Solution technologies offer an opportunity to reduce the size and extent of the anticipated sewer separation infrastructure. The level of detail should be sufficient for that decision. Further detail will be required as part of final design.

The approaches presented are intended to offer some suggestions on how to address the nuances of computation associated with the benefits of Green Solutions. They build on the information provided in the *Omaha Regional Stormwater Design Manual* (Manual). It is the intention of the following sections to be compliant with the requirements of the Manual. The sewer separation designers will continue to be responsible for the compliance with the Manual and all other development and regulatory requirements.

The approaches are not intended to be prescriptive. That is, they are suggestions and are not intended to usurp the ingenuity or creativity of the designer. Other approaches to represent the benefits of the Green Solutions technologies should be explored if the designers feel that they better represent the performance of particular facilities. Regardless of the approach used, the designers should be prepared to offer evidence and computations that demonstrate that the impacts of Green Solutions have been quantified and appropriately considered. The documentation should be presented to the PMT in a format consistent with the requirements articulated herein and in accordance with the contractual obligations of the design contract.

Hydrologic Evaluation

Hydrologic computations need to be modified to reflect the BMP's function. Green Solutions BMPs generally function in one of three ways:

- Runoff reduction
- Storage
- Basin response

Graphically, these three response mechanisms affect hydrographs similar to the examples provided in Figure 3.

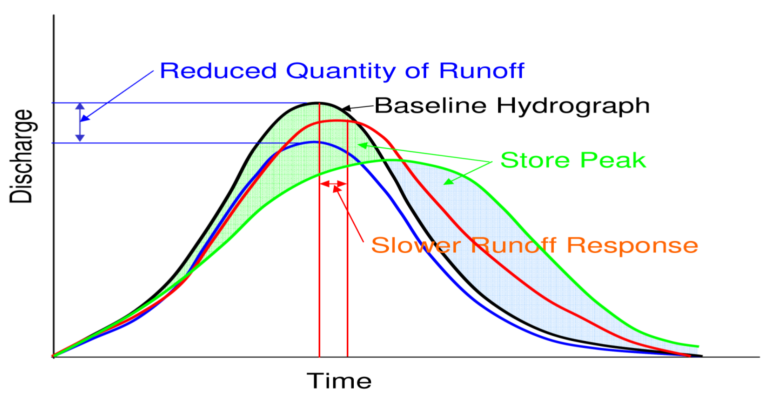


Figure 3: Green Solutions Technology Selection Methodology

Runoff reduction is just that, the amount of runoff, both peak and total volume, is reduced. When storage is used, the total amount of runoff isn't changed, but the peaks are reduced by detaining a portion of the peak flow and releasing it at a later time. Changing the response time of the watershed attenuates the peak flow, often changing the shape of the hydrograph and reducing the resulting peak. Regardless of which measures are employed, the resulting peak flows are likely to be lower with the appropriate implementation of Green Solutions Controls.

Runoff reduction

Runoff reduction can be achieved through Green Solution technologies that either reduce the amount of impervious area or increase the overall infiltration of rainfall. Infiltration rates for various pervious surfaces are generally not used directly in computations referenced in the *Omaha Regional Stormwater Design Manual* (Manual). Rather, they are represented through the use of a runoff coefficient (C) or a Curve Number (CN).

When impervious areas are reduced, the representation is simply an adjustment of the impervious area. Adjustments should be made to reflect the new total impervious area or a new weighted percent impervious. In most cases, no further adjustment is necessary as the total benefit of the reduced area will be clearly determined using the conventional runoff computations based on the adjusted area.

Runoff coefficients (C or CN) are used to represent the overall character of the watershed when using the Rational Method. These coefficients reflect a number of variables that impact runoff including infiltration rates, interception, evapotranspiration, etc. Creating a weighted runoff coefficient for either the Rational Method or the SCS methodology allows the representation of various Green Solution measures that reduce the level of imperviousness. Runoff coefficients for various pervious surfaces for use in the Rational Method can be found in Tables 2-3 and 2-4 of the Manual. Coefficients for the SCS methodology can be found in Tables 2-8, 2-9, 2-10 and 2-11 of the Manual.

In some cases, impervious areas are replaced with permeable surfaces that may not have the same infiltration characteristics as native impervious areas in the basin. Such a case might be when using pervious pavements. In this case, it may be necessary to develop a composite representation for the revised infiltration. This uses a weighted average value to represent the entire basin. When conditions are appropriate, adjustments using the procedures presented in Appendix 2-B of the Manual should be considered.

When possible, conducing the analysis by segregating areas with different infiltration characteristics is desirable. If areas can be segregated, then separate estimates for each type of pervious area can be developed and aggregated into a single runoff estimate. The reduction of runoff from those areas that have been converted from impervious to pervious can be seen very clearly.

Disconnected imperviousness, while not necessarily reducing the level of imperviousness, does increase infiltration and has the same beneficial effect of reducing overall runoff. In the places where this technology is proposed, the benefits can be simulated by increasing the relative area of pervious land. Care needs to be taken that the overall mass balance of rainfall is maintained and that infiltration capacity of the receiving pervious area is not exceeded. The preferred approach for representing these conditions is to use the SCS methodology with the CN modifications presented in Appendix 2-B of the Manual.

The SCS methodology as recommended by the Manual uses an implicit representation for the initial abstraction. In some cases the best way to represent Green Solution technologies might be to merely increase the initial abstraction. This may be the case where infiltration basins or other measures are employed that capture runoff and prevent it from being released downstream rather than merely storing it for future release. In these cases, the amount of water captured can be taken out of the system without regard to infiltration capacity. The most accurate representation would be to either entirely remove the area tributary to these facilities from the overall basin area or to adjust the initial abstraction for those areas to reflect the overall capacity of the infiltration system. This may be possible if the SCS model represents these initial abstractions directly. If not, it is probably preferable that the area or the runoff coefficient be adjusted to reflect the benefit.

Storage

Storage provides the opportunity to retain runoff from the basin and release it at lower rates later after the peak flood flows have passed. In so doing, the overall size of the downstream infrastructure can be reduced without reducing the overall volume of runoff. This type of approach can be used to represent many different types of Green Solutions technologies, including wet or dry detention ponds. The Manual presents two primary ways to compute the benefits of storage: one for preliminary sizing of basins and the other for a more rigorous approach.

The simplified method is presented in Section 6.8 of the Manual and presented as Figure 6-9a. In summary, this method allows the designer to estimate the required storage volume to match a desired peak outflow or to estimate the peak discharge for a facility of given volume when the total runoff volume and the peak inflow are known. While only useful for preliminary sizing computations, this level of resolution is certainly appropriate for the early evaluations of the viability of Green Solutions on a separation project.

The more rigorous approach requires the routing of an inflow design flood through an assumed storage facility. In this case, more care needs to be taken to lay out feasible facilities and to determine the geometry of the storage reservoir and the character of the outlet structure. With that information, stage-storage-discharge relationships can be determined for the purpose of routing the inflow flood through the facility and the outflow hydrograph computed. Section 6 of the Manual presents this evaluation approach.

Response lag

Many Green Solutions technologies change the character of runoff by changing the timing of the basin response. These types of measures include grass swales, wetland channels and other conveyance features. These measures slow the collection of the runoff at the design point and have the effect of reducing the overall peak flow from the basin. Volumes are generally not impacted, other than incidental storage or infiltration, and no adjustment for runoff volume is made. However, peak flows are reduced due to the routing effects of the conveyance system. The longer response time tends to lower unit hydrograph peaks in the SCS method and reduces the rainfall intensity of the Rational Method.

When using the rational method, the basin time of concentration is computed using the guidelines presented in Appendix 2-A of the Manual. Adjustments to reflect the lag from Green Solutions technologies on the sheet flow areas of a watershed can be made by using a revised roughness coefficient as presented in Table 2-A-1. When represented changes to the shallow concentrated flow, the methods of Appendix 2-A, Sections 2.A.5 and 2.A.6 can be used or the curve presented in Figure 2-1 can be used to represent changes in conveyance characteristics. The effect of these revisions will be to have a longer time of concentration and subsequently lower rainfall intensity.

When using the SCS methodology, the methodology presented in Appendix 2-A of the Manual is to be used. However, modifications to the lag time used in the SCS methodology to reflect different materials or alignments need to be made. In some cases, it may be possible to use the approach presented in Figures 2-5 and 2-6 of the Manual but to apply them in a way that counteracts the effects of urbanization. That is, a process that applies these factors to lengthen lag rather than shorten it should be used.

Hydraulic Evaluation

Hydraulic evaluations should be conducted to determine if the implementation of Green Solutions results in any infrastructure benefits. The purpose at this level of evaluation is to better understand if the hydrologic benefits result in any material benefit to the size of the necessary infrastructure. Final design will include a more detailed evaluation and sizing of facilities.

Because of the preliminary level of these computations, it is appropriate to conduct relatively simplified evaluations. Hydraulic sizing using normal depth computations are reasonable and will allow a comparison of various alternatives. Localized impacts such as backwater effects should also be ignored at this level. The Manual presents guidance for the sizing of drainage systems, culverts and open channels. These various approaches recommended should be employed.

The intent of the evaluation is to determine the infrastructure sizes and determine if any reductions from the original layout are possible through the use of Green Solutions technologies. If so, these will serve as the basis for determining the potential financial benefit associated with the implementation of the measures.

Regardless of the outcome of the Green Solutions implementation analysis, a more detailed design of the infrastructure elements will be required at which time rigorous hydraulic computations will be developed to support the design.

Economic Analysis

Based on the hydrologic and hydraulic evaluation performed, an economic analysis can be performed to quantify the economic benefit or loss related to the implementation of Green Solutions in a sewer separation project. The purpose of this analysis is to provide a comparison of the capital and life cycle cost for the planned sewer separation project with and without Green Solutions. This comparison will assist the design team and PMT in determining if the cost relative to the benefit leads to incorporation of Green Solutions on a sewer separation project.

Within the economic analysis the designer should consider material cost, labor cost, project contingencies, and life cycle costs. The material and labor cost estimate is information that the designer should provide based on regional bid tabulations for past projects. This information should include a furnished in place cost for all the construction items in the project. The economic analysis should also consider if property acquisition is required for the project. If an entire property is to be purchased for a project, the current assessed land value for the property should be used for the analysis. The property value is readily available from the County Assessor. In the case where an easement is to be acquired a cost of $2 per square foot should be utilized. For the purposes of this assessment it is assumed that the easement would be purchased. There may be circumstances where a property owner would grant an easement on their property for no fee, however, at this level of analysis this would not be known.

The analysis should be consistent in assigning contingencies to the project costs with and without Green Solutions. Contingencies that should be included in the economic analysis are included in Table 1 below.

TABLE 1
Economic Analysis Contingencies

Description	Percent of Construction Cost
Program Management	2%
Administrative & Legal Fees	5%
Field Engineering and Inspection	5%
Project Contingency	10%

As a part of this analysis it is important to consider the life cycle cost for the elements planned in the design. To be consistent with other programs within the LTCP an interest rate of 6% should be assumed for a period of 50-years. The life cycle analysis should be applied to maintenance costs for the proposed Green Solutions. The maintenance cost for the sanitary sewer and storm sewer pipe should be same, and for the purposes of this analysis, a value of $1.24 per linear foot of pipe per year. Utilizing the 50 year life cycle and 6% interest rate the total life cycle cost can by determined by multiplying the annual maintenance cost by 15.7619. For various types of Green Solutions, Table 2 provides planning level maintenance costs for use in the economic analysis.

TABLE 2 Green Solutions Maintenance Costs		
Green Solution	**Annual Maintenance Cost**	**Unit**
Bioretention/Rain Garden	$200	Square Foot
Infiltration Basin	$100	Acre-Foot
Infiltration Trench	$2	Linear Foot
Wet Detention	$100	Acre-Foot
Wetland	$200	Square Foot
Dry Detention	$100	Acre-Foot
Vegetated Swale	$2	Linear Foot
Filter Strips	$2	Linear Foot

As more green solutions are implemented, additional cost data is being developed. Locally, the City of Omaha has approved a number of green solutions that have been installed by developers. The EPA has developed a web site http://www.epa.gov/nps/lid/ that contains references to multiple documents and resources that can be utilized to help determine costs for green solutions.

Documentation

The incorporation of Green Solutions into the Long Term Control Plan is important for environmental stewardship as well as to meet commitments to the EPA and the public. Therefore it is important to provide documentation to summarize findings of the Green Solutions implementation process.

The documentation process will culminate in a Technical Memorandum to the PMT that should include the following sections.

1. Project Description
   a. Discussion of project area
   b. Discussion of potential infrastructure benefits by incorporating green solutions
2. Screening of Green Solutions
   a. Project constraints
   b. Project opportunities
3. Engineering Analysis

a. Green Solutions evaluated
b. Hydrologic analysis
c. Hydraulic analysis

4. Green Solution Impacts
    a. Reductions of infrastructure
    b. Water quality benefits
5. Economic Analysis
    a. Capital cost comparison
    b. Life cycle cost comparison

If during the evaluation process of implementing Green Solutions into a sewer separation project it is determined that one or more Green Solutions are not recommended for implementation; the design engineer needs to present the reasoning why a Green Solution is not recommended to the PMT for discussion and a decision from the PMT on whether or not a Green Solution should be implemented.

Appendix C
Green Infrastructure Conceptual Design Project
TM Executive Summary

1.0 Executive Summary

The City of Omaha developed and submitted for approval a Combined Sewer Overflow Long Term Control Plan (CSO LTCP) in 2009. The plan was approved by the State of Nebraska Department of Environmental Quality (NDEQ), and the City has been implementing projects included in the plan over the past 5 years. The original LTCP included both "green and grey" solutions, where the green solutions were focused on "potential cost effective green solutions that could be incorporated into sewer separation projects". The Green Infrastructure evaluation described in this report was a continuation and expansion of that work. The effort looked at Green Infrastructure, not only in the context of sewer separation projects, but also where sewer separation is not proposed. The term "Green Infrastructure", as applied in the City of Omaha, is an approach to stormwater management that attenuates both the volume of flow and the peak rate of flow. Often the implemented projects include vegetation as part of the approach, hence the "green" terminology.

The 2009 CSO LTCP indicated that, "The City, as part of the implementation of the LTCP, will develop a Green Solutions Program." This current effort is therefore a component of the City's adaptive management strategy, which provides the City with the opportunity to consider "the latest technologies, the performance of the controls as they are implemented, and the health of the watersheds" in refining the definition of projects that are part of the LTCP. The conclusions of the evaluation are intended to inform the 2014 CSO LTCP Update, which is currently under development.

The current Green Infrastructure evaluation considered a broad suite of possibilities and identified:

- a wide range of approaches and opportunities where the implementation of green infrastructure could be used to reduce stormwater runoff into the combined sewer system; and
- specific projects that could be included in the 2014 LTCP Update and could be implemented in the following five year cycle of LTCP implementation.

The Green Infrastructure evaluation proposes the following elements to be incorporated into the City's Green Infrastructure Program:

- The development and implementation of pilot projects to be completed in the near team, with monitoring systems installed to assess performance. These projects would not only reduce CSO discharges, but would also help to determine the potential benefit of Green Infrastructure in the City's LTCP.
- A series of "Programmatic Opportunities" that could be implemented in order to further reduce the volume and rate of stormwater into the combined system. These opportunities would be jointly implemented with other City departments or would be carried out on parcels that are not owned by the City.

Pilot Projects

The current evaluation identified locations and developed conceptual designs for a series of green infrastructure projects. As a prerequisite, it was determined that the selected projects must be ones which the City has the capacity to implement and do not hinge on the cooperation of private property owners. This is because a commitment to these projects will be made to the NDEQ. Through implementation and monitoring of these projects, a better understanding of the CSO performance benefits and the costs of both construction and maintenance will be accomplished.

The selected projects maximize the prior investment made by the City in localized sewer separation by using the existing storm sewers to convey runoff to the proposed regional stormwater practices. All projects are located in City parks. In general, the stormwater practices provide detention and infiltration opportunities for stormwater. Subsurface storage/infiltration galleries are the predominant technology that is used in the projects. This type of storage maintains the surface of the park for recreational activities. Other practices used include bioretention and bioswales.

The candidate projects, costs, and their benefits are summarized in Table 1-1. Locations are shown in Figure 1-2. Actual projects selected for implementation will be determined based on confirmation of site feasibility and budgetary constraints.

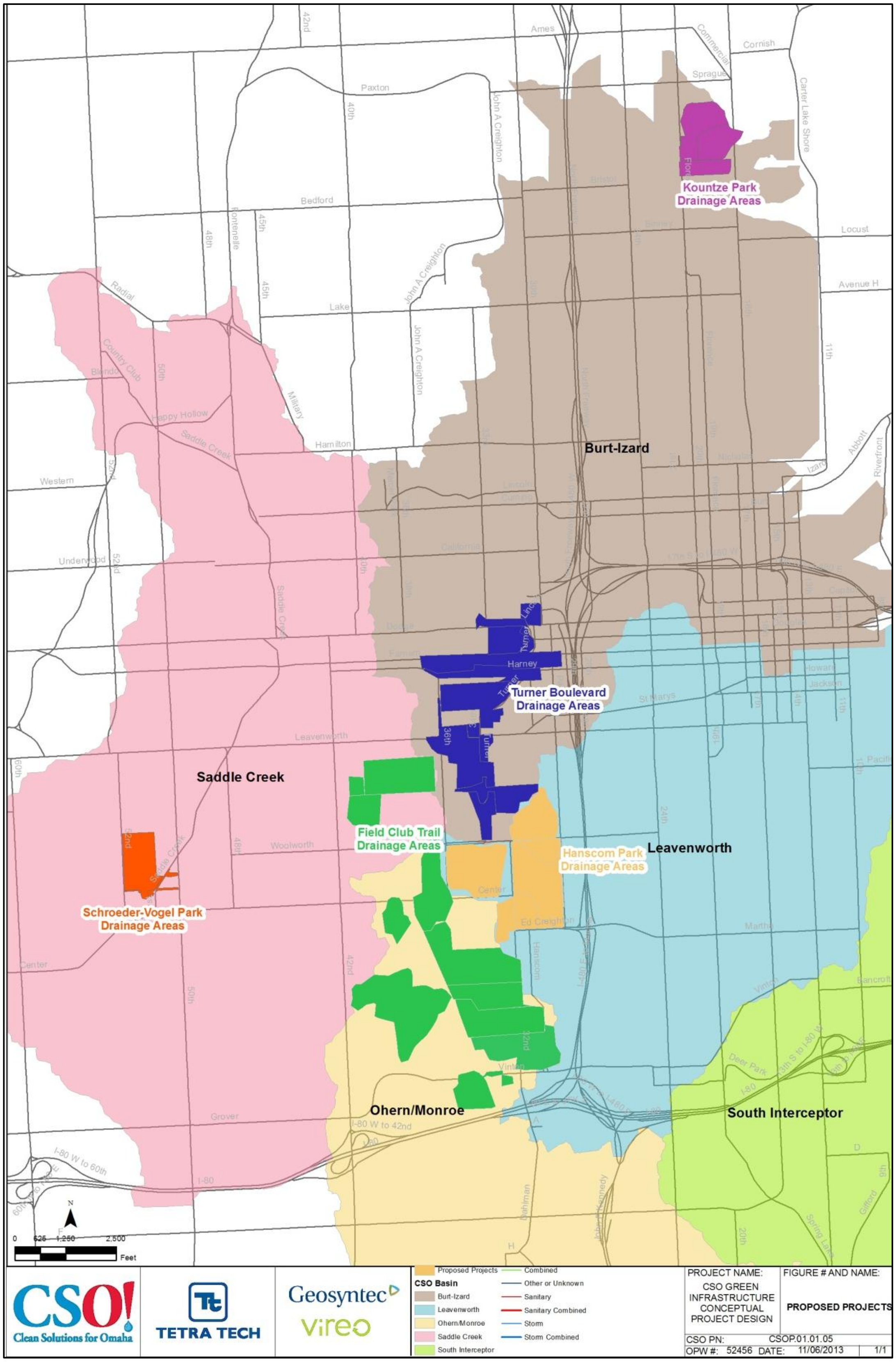
Table 1-1 Proposed Projects and Benefits

Project Location	**CSO Basin**	**Acres of Stormwater Managed**	**Estimated Annual CSO Avoided (MG)[1] (%)**	**Construction Cost**	**Cost/ CSO gallon avoided[2]**
Field Club Trail	118 - Ohern Monroe	167	-26.6 (-25.3%)	$5,427,000	$0.20
Hanscom Park	109/121 - Leavenworth	133	-17.6 (-4.6%)	$3,076,000	$0.17
Kountze Park	107 - Burt Izard	54	-6.5 (-5.3%)	$1,297,000	$0.20
Schroeder-Vogel Park	205 - Saddle Creek	30	-4.2 (-0.6%)	$1,465,000	$0.35
Turner Boulevard	108- Burt Izard	175	-38.2 (-12%)	$8,395,000	$0.22
Total		**559**	**-93.1 (-5.8%)**	**$19,660,000**	**$0.21**

[1]Annual CSO avoided is the total gallons of CSO that would be reduced through the implementation of the green infrastructure project as modeled.

[2] This value is the CSO gallon managed represents the construction cost divided by the gallons of CSO avoided in the Representative Year.

Figure 1-1 Proposed Projects



Programmatic Opportunities

Green infrastructure as applied in CSO control programs is intended to help manage stormwater before it enters the combined sewer system. In order to maximize the application of green infrastructure as well as the associated benefits, a variety of approaches can be developed to control stormwater from different sources. These approaches work from the philosophy of controlling stormwater near its point of origin, whether that is a private property, a City street or Nebraska Department of Roads (NDOR) rights-of-way. They require the development of various City policies and processes that address each of the various property types. They also require coordination with the property owners/ agencies involved to identify goals and objectives and to craft mutually beneficial projects. In implementing these approaches, communities across the country have found that much of the desired stormwater management efforts can be incorporated into the normal course of projects, defraying the majority of the implementation expense.

This current evaluation identified multiple locations where a variety of stormwater management techniques could be used to support the CSO control program. The green infrastructure evaluation identified over 50 specific opportunities, which could impact over 3,500 acres of runoff into the combined sewer system. These opportunities were considered from a technical feasibility perspective, more work would be required to assess true implementation feasibility and the impact versus the cost of the opportunity. The types of opportunities identified included parcel flow management associated with larger institutions, incorporating stormwater management into City green streets, and controlling runoff from limited access roadways owned by NDOR.

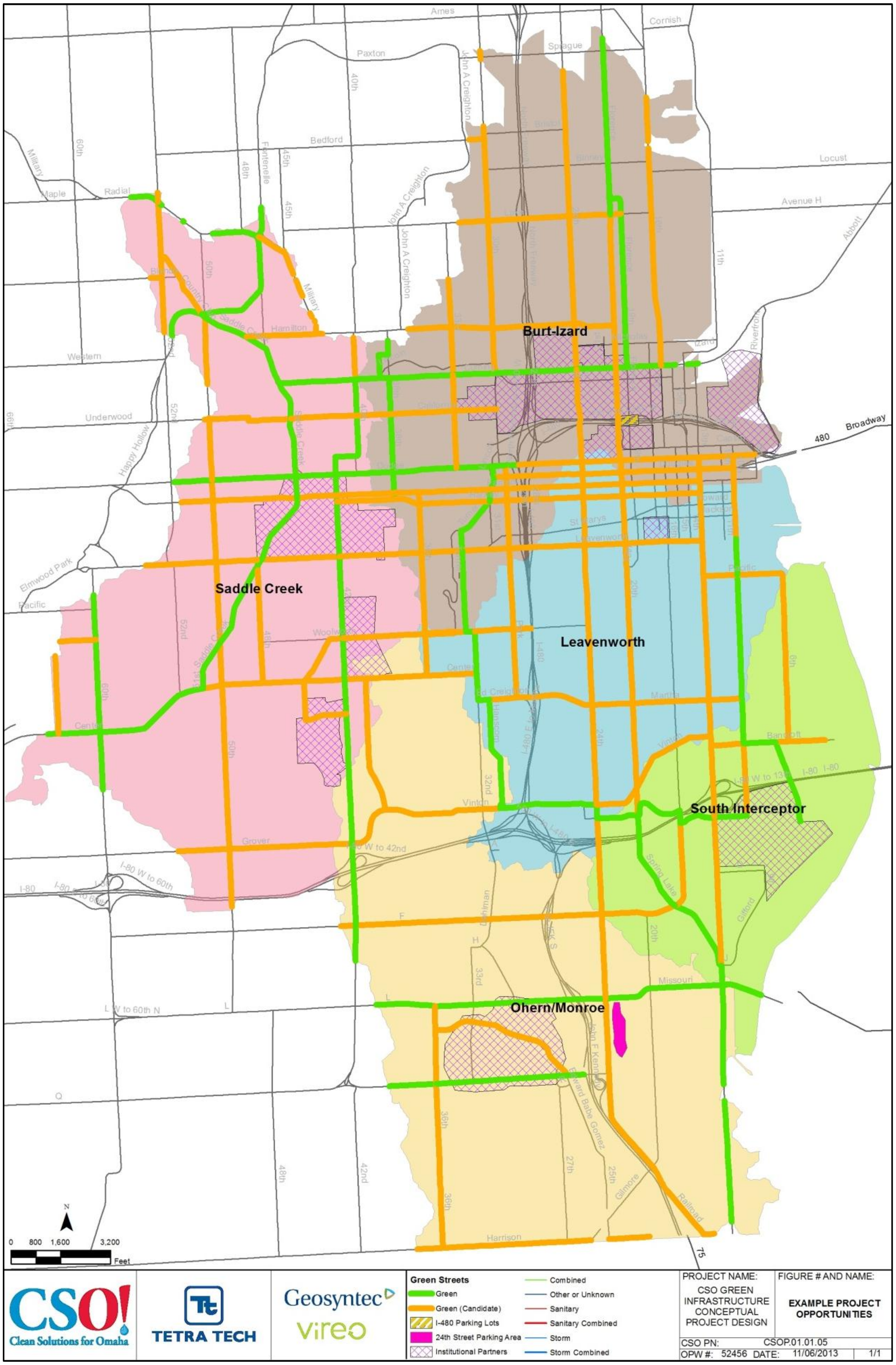
As a result of the institutional and policy complexities of these project types, they were not included in the short list of pilot projects. Nevertheless, it is a recommendation of this report that these project types continue to be explored, prioritized and tested at a trial scale by the City. This will help define the institutional structures, and processes necessary to support them and aid in the evaluation of the associated costs and benefits. At a minimum, the City should actively engage in infrastructure and development projects) in their formative stages so that beneficial stormwater management measures can be explored early in project development. A list of example projects of this type is presented in Table 1-2. Potential locations impacted are reflected on Figure 1-2.

Table 1-2 Examples of Project Opportunities for Omaha

Project Type	Where Applicable	Potential Acres Impacted	Examples of Potential Projects
City Road Projects, Particularly Designated "Green Streets"	Street reconstruction projects or locations where sewer work results in full width restoration	250 (Green) 500 (Green Candidate)	Missouri Street, 41st Street, Deer Park Street, Cuming Street, Saddle Creek
Institutional Partner Projects	Most applicable with major institutions who are expanding, redeveloping or upgrading their sites	Approximately 1,200 acres were identified related to a variety of major institutions	Creighton University, UNMC, Henry Doorly Zoo, Douglas County, Omaha Public Schools
Redevelopment projects	Redevelopment in combined sewer areas	Dependent on development	
NDOR Drainage	Locations where NDOR drainage enters the combined sewer system	450	I-480 Parking Lots
Streetscape or	Streetscape locations; other	Dependent on locations	24th Street Parking Area

beautification projects	community enhancement	where other work is occurring	

Figure 1-2 Example Project Opportunities for Omaha



Next Steps

The City has initiated a Green Infrastructure Program of which the current evaluation is a critical component. The City should both implement these green infrastructure projects and pursue other programmatic elements that will enable additional implementation of green infrastructure and stormwater management. Next steps should include the following efforts.

1. Pilot projects: Implement selected projects for which conceptual designs are provided in this report. Phasing of implementation should be such that performance evaluations can be completed prior to the next LTCP Update. This will allow for the findings to inform the adaptive management component of that effort. In order to accommodate this schedule, the projects need to move ahead expeditiously. In general, the following durations are expected:
    a. Site investigations and design: Approximately 1 year
    b. Construction: 1 year. In order to minimize impact on the parks operations winter construction should be considered. Also, construction may be spread over two years in order to reduce parks disturbance across the City.
    c. Monitoring: 1 year.
    d. Synthesis of results into 2019 CSO LTCP update: 1 year.
2. Evaluate desired application and develop standards for additional stormwater management and green infrastructure implementation.
    a. Development of design criteria and standard details for green infrastructure in City roadway projects, particularly green streets.
    b. Evaluate redevelopment standards for combined areas of the City.
3. Coordinate with large property owners/ institutional partners that could incorporate green infrastructure on their campuses or properties. Specific institutions to explore include: Creighton University, Henry Doorly Zoo, UNMC campus, Douglas County and Omaha Public Schools.
4. Identify points of connection of NDOR roadway drainage to the City's combined sewer system and the associated tributary area characteristics. Evaluate potential stormwater management options for these points of connection.

CITY OF OMAHA PUBLIC WORKS
COMBINED SEWER OVERFLOW (CSO) CONTROL PROGRAM

DRAFT
CONCEPTUAL GREEN INFRASTRUCTURE PROJECT DEVELOPMENT TECHNICAL MEMORANDUM

GREEN INFRASTRUCTURE CONCEPTUAL PROJECT DEVELOPMENT
OPW-52456

Prepared by:

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April 2014

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1.0 Executive Summary

The green infrastructure evaluation described in this report was intended to support the City of Omaha's CSO control program. The Long Term Control Plan (LTCP) identifies green solutions as both a historic approach that has been used in the City's CSO control efforts, as well as an approach to be continually considered in LTCP implementation. The LTCP indicates that, "The City, as part of the implementation of the LTCP, will develop a Green Solutions Program." The LTCP also indicates that the City intends to use an adaptive management strategy. The adaptive management strategy provides the City with the opportunity to consider "the latest technologies, the performance of the controls as they are implemented, and the health of the watersheds" in refining the definition of projects that are part of the LTCP. This current green infrastructure evaluation was intended to support these objectives. It a) identified a wide range of approaches and opportunities where the implementation of green infrastructure could be used to reduce stormwater runoff into the combined sewer system and b) identified specific projects that could be included in the 2014 LTCP Update and could be implemented in the following five year cycle of LTCP implementation.

The green infrastructure evaluation has resulted in two primary outcomes: Five conceptual designs for green infrastructure projects to be included in the LTCP Update and a series of proposed actions that could be incorporated into a Pilot Green Solutions Program.

Near Term Projects

A specific product of the current evaluation was conceptual designs of projects to be included in the City's 2014 LTCP Update. As a prerequisite, it was determined that the selected projects must be ones which the City has the capacity to implement and do not hinge on the cooperation of private property owners. This is because a commitment to these projects will be made to the NDEQ. These projects will support the Pilot Green Infrastructure Program. Through implementation and monitoring of these projects, a better understanding of the CSO performance benefits and the costs of both construction and maintenance will be accomplished. The budget allocated for implementation of these projects was identified as approximately $15 million, less than 1% of the overall CSO program cost.

The projects selected are similar to many prior green solutions projects implemented by the City. That is, they employ regional detention of stormwater prior to discharge into the combined sewer system. Additionally, many of the sites selected for these practices are ones which have been previously identified as locations for stormwater management. There is, however, a fundamental difference in the conceptual design developed versus prior green evaluations of these same locations. That is that these projects maximize the prior investment made by the City in localized sewer separation by using the existing storm sewers to convey runoff to the proposed regional stormwater practices.

The five selected projects are located in City parks. Subsurface storage is the predominant technology that is used in the projects. This type of storage maintains the surface of the park for recreational activities. Other practices used include bioretention and bioswales. The proposed projects and their benefits are summarized in Table 1-1.

Table 1-1 Proposed Projects and Benefits

Project Location	Acres of Stormwater Managed	Estimated Annual CSO Change (MG)	Project 20-Year Life Cycle Cost	Cost/CSO gallon Managed
Field Club Trail	167	-26.6 (-25.3%)	$7,171,000	$0.27
Hanscom Park	133	-17.6 (-4.6%)	$3,987,000	$0.23
Kountze Park	54	-6.5 (-5.3%)	$1,621,000	$0.25
Schroeder-Vogel Park	30	-4.2 (-0.6%)	$1,845,000	$0.44
Turner Boulevard	175	-38.2 (-12%)	$11,250,000	$0.29
Total	**559**	**-93.1 (-5.8%)**	**$25,874,000**	**$0.28**
Total for Recommended Projects (all listed except North Turner in Turner Boulevard)	**501**	**-79.2 (-5.2%)**	**$21,668,000**	**$0.27**

Programmatic Opportunities

Green infrastructure as applied in CSO control programs is intended to help manage stormwater before it enters the combined sewer system. In order to maximize the application of green infrastructure as well as the associated benefits, a variety of approaches must be developed to control stormwater from different sources. Stormwater needs to be controlled near its point of origin, whether that is a private property, a City street or Nebraska Department of Roads (NDOR) rights-of-way. This intentional stormwater management requires the development of various City policies and processes that address stormwater management on for each of these property types. In implementing such policies, communities across the country have found that much of the desired stormwater management efforts can be incorporated into the normal course of projects, defraying the majority of the cost of implementation.

This current evaluation identified multiple locations where a variety of stormwater management techniques could be used to support the CSO control program. The green infrastructure evaluation identified over 50 specific opportunities, impacting over 3,500 acres of runoff into the combined sewer system. These opportunities included working with institutional partners, management of site runoff, greening of City streets and management of runoff from limited access roadways owned by NDOR.

As a result of the institutional and policy complexities of these project types, they were not included in the short list of projects which would be incorporated into the LTCP Update. Nevertheless, it is a recommendation of this report that these project types continue to be explored, prioritized and piloted by the City. This will support the development of institutional structures necessary to support them and aid in the evaluation of the associated costs and benefits. At a minimum, the City should actively engage in projects (whether City led or by other entity) in their formative stages so that beneficial stormwater management measures can be identified and so that associated opportunities for flow management are not "lost opportunities." A list of example projects of this type is presented in Table 1-2.

Table 1-2 Examples of Project Opportunities for Omaha

Project Type	Where Applicable	Potential Acres Impacted	Examples of Potential Projects
City Road Projects	Street reconstruction projects or locations where sewer work results in full width restoration	Not quantified	List from opportunity assessment
Institutional Partner Projects	Most applicable with major institutions who are expanding, redeveloping or upgrading their sites	Examples: 62 (University of Nebraska Medical Center, UNMC) 140 (Creighton)	Creighton University, UNMC, Henry Doorly Zoo, Douglas County, Omaha Public Schools
Redevelopment projects	Redevelopment in combined sewer areas	Not quantified	
NDOR Drainage	Locations where NDOR drainage enters the combined sewer system	450	I-480 Parking Lots
Community Enhancement Projects	Streetscape locations; other community enhancement	Not quantified	24th Street Parking Area

Next Steps

The City has initiated a Green Infrastructure Program of which the current evaluation is a critical component. Over the next five years, the City should both implement these green infrastructure projects and pursue other programmatic elements that will enable additional implementation of green infrastructure and stormwater management. Next steps should include the following efforts.

1. Implement the five projects for which conceptual designs are provided in this report. Phasing of implementation should enable performance evaluations to be completed prior to the next LTCP Update, so that results can be addressed in the adaptive management component of that effort. The suggested schedule for this work is as follows:
    a. Preliminary and Final Design: 2014 – 2015
    b. Construction duration: Fall 2015 – Fall 2016
    c. Monitoring and Evaluation: 2017
    d. Identification and conceptual development of Green Infrastructure projects to include in next CSO Plan Update: 2018
    e. Preparation of CSO Plan Update: 2018 – 2019.
2. Evaluate desired application and develop standards for additional stormwater management and green infrastructure implementation.
    a. Development of design criteria and standard details for green infrastructure in City roadway projects, particularly green streets.
    b. Evaluate redevelopment standards for combined areas of the City.

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3. Coordinate with large property owners/ institutional partners that could incorporate green infrastructure on their campuses or properties. Specific institutions to explore include: Creighton University, Henry Doorly Zoo, UNMC campus, Douglas County and Omaha Public Schools.
4. Identify points of connection of NDOR roadway drainage to the City's combined sewer system and the associated tributary area characteristics. Evaluate potential stormwater management options for these points of connection.

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2.0 Introduction

2.1 Purpose and Scope of Study

The green infrastructure evaluation described in this report was intended to support the City of Omaha's CSO control program. The Long Term Control Plan (LTCP) identifies green solutions as both a historic approach that has been used in the City's CSO control efforts, as well as an approach to be continually considered in LTCP implementation. The LTCP indicates that, "The City, as part of the implementation of the LTCP, will develop a Green Solutions Program." The LTCP also indicates that the City intends to use an adaptive management strategy. The adaptive management strategy provides the City with the opportunity to consider "the latest technologies, the performance of the controls as they are implemented, and the health of the watersheds" in refining the definition of projects that are part of the LTCP. This current green infrastructure evaluation was intended to support these objectives. It a) identified a wide range of approaches and opportunities where the implementation of green infrastructure could be used to reduce stormwater runoff into the combined sewer system and b) identified specific projects that could be included in the 2014 LTCP Update and could be implemented in the following five year cycle of LTCP implementation.

The green infrastructure evaluation has resulted in two primary outcomes: Five conceptual designs for green infrastructure projects to be included in the LTCP Update and a series of proposed actions that could be incorporated into a Pilot Green Solutions Program.

2.2 Study and Project Area

The study area for the project includes the following CSO basins within the combined sewer system: Cole Creek, Saddle Creek, Burt-Izard, Leavenworth, South Interceptor, and Ohern-Monroe. The Minne Lusa basin is being evaluated under separate study and is therefore not included herein.

2.3 General Project Approach

The project includes three phases:

1. Opportunity identification: The opportunity identification phase produced a wide range of possibilities for green infrastructure implementation. Opportunities were identified based on both where runoff was generated and where runoff could be managed. This phase considered prior evaluations and new perspectives.
2. Project Evaluation: This phase of the project selected ten opportunities for further evaluation. Topics addressed were construction and logistical (e.g. ownership) feasibility, potential volume reduction to the combined sewer system, and capital and present value costs. The evaluation resulted in five projects selected for further development.
3. Project Development: In this phase, the five selected projects were developed into conceptual designs. Design aspects of the projects were further refined. This included coordination with the parks department for use of park space, establishment of conceptual project footprints and profiles, development of conceptual cost estimates and hydraulic modeling to confirm the size of components and their benefits.

3.0 Background/Methodology

This section presents the methodology used throughout the project for identifying and developing green infrastructure project opportunities. Information sources are described as well as the methodology for hydrologic and hydraulic modeling; opportunity identification and narrowing; capital, operation, and maintenance costing; and project prioritization.

3.1 Information Sources

3.1.1 Overview

The project uses a variety of information supporting different phases of work. The opportunity identification phase built on prior work and explored new opportunities. The prior work included efforts performed as part of the Long Term Control Plan. In addition, concurrent work by the Program Management Team (PMT) was used as an information source.

As opportunities were carried into the evaluation and development phases, the sources of information were expanded to include more specific local information that helped verify feasibility and further define the project.

This section identifies the sources of information that were used during the opportunity identification, project evaluation, and project development phases of the project.

3.1.2 Previous Reports and Studies

The Project Team reviewed a variety of Omaha CSO program reports that described prior identification of green infrastructure opportunities. The following is a list of the reports used by the Project Team.

The following reports were developed as part of the City of Omaha Long Term Control Plan and associated work:

1. *Burt Izard Green Solutions TM;* HDR Engineering, Inc., 2008
2. *Cole Creek Green Solutions TM;* Kirkham Michael, 2008
3. *Leavenworth Green Solutions TM;* Wade Trim, 2008
4. *Long Term Control Plan for the Omaha Combined Sewer Overflow Control Program;* City of Omaha and engineering consulting firms, October 2009
5. *Ohern-Monroe Green Solutions TM;* Camp, Dresser & McKee, Inc., 2008
6. *Saddle Creek Green Solutions TM;* Olsson & Associates, 2008
7. *South Interceptor Green Solutions TM;* HDR Engineering, Inc., 2008

The following additional documents were considered in the identification of green infrastructure opportunities:

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8. *South Omaha Development Project;* Completed by Greater Omaha Chamber and consulting firms, July 2010
9. *Omaha Green Solutions Site Suitability Assessment and BMP Selection Process Guidance Document;* Omaha Program Management Team (PMT), 2009; Revised 2011
10. *Green Solutions in Facility Design – Final;* Omaha Program Management Team (PMT), 2010
11. *University of Nebraska Medical Center Facilities Development Plan 2006-2015*; RDG Planning and Design, 2006
12. *Missouri Avenue/Spring Lake Park Green Infrastructure Technical Memorandum (TM) Phase I;* Kirkham Michael Project Team, 2013

3.1.3 GIS Data

Extensive GIS data exists for the City of Omaha and Douglas County. In addition, specific layers were generated for use on this project by the PMT. Relevant GIS information used throughout the project includes the following:

- CSO basin and outfall boundaries, including model catchment areas
- Sewer system data, storm, sanitary and combined pipes
- Streets data
- Imperviousness classification data
- Contour elevations
- Parcel/ parcel ownership information
- PMT site suitability results
- RNC project drainage areas

3.1.4 Sewer and Geotechnical Data

Sewer and geotechnical information used on the project came from the following sources:

Quarter Section Maps

Quarter section maps were made available for the entire study area. The maps typically provide approximate sewer system information, such as routing, size, slope and invert elevation, and were used as the reference map for the record drawings.

Record Drawings

Record drawings, primarily for locally separated sewer projects, were provided for the study area. The drawings contain information such as sewer inverts, size, and locations, which assisted in placement of the proposed green infrastructure practices and in determining the feasibility of daylighting existing separate stormwater into the practices.

Geotechnical Reports

Geotechnical reports were reviewed for soils information at project locations during the project development phase. Reports include the following:

- Case Study (Omaha NE): Soils Investigation for Infiltration-based Green Infrastructure for Sewershed Management (DRAFT); Shuster, W. and S. Dadio, February 2013
- Geotechnical Exploration Report, RNC 5841, 35th & Vinton Street, Omaha, Nebraska; TG Project No. 02016.0, Thiele Geotech, Inc., January 31, 2002
- Geotechnical Exploration Report, Dewey Park Handball Courts, South 33rd & Dewey Avenue, Omaha, Nebraska; TG Project No. 05597.0,Thiele Geotech, Inc., November 4, 2005
- Geotechnical Exploration Report, Turner Boulevard Trail, Pacific Street & Turner Boulevard, Omaha, Nebraska; TG Project No. 06133.0, Thiele Geotech, Inc., April 19, 2006
- Record Drawings for OPW 51139 – Kountze Park
- Record Drawings for OPW 50657 – Schroeder-Vogel Park
- Record Drawings for OPW 5686 – Jones Street & Turner Boulevard

Utility Records

Gas and water main records were used to identify potential for major conflicts with proposed sewers or practices. The date of these records was approximately XXXX. No other subsurface utility information was provided, although some sewer record drawings identified locations of duct banks, and these were considered in project development.

3.1.5 Site Suitability Evaluation

The PMT developed a process to identify potential parcels for green infrastructure opportunities. The process considered the following primary characteristics:

- Land Use: This factor considers how the property is being utilized. Open space will be valued highly, while railroads would be valued low.
- Terrain: This factor considers the slope of the property and if there are natural depressions on the site.
- Problem Areas: This considers known basement backup and street flooding areas.
- Impervious Area: Includes size of impervious area, including buildings
- City Right of Way: Includes green streets, medians, roadway classifications

Information provided to the Project Team included a GIS layer of candidate parcels, GIS raster data showing ranking in various primary characteristics, a tabulated list of “Ranked Sites Clustered Areas” and 32 preferred opportunities. The work by the PMT is documented in a Technical Memorandum, *OPW 52456 – Green Infrastructure Site Suitability Analysis* dated August 9, 2013.

3.1.6 Input from City Departments and Stakeholders

The following entities were coordinated with during the implementation of the evaluation:

- City of Omaha Parks Department
- City of Omaha Planning Department
- Creighton University

City of Omaha Parks Department

The Parks Department participated in progress meetings after the candidate list of projects was developed. They provided input on type of practices acceptable in various locations (for example, surface or subsurface), preferred location of stormwater practices, existing drainage concerns in City Parks, and timing of planned parks improvements.

City of Omaha Planning Department

City CSO staff met with the planning department to identify opportunities for green infrastructure projects that would mesh with planning department activities. These opportunities included: coordination with redevelopment projects and use of vacant properties in distressed areas for community benefit. No specific locations were identified in these discussions.

Creighton University

City CSO staff met with Creighton University to discuss partnering opportunities as part of the opportunity identification phase. Creighton is highly committed to sustainability and provides significant opportunities for partnership in the future.

3.2 Hydrologic and Hydraulic Modeling

Hydrologic and hydraulic modeling was used to support the understanding of a green infrastructure's ability to reduce stormwater to the collection system and to generally assess the impact on CSO discharges. Modeling was also used for preliminary sizing of green infrastructure practices and to support the selection and assessment of the opportunities. The modeling work performed in this evaluation was based on the City's CSO model. The City's model was used as it has been calibrated to observed flow conditions – and no flow monitoring was available for the current evaluation. In addition, use of the CSO model provided the opportunity to estimate the CSO reduction that would result from the green infrastructure projects. This section describes the approach to hydrologic and hydraulic modeling that was used in evaluating and developing green infrastructure opportunities.

Modeling of opportunities was performed in two stages:

- Project Definition and Selection. The scope for this stage of modeling included addition of green infrastructure elements and their tributary subcatchments to the City's InfoWorks CS CSO model for the evaluation of local flow generation before and after the implementation of the identified green infrastructure projects.
- Green Infrastructure Project Development. This stage of modeling refined the analysis supporting the sizing of green infrastructure, assessed performance during the Representative Year and better defined the ability of the projects to control CSO discharges.

3.2.1 Objectives of Modeling

The modeling performed under this project was used to prioritize opportunities, assess their impact and help inform the sizing (and hence the cost) of the project components. In addition, the modeling effort had the following specific objectives:

- Provide performance information sufficient to compare the benefits of the identified opportunities and prioritize projects for implementation. Maintain consistent hydrologic representation of each of the green infrastructure project areas so that comparisons can be made.
- Evaluate performance primarily in the context of CSO control (for example, 85 percent annual volume control or the 5th largest annual overflow event). Evaluation of flood control benefits was only considered on a case by case basis.
- Promote consistency in the interpretation of results between OPW52456 and CSO planning efforts. This was accomplished through the use of the existing CSO planning model as the primary modeling platform.
- Use improved information where available to better define hydrologic response within the various green infrastructure practice tributary areas. Examples included such items as the 2010 LIDAR-based impervious planimetrics and refined park area hydrologic parameters.
- If there was more than one green infrastructure project tributary to a CSO regulator, assess the cumulative benefits of multiple green infrastructure projects on the combined system as well as the local area.
- Simplify representations of green infrastructure practices to maintain a level of effort consistent with project budgets.

3.2.2 Existing CSO Model Framework

The OPW52456 Green Infrastructure Model was built off of the existing InfoWorks CS CSO planning model. Relevant characteristics of the model used are described in the following sections.

Model Platform

InfoWorks CS version 13.5 was used for the modeling. The PMT provided two models for use for this project including:

- 2018 Missouri River Basin Interim Model – This model includes the sewer basins that have overflows to the Missouri River. It also includes future projects scheduled to be implemented prior to 2018.
- 2010 Existing Conditions Model – This model represents the 2010 sewer network and includes all sewer basins tributary to both the Missouri River and Papillion Creek. For the purposes of this project, it was only used to calculate the impacts of the green infrastructure opportunities in the Cole Creek and Saddle Creek Basins.

These models are referred to collectively as the “CSO model” to distinguish them from the green infrastructure version of the InfoWorks model.

CSO Model Description

This section identifies key model aspects and how they were considered in the context of green infrastructure evaluation. The documentation for the CSO model was provided in the following reports:

- *TM #7 – Model Development and Calibration, Version 5*; February 21, 2005
- *Draft Omaha CSO InfoWorks CS Model 2010 Calibration and Model Update Technical Memorandum;* July 23, 2013

The description of the model as presented includes information based on the documentation as well as a review of the models provided. For each topic, the relevance to the green infrastructure modeling is discussed. The approach to green infrastructure modeling is presented in Section 3.2.4.

Subcatchments

The CSO model of the Missouri River and Papillion Creek basins included 761 subcatchments, with approximately 90 percent of them less than 80 acres in size. The subcatchments were delineated based on topography and the pipe network (TM #7 version 5, page 6). Subcatchments were defined to contain sanitary, storm, and / or combined catchments, some of which were overlapping. Baseflows were loaded within sanitary and combined catchments, and stormwater was loaded within storm and combined catchments.

The total physical area of the subcatchment is included in the model, but is not used in the hydrologic calculations. Instead, the model used a contributing area for the hydrologic calculations. Approximately 90 percent of the combined and storm subcatchments contained a contributing area that is less than the total physical area. The initial contributing area was set based on the type of separation in the subcatchment (see TM #7 version 5, page 10), and was refined as a calibration component if flow monitoring was completed in a particular area.

The subcatchments needed to be divided in the green infrastructure model. Generally, a portion of the existing subcatchment became tributary to the green infrastructure practices, and a residual area remained directly tributary to the combined system. Subcatchment delineations needed to be reviewed. It was also important that contributing area factors were consistently defined within the drainage areas tributary to green infrastructure practices. This is necessary to ensure consistency in the evaluation of green infrastructure project opportunities.

Impervious and Pervious Areas

The CSO model classified the impervious area into road or non-road areas. Road imperviousness reflected the impervious area associated with streets and alleys. Non-road imperviousness includes all other impervious surfaces. Imperviousness of parks and cemeteries was based on an R5 zoning classification and reduced on a case by case basis.

As expected, neither the road nor the non-road impervious areas included infiltration, but they did have different initial abstraction values. The initial abstraction for the road impervious areas was based on the slope of the subcatchment (0.0028 inches ÷ $\sqrt{slope}$), while the initial abstraction for the non-road impervious areas was an absolute value of 0.27 inches (the same value was used for pervious surfaces as well).

Green infrastructure modeling required the quantification of flows directly tributary to the practices. Thus, the location of the imperviousness within a subcatchment became significant and needed to be assigned to areas that were tributary to a practice versus the residual area. Also, the imperviousness of many of the park areas tributary to practices was overrepresented in the CSO model. . Impervious area classification aided in placing the impervious area within subcatchments.

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Precipitation

The CSO model used a "representative year" of rainfall that was based on the year 1969. The rainfall was uniformly applied across the entire drainage area in hourly increments.

The green infrastructure evaluation applied the Representative Year rainfall to assess performance. .

Flow Generation (Hydrology)

A review of the runoff volume in the CSO model, as generated during the Representative Year, indicated that volume was almost exclusively associated with impervious areas. This results in a relatively linear relationship between precipitation and runoff volume.

This suggests that green infrastructure effectiveness is related to the control of impervious area, rather than total contributing area. However, the intense rainfall and clay soils in Omaha would suggest that runoff from pervious areas existed in many events. We would typically expect that the fraction of precipitation that becomes runoff is less in small/ low-intensity storms and increases with larger/ high-intensity storms.

Detailed evaluation of this issue did not occur during this project, but design of projects will need to ensure that the range of flow conditions can be managed. Future flow monitoring for green infrastructure projects should include an evaluation of the runoff generation from permeable areas.

Potential Surface Flooding

Most nodes representing manholes in the CSO model were set to store water when the hydraulic grade line (HGL) reached the ground surface. Excess flows then re-entered the pipe system as the HGL decreased. There were some locations, such as along Saddle Creek Road, where one-dimensional overland flow was calculated in the model.

The other nodes in the CSO model were sealed and represented force main, closed conduit systems. At a few nodes, the setting in the model allowed the volume that reaches the surface to be lost.

Project Team Assumption

The following assumptions were made by the Project Team relative to the existing model:

- The model received from the PMT was calibrated/ validated based on flow monitoring data that had been collected over the course of the program. The locations of calibration were assumed to correspond to the historic flow monitoring locations. Therefore the net effective tributary area at the downstream flow metering point should be maintained.
- The existing model hydraulic representation of the system was assumed accurate for the purposes of this project and was not adjusted.

Quality Assurance for Model Consistency

The Project Team ran the CSO models without modification and the output was compared to the output from the PMT to ensure that the analysis would start at a point that matched previous modeling work. Both subcatchment runoff output and link flow output were compared.

The runoff from five subcatchments in the Project Team and PMT simulations were compared at each 60-minute time step in the Representative Year (43,805 total comparisons). The maximum absolute difference in the runoff generated at a subcatchment at any time step was 0.0001 MGD. Over the entire Representative Year, the total runoff volume between the Project Team and PMT simulations were within 0.001 MG (0.0001 percent).

The flow rate at five links was also compared for each 15-minute time step in the Representative Year (175,205 total comparisons). The maximum absolute difference in flow rate at any time step was 0.014 MGD. Over the entire Representative Year, the total volume for the Project Team and PMT simulations in the five links were within $4 \cdot 10^{-4}$ MG ($3 \cdot 10^{-6}$ percent).

Based on these results, the model used by the Project Team was deemed to be consistent with past modeling efforts by the PMT.

3.2.3 Green Infrastructure Sizing Criterion

Identified green infrastructure opportunities were primarily intended to reduce the amount of CSO discharges consistent with regulatory requirements. This may aid the City's efforts to reduce end of pipe CSO controls. The green infrastructure practices were not intended to manage design storm conditions (e.g. 2-year or 10-year design rainfalls), although their potential to support control of these conditions could be considered on a case by case basis.

Control Objectives

While OPW 52456 builds off of prior efforts, including the work documented in the *Green Solutions Guidance for the City of Omaha Long Term Control Plan* (2008) (hereinafter called *Guidance),* modifications that would enhance the value of green solutions were considered. As a result, there were some differences in the approach used in this project in comparison to those prior efforts. Topics are summarized in Table 3-1; an expanded discussion follows the table.

Table 3-1 Comparison of Modeling Approaches

Concept	OPW 52456	2008 Guidance
Sizing criterion	Consistent with CSO control objective	Knee of the curve precipitation event
Anticipated Impact	Effectively manage area tributary to identified practices	No significant impact on CSO controls
Principal Flow Control Objective	Reduce stormwater flow rates and volume	Reduce stormwater peak flow rates
Dewatering of facilities	Generally practices are assumed to behave as detention. No volume was assumed to be lost to evaporation or infiltration. Dewatering time assumed to be 48 hours.	Refers to Stormwater Drainage Manual which calls for a 40-hour dewatering time
Evaluation by Outfall	Specific to outfall	Generalized to basin

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Sizing Criterion

The approach used in OPW52456 was based on adequately sizing green infrastructure to control the critical CSO event in the area tributary to the green infrastructure practices. This could result in a reduction in other CSO control infrastructure by effectively reducing the tributary area that influences the sizing of the end of pipe controls.

The current LTCP was based on controlling CSOs to reduce both frequency of discharge and volume of discharge. The CSO criterion in the 2009 LTCP was to limit discharges to four overflows/year and control 85% of wet weather flows. Using the precipitation during the Representative Year, the CSO control criterion formed the basis of evaluation of the "critical event" for green solutions as part of the current study. That evaluation is presented in Section "Rainfall Event for Green Infrastructure Sizing ".

The 2008 Guidance developed sizing curves for green infrastructure based on the cumulative number of events at various precipitation depths. The result of this analysis was that: "If the BMPs are sized to capture 1 inch of rainfall across the entire watershed, about 85% of all CSO events are eliminated for both watersheds." (It should be noted that the level of control associated with 85% of the *events* is less than 85% of the annual *volume*).

The approach in the current study was intended to identify an event volume that reasonably corresponds to the four overflow/ 85% criterion by outfall. This would be the basis for green infrastructure practice sizing.

Other potential tradeoffs that may influence the sizing for green infrastructure practices include:

1. Comparative performance for a given green infrastructure volume dependent on:
    a. More area managed with a lower level of control
    b. Less area managed with a higher level of control
2. Benefits to flooding/drainage problems. This may include more efficient movement of runoff to practices and improved capacity in downstream areas.

However, in the final project evaluations for this study, all practices were consistently sized to manage the fifth largest event and were evaluated relative to the Representative Year.

Anticipated Impact

The green infrastructure practices are sized to allow for a reduction in end of pipe CSO controls. In order for this to occur, the green infrastructure impact was evaluated at the downstream end of the system. Impacts were expected to include reduced and delayed peaks and reduced CSO volume. This compares with the *Guidance*, which stated, "The incorporation of green solutions into the LTCP is not anticipated to have a significant impact on the structural CSO controls proposed because they are designed to address large events. [Green solutions] could result in the reduction of CSOs during smaller, more frequent runoff events."

Principal Flow Control Objective

Ideally, the practices selected for the various projects would result in infiltration and evapotranspiration that reduces runoff volumes that ultimately enter the sewer system. However, the extent to which these flow reduction mechanisms would occur is uncertain, both initially and as the practices age. Therefore, modeling of green infrastructure assumed that the projects serve only as detention. Discharge from the green infrastructure practices during the wet weather event would occur at a significantly reduced rate. In some cases, discharge could be delayed until the conclusion of the event.

Dewatering of Facilities

Green infrastructure sizing was impacted by the manner in which facilities are dewatered. This can occur by a mix of infiltration, evaporation/evapotranspiration and conveyance discharge. The sizing criterion was based on being physically able to dewater within 48 hours. Modeling evaluated a range of conditions from 48-hour dewatering to complete capture. Some variations were considered for bracketing performance capabilities.

It is noted that the standard for dewatering time in the *Stormwater Drainage Manual* is 40 hours, which appeared to be derived from studies that determine an ideal detention time for pollutant removal. The objective of the green infrastructure projects was volumetric control, rather than pollutant removal, so modeling under this project evaluated practices only from a stormwater management perspective.

Evaluation by Outfall

In the current project, assessment of green infrastructure sizing criteria was performed via the model with results reported for each outfall. Prior work was performed by receiving water (e.g. Missouri River or Papillion Creek).

Rainfall Event for Green Infrastructure Sizing

The rainfall event that corresponded with the green infrastructure sizing criteria was determined for each CSO outfall using the Representative Year rainfall and simulation results. The methodology used to determine this rainfall event is presented in this section. Table 3-2 presents the results by outfall for the Representative Year. While the rainfall event was determined for each outfall, the results were relatively consistent. For simplicity of application a single rainfall event was selected.

Model Details

For the Missouri River and Papillion Creek basins, the 2018 Interim Missouri River basin network and 2010 Existing Papillion Creek networks were used, respectively. For each CSO outfall, Representative Year time series data in 15-minute increments for all of its tributary stormwater (combined and separate storm) subcatchments, conduits influent to the regulator, and outfall conduits were exported into Excel. Time series data for both dry and wet weather simulations were used.

Rainfall and Runoff

The rainfall events were differentiated using a 12-hour inter-event period, consistent with past work completed by the PMT. A total of 86 rainfall events occurred during the Representative Year, ranging from 0.01 to 2.79 inches (the same rainfall pattern is applied to every subcatchment in the model). The total rainfall during the Representative Year was 29.55 inches. The peak hour rainfall intensity and duration were also extracted from the time series data for each event.

The runoff volume generated during each event was calculated for each subcatchment then summed to produce the runoff volume over the entire area tributary to the CSO outfall. The amount of runoff varied by subcatchment and by CSO outfall.

Flow Data

The wet weather flow generated influent to each CSO regulator was calculated by subtracting the dry weather flow time series from the total flow time series. The duration of the influent wet weather flow hydrograph was influenced by travel time to reach the regulator. Node flooding upstream of the regulator would reduce the wet weather influent flow rates.

The overflow hydrograph was used to calculate a peak overflow rate and an overflow volume for each CSO outfall.

Overflow Frequency and 85 Percent Capture

The overflow frequency and 85 percent capture were calculated using the summarized rainfall, runoff, and flow data. Calculations were not completed for CSOs 102 and 201 because they were downstream of multiple basins.

Overflow Frequency:
Overflow events were sorted by both peak overflow rate and volume. The top ten ranked events were then tabulated for each CSO outfall. Total precipitation driving the 5th, 7th, and 9th largest runoff events was identified. Controlling the 5th, 7th, and 9th largest events would limit overflows to four, six, and eight per year, respectively.

The ratio of the wet weather volume (influent to the regulator) to the overflow volume was also calculated. This ratio is unique to each location and event based on precipitation characteristics and system hydraulics. The ratio provided an indication of the gallons of stormwater that would need to be managed to reduce a gallon of CSO (the smaller the ratio indicates that less stormwater needs to be managed to control a gallon of discharge). This ratio was also averaged for the 1st through 4th, 6th, and 8th largest runoff events.

For all CSO outfalls, the design event was larger based on control of overflow volume rather than peak overflow rate. Thus, this ranking was used to define the controlling rainfall events for the frequency targets of four, six, and eight overflows per year. There was some variability dependent on the specific CSO outfall, but the calculations showed that CSOs could be reduced to four overflows per year by controlling the runoff from the 1.23- to 1.36-inch rainfall. CSOs could be reduced to six and eight overflows per year by controlling the 0.95- to 1.09-inch rainfall and the 0.82- to 0.95-inch rainfall, respectively.

There was relatively small variability in the ratio of wet weather volume (stormwater) to CSO volume. The values were different for each CSO, but were between 1:1 (gallon stormwater/gallon CSO) and 2:1 for 11 of the 15 CSOs that were analyzed.

CSOs 111, 112, and 114, in the South Interceptor basin, all had fewer than four overflows in the simulation, and the ratio of influent wet weather volume to overflow volume was greater than 2:1. CSO 117, in the South Interceptor basin, had a ratio less than 1:1, which implies that there was more overflow than there was upstream wet weather flow. It is possible that a high hydraulic grade line in the interceptor causes some discharge of the baseflow or diversion of flow originating elsewhere in the system during wet weather events.

85 Percent Capture:
The 85 percent capture was calculated at each CSO on an annual volumetric basis. The calculation was based on the runoff generated. It was assumed that the runoff was linearly proportional to the rainfall. If the rainfall volume for a particular event was less than the 85 percent capture rainfall, then its runoff was assumed to be fully captured. If the rainfall volume for a particular event was greater than the 85 percent capture rainfall the amount of its runoff that was assumed to be captured was proportional to the rainfall. For example, if the 85 percent capture rainfall was 1 inch, the runoff captured during a 2-inch rainfall would be 50 percent of the total runoff generated.

For the CSO overflows that were analyzed, it was calculated that 85 percent of the runoff in the Representative Year could be controlled by controlling the runoff from the 1.13-inch rainfall (all basins had a control rainfall of 1.12 or 1.13 inches, except CSO 118, which had a control rainfall of 1.24 inches).

Table 3-2 Critical Precipitation Volume (inches) to Accomplish Control Objective

Outfall	Basin	Frequency Based Control (Overflows/year)			Volumetric Based Control
		4	6	8	85% annual control
102	Ohern-Monroe (connected to interceptor)	-	-	-	-
106	Burt-Izard, Minne Lusa, Bridge	1.23	0.95	0.82	1.12
108	Burt-Izard	1.36	1.09	0.95	1.12
109 / 121	Leavenworth	1.36	1.04	0.93	1.12
110	South Interceptor	fewer than 4 overflows			1.13
111	South Interceptor	fewer than 4 overflows			1.13
112	South Interceptor	fewer than 4 overflows			1.12
114	South Interceptor	1.23	0.95	0.82	1.12
115	South Interceptor	1.36	1.04	0.93	1.12
117	South Interceptor	1.36	1.04	0.93	1.13
118	Ohern-Monroe	1.36	1.04	0.95	1.24
119	Ohern-Monroe	1.23	0.95	0.82	1.12

Outfall	Basin	Frequency Based Control (Overflows/year)			Volumetric Based Control
		4	6	8	85% annual control
201	Papillion Creek basins	-	-	-	-
202	Cole Creek	1.36	1.08	0.95	1.12
203	Cole Creek	1.36	1.08	0.95	1.12
204	Cole Creek	1.36	1.05	0.93	1.12
205	Saddle Creek	1.36	1.08	0.95	1.13

3.2.4 Green Infrastructure Modeling Approach

The existing CSO model was developed at a planning scale to provide reasonable projections of combined flows at CSO discharge locations. The current use of the model was for assessment of green infrastructure projects at a localized or subcatchment scale.

Green infrastructure was very sensitive to the hydrology of the tributary area. This resulted in the need to identify approaches that would represent the green infrastructure projects while maintaining consistency with the overall CSO model. In addition, closer examination of the model hydrology raised some issues that needed to be considered in developing the approach and interpreting the results. These issues and proposed approaches to green infrastructure modeling are discussed in this section.

Drainage Areas and Imperviousness

Examination of the CSO model identified some localized issues with drainage delineation and hydrologic representation. There was no scope item in the OPW52456 model to redistribute runoff other than as related directly to defining subcatchments tributary to green infrastructure. However, in some locations, the results could be misleading if this were not addressed. Therefore, selective revisions to the delineation were performed to restate the existing conditions. This sequence occurred as follows:

a) Review of existing CSO model for definition of the local hydrology
b) Revision to the CSO model to better represent existing hydrology (under select circumstances)
c) Use of revised CSO model to assess green practices.

Changes were only made if they were deemed significant, so the primary approach was to use the CSO model without revisions to represent the baseline condition.

Subcatchment Delineation Discrepancies

It was understood that the original delineations in the CSO model were developed based on a review of the topography and the location of sewers. At the planning level scale, discrepancies in the subcatchment boundaries and the actual drainage area were relatively small and generally balance across the sewer network. However, for local stormwater evaluation, these issues may be more significant.

For example, in the Turner Boulevard opportunity area, there is a 16-acre portion of a subcatchment which is tributary to the western Burt (Gifford Park) sewer branch in the CSO model. In reality, this flow is tributary to the Turner Boulevard corridor sewers. These differences had an impact on both the Turner Boulevard and Gifford Park opportunities.

The approach involved a review of the tributary area delineation to the green infrastructure areas. These were developed and compared with current subcatchment delineations. When the green infrastructure tributary area extended beyond the subcatchment delineation and the difference was more than 15% or 10 acres, the subcatchment boundary was modified in the model.

If subcatchments were re-delineated, the changes were stored in a model network that represented the modified existing conditions without green infrastructure. The areas of road imperviousness, non-road imperviousness and pervious areas were conserved.

The proposed approach allowed the Project Team to separate the impacts of the subcatchment delineation modification with the impacts of the green infrastructure when changes were made.

Contributing Area Factor

In some locations within the CSO model, only a portion of the physical area of the subcatchment was used in the model for the hydrologic calculations. The portion of the physical area used by the model in the hydrologic calculations was called the contributing area, so the ratio of the contributing area to the physical area was the contributing area factor. According to the CSO model documentation, the contributing area factor was assigned based on past experience with CSO systems and flow monitoring.

Based on an inspection of the contributing area factors contained within the model, it appears that the contributing area factor was adjusted uniformly upstream of monitoring locations to reduce the amount of flow generated and accomplish better calibration. Calibration locations are limited to locations where flow monitoring has been performed. Those locations were typically on the order of several hundred acres and were not necessarily aligned with the green infrastructure opportunity areas. Table 3-3 lists the contributing area factors within the green infrastructure opportunity areas that were evaluated using the model. Only the Upland Park and Schroeder-Vogel Park green infrastructure opportunity areas have more than one contributing area factor. In the table, the Field Club Trail area was split between the two CSO basins it was located within.

Table 3-3 Contributing Area Factors listed by Green Infrastructure Opportunity Area (CSO Model)

Basin	Green Infrastructure Opportunity Area	Contributing Area Factor (Percent)
Burt-Izard	Bemis-Mercer Park	60
	Gifford Park	60

Basin	Green Infrastructure Opportunity Area	Contributing Area Factor (Percent)
	I-480 Parking Lots	50
	Kountze Park	60
	Turner Boulevard	100
Leavenworth	Hanscom Park	100
Ohern-Monroe	Field Club Trail (portion in Ohern-Monroe)	37.5
	Upland Park	38.5 to 60
Saddle Creek	Field Club Trail (portion in Saddle Creek)	80
	Norris Middle School	50
	Schroeder-Vogel Park	85 to 95

Specific issues related to the contributing area factor include the following. These issues were important at the local scale of green infrastructure modeling:

- Contributing area factors were not based on the types of imperviousness in the tributary area, but were rather applied to all imperviousness types. In reality, different types of imperviousness are expected to have different levels of effective imperviousness. For example, a roadway will drain more effectively than a sidewalk.
- The variability in contributing area factors resulted in non-uniform flow generation between the different green infrastructure opportunity tributary areas. In some cases, areas with less physical imperviousness generate more flow than locations of more imperviousness. For example, the contributing area factor for Hanscom Park is 100 percent and the contributing area factor for Field Club Trail in the Ohern-Monroe Basin is 37.5 percent. However, GIS analysis of the impervious cover indicated that Field Club Trail and Hanscom Park had similar imperviousness (40 to 45 percent) and, therefore, should have similar runoff generation when normalized by contributing area.

When different contributing area factors are used for similar land uses, the ability to compare effectiveness of green infrastructure practices was impacted. In the above example, green infrastructure practices located along Field Club Trail would indicate a smaller benefit from a flow management perspective.

The approach used to address this issue was intended to ensure consistency in the benefits associated with green infrastructure between locations. Fundamental items in the approach included:

1) Impervious areas tributary to green infrastructure were defined based on the “effective impervious area” (discussed in the following section).
2) Contributing area factors were not used in green infrastructure tributary areas.
3) The total amount of area (physical, contributing, road impervious, and non-road impervious area) was conserved consistent with the CSO model by readjusting the allocation of tributary areas between green infrastructure and residual subcatchments. Generally, the

goal was to accomplish the readjustment within the existing subcatchment, although it may have resulted in changes to adjacent subcatchments if there was not an adequate amount of contributing impervious area in the existing subcatchment.

Identification of Effective Impervious Area

Not all the rainfall that falls on impervious surfaces runs off and into the sewer. The effective impervious area is the portion of the impervious area that contributes runoff. Impervious areas such as roads and parking lots that tend to be well graded and have inlets or catch basins, have a higher effective impervious area than dispersed residential roofs, which may only make it into the sewer after traveling across other surfaces. Other than calculation of the initial abstraction, the CSO model treats road and non-road imperviousness the same. In the CSO model the contributing area factor, which was applied uniformly to all area types, is the only mechanism to address effective impervious area.

The Green Infrastructure Model used the differentiated types of impervious area to define effective impervious areas. An effective area coefficient was applied to each impervious cover type to calculate the effective imperviousness used in the Green Infrastructure model tributary to green infrastructure practices. Runoff coefficients for each surface type are shown in Table 3-4.

Table 3-4 Runoff Coefficients used to Define Effective Imperviousness

	Commercial Land Use	**Residential Land Use**
Buildings	0.95	0.20
Paved Alley	0.95	0.95
Paved Driveway	0.95	0.95
Paved Parking	0.95	0.95
Paved Road	0.95	0.95
Sidewalk	0.95	0.20
Unpaved Alley	0.80	0.80
Unpaved Driveway	0.80	0.80
Other Paved Area	0.95	0.10
Pervious	0.15	0.15

Balancing Areas

Figure 3-1 illustrates the manner in which the total drainage area and the corresponding area types were conserved when distributing the area between the green infrastructure tributary area and the residual area. In general, the residual CSO subcatchment is the difference between the original CSO subcatchment and the green infrastructure subcatchment.

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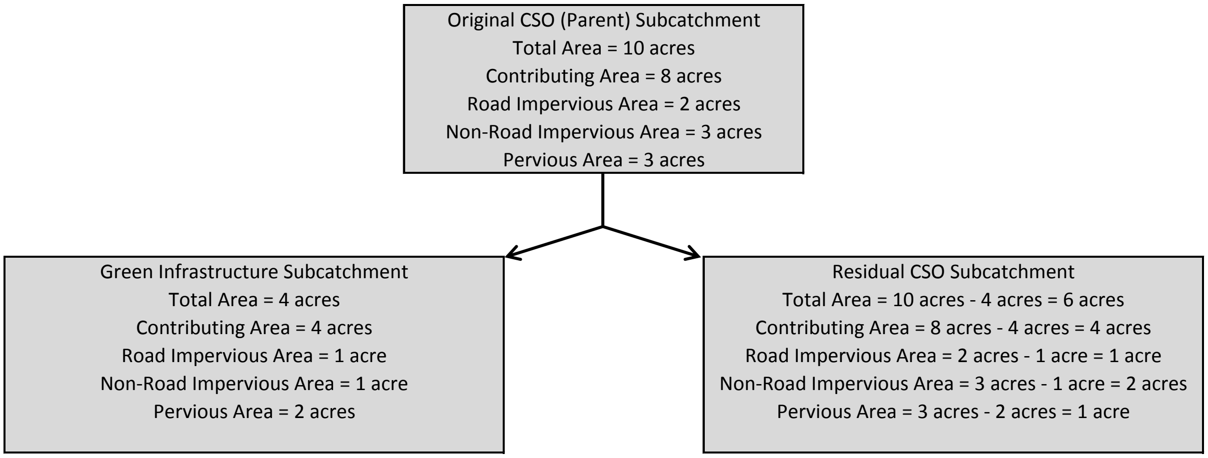

Figure 3-1 Example for Distribution of Areas from Original CSO Subcatchment to Green Infrastructure and

Pervious Area Runoff

The infiltration rate in the CSO model was large enough that during the Representative Year, there was no runoff from pervious areas. This is despite the observation that in some parts of Omaha there are relatively impervious soils (clay) that limit infiltration.

Basic hydrologic performance is best determined through flow monitoring performed for relatively small catchments over a wide variety of storm events. The actual contributions from pervious (and impervious) surfaces should be better defined through flow monitoring and in advance of detailed design.

Representation of Green Infrastructure Practices

The representation of green infrastructure in the Green Infrastructure Model was usually simplified for the modeling effort and includes the following characteristics:

1. Practices were represented as a storage node.
    a. No loss of volume was assumed (such as due to infiltration or evapotranspiration).
    b. The actual physical dimensions (other than total volume) of the practices were not modeled.
2. Discharge from practices.
    a. A constant rate based on emptying the volume in 48 hours was used. For comparison purposes of the maximum beneficial impact, a second simulation was created that assumed no discharge from the practice.
    b. Once practice is full, flow in equals flow discharged.
3. Grouping of practices
    a. Multiple practices within a close geographic proximity and with similar drainage areas were consolidated as a single entity. This was determined on a case by case basis.

Evaluation Modeling

This section presents the steps used in the modeling approach. Four general models were used in the evaluation:

- CSO Model: The existing model provided by the PMT.
- CSO Model with Modifications: Modifications to subcatchment delineations, imperviousness, or other modeling parameters were made to the CSO model. This model was used to distinguish impacts from modifications to the CSO model to those caused by the green infrastructure. Changes to the CSO model were documented. This was considered the baseline model.
- Green Infrastructure Model: This added the green infrastructure components to the CSO Model with Modifications.
- Green Infrastructure Model with No Release: This model showed the maximum benefit of the green infrastructure by not releasing any runoff to the sewer system.

This modeling approach focused on the tasks that needed to be completed for the ten screening level green opportunity areas / sites and was based on a limited level of effort per site.

The goal of the modeling was to calculate the potential impacts of the selected green opportunities on the combined sewer system in the area local to the green opportunity area / site and at the CSO regulator. To do this, the tasks were grouped into the following categories:

- Prior to Building Green Opportunities in the Model – These tasks included a review of the model in the area of the green opportunity area / site and a comparison of model information to available GIS data.
- Building the Green Opportunities into the Model – These tasks built the green opportunity into the model.
- Simulations – These tasks were used to develop the model simulations.
- Analysis – These tasks were used to calculate the impact of the green opportunities.
- Non-quantified Items – This task took into consideration information that was not captured by the model work.

Prior to Building Green Opportunities in the Model

The follow tasks were completed prior to building the model:

- Developed and/or reviewed the locations of selected green opportunities and their associated natural drainage area.
- Compared model subcatchment delineations to the drainage areas for the selected green opportunities. There was no intent to make adjustments to model subcatchment boundaries, except in rare circumstances (on a case by case basis). At the request of the PMT, significant discrepancies were noted and provided to them for their use.
- Located a point in the model downstream of the green opportunity area / site where the assessment of the impact of the green opportunity could be made.
- Compared the existing model subcatchment surfaces with the GIS impervious cover data for the entire subcatchment and answered the following questions.
  - Was the total impervious area similar?
  - Was the total road impervious area similar?

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  - Was the total non-road impervious area similar?
- Completed the same step for the area tributary to the green opportunity area / site, if applicable.
  - The model was not re-calibrated based on this effort.

Building the Green Opportunities into the Model

The following tasks were used to build the green opportunities into the model. Small sites contained to single properties were completed similarly to distributed opportunities.

- Built all green opportunity areas / sites in the Missouri River basins into a single version of the 2018 Missouri River Interim Model. Green opportunity areas / sites chosen in the Cole Creek or Saddle Creek Basins were built into the 2010 Existing Conditions Model. Building all the green opportunities into a single model allowed the cumulative effect of all the projects to be determined.
- Created new stormwater subcatchments out of the existing combined subcatchment (or used an existing stormwater subcatchment if it already exists). At the screening level, the subcatchments were split numerically in the modeling parameters, but not drawn in the model as a unique geographical area.
  - The total contributing area and total impervious area used to create the stormwater subcatchment was removed from the combined subcatchment. Adjustments to the time of concentration, slope, and width were not made when adjusting the subcatchment contributing area at the screening level.
  - The stormwater subcatchment was routed to a detention basin without infiltration. The volume of the basin was developed using the model, but its length, width, and depth dimensions were not represented in the model because they should not impact the results.
  - The detention basin was dewatered using a pump with a constant rate. This was a simplified modeling technique to achieve a constant dewatering rate. The release rate to simulate dewatering was defined as the practice volume released over 48 hours. When the volume exceeded the green practice volume, the release rate approximately equaled the influent runoff rate.
    - As a test of sensitivity, the release rate was set to zero in some cases to determine the maximum effectiveness of the green opportunity (i.e. what would happen if it controlled 100 percent of the runoff) by completely removing the stormwater subcatchment from the sewer network.

Simulations

The Representative Year was used as the final model simulation used for the analysis steps.

Analysis

The following calculations were made to determine the impact of the green opportunity:

- Percent reduction in peak flow rate and volume at the assessment point on the downstream side of the green opportunity area / site.

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- Reduction in the hydraulic grade line at the assessment point on the downstream side of the green opportunity area / site.
- Percent reduction in CSO volume for the selected single storm event (by overflow).
- Volumetric reduction in CSO volume for the Representative Year (by overflow).
- Comparison of the ratio of the regulator's influent wet weather volume to the overflow volume before and after the green opportunities are applied.

3.3 Opportunity Identification and Narrowing

Green infrastructure project opportunities were identified from a variety of sources. The initial set of project opportunities was based on a broad series of approaches that could result in either stormwater management control to the sewer system or implementation of green infrastructure. This effort generated a list of over 100 opportunities. The approaches used in this effort and the associated results are presented in Section 4.0 of this report.

The selection of projects to include in the LTCP Update was determined in a series of progress meetings and workshops that reviewed project concepts and benefits and selected projects to move forward. The list of project opportunities was initially narrowed to ten for project evaluation and then to five for further project development.

The meetings included the Program Management Team, City staff (CSO, Public Works, Environmental Quality Control, and Parks, Recreation & Public Property), and the Project Team. The opportunity narrowing process was collaborative and was based on effects on the combined sewer system, cost, desires of the various departments and stakeholders, the potential coordination with other projects, and the likelihood as a demonstration project.

For more information regarding opportunity identification and narrowing, refer to Section 4.0.

3.4 Design Development

Green infrastructure designs were developed based on the following process:

- Identification of area that would be tributary to the practice(s). For all of the final projects, this included areas that were served by local storm sewer systems. Additional tributary area was identified based on ground contours and inlet locations.
- Perform hydrologic/ hydraulic modeling as previously described.
- Estimate volume required based on tributary area characteristics and compare with space available for practice(s).
- Develop conceptual profile to determine depth of practices inlet/ outlet elevations. Review readily available utility information from maps and sewer record drawings to address any obvious conflicts. Profile determines feasibility for surface/ subsurface practices.
- Identify and route sewers to collect flows from drainage areas.
- Develop costs and performance data.
- Throughout the development, present interim products to gather input from the PMT, City and Parks.

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The City has existing publications that apply to the design of stormwater infrastructure. These include the Storm Sewer Design Basis and Methodology Guidance (6/27/10) and the Omaha Regional Storm Water Design Manual. The project approach relative to the *Green Solutions Guidance for the City of Omaha Long Term Control Plan* (2008) was previously discussed. Relevant aspects of these documents which needed to be considered in the modeling approach are included in Table 3-5.

Table 3-5 City of Omaha Publications Relevant to Stormwater Infrastructure

Document	Requirement	Application to OPW52456
Storm Sewer Design Basis and Methodology Guidance	Design storm sewers per the City's Stormwater Design Manual Submit design information for review by the City/PMT Apply spreadsheet tool for preliminary 10-year storm sewer sizing Street slopes >1.5%, maximum of 5 acres tributary to the upstream inlet; <1.5% locate at most upstream intersection	Storm sewer sizes, slopes and inlet locations will conform to the storm sewer design basis.
Omaha Regional Stormwater Design Manual (April 2006)	Minor drainage system designed for runoff from the 10-year storm. Major drainage system designed for runoff from the 100-year storm. Storage facilities designed to maintain the peak rates from the 2-, 10- and 100-year storms.	Stormwater management implemented as part of the project was expected to be for smaller events. Modeling assessed larger storms to ensure that system performance is generally equivalent or better than existing conditions.
	Dewatering of facilities in 40 hours	Dewatering criteria assumes 48-hour dewatering duration
City of Omaha Municipal Code, Chapter 32, Section 32-121 to Section 32-123	Provide water quality control of the first 0.5-inch of runoff Maintain the peak discharge rate during the 2-year event to baseline conditions	It was expected that green solutions would provide water quality control of the first 0.5-inch of runoff. This was not directly reflected in the modeling of green infrastructure.

3.5 Capital and Present Value Costing

Capital and present value conceptual costs were estimated for each project during the project evaluation and development phases to quantify project budgets and to assist in ranking the projects. The projects costs were divided into gray infrastructure costs and green infrastructure costs. The gray infrastructure costs include the storm pipes and structures necessary to convey and outlet stormwater to and from a green infrastructure practice. The costs were divided in this way so that the gray infrastructure costs could be estimated using the City of Omaha's Project Capital Cost Summary Costing Tool (Costing Tool), and the green infrastructure costs, which included surface and subsurface storage, were estimated using customized pay items that were compiled in a table. Costs within the Costing Tool and for each individual green infrastructure pay item were adjusted to ENRCCI 9668 (December 2013).

The multipliers used for the total project costs are 67% to 77% based on those from the Costing Tool. The multipliers include administration, contingency, interest, miscellaneous, field engineering/inspection, design & engineering services, program management, planning and preliminary design, and bond multipliers.

- If the sum of 'total estimated constructed' is less than $350,001, contingency is 35% (total multipliers= 77%).
- If the sum is between $350,001 and $1,100,001, contingency is 30% (total multipliers= 72%).
- If sum is greater than $1,100,001, contingency is 25% (total multipliers= 67%).

3.5.1 Gray Infrastructure Costing

The majority of the infrastructure quantified in the Costing Tool was the length of open cut sewer used to convey stormwater to the green infrastructure practices. The costs for the Costing Tool rely on the Engineer's Estimated Prices that are continually being updated.

Related to open cut sewer, the Costing Tool parameters include:

- Construction cost includes start up, excavation, backfill, site preparation, materials, labor, equipment, and finish construction
- Excavation and backfill costs use the user-inputted average pipe depth, pipe length, and trench width values to calculate the volume of soil removed. Trench width is based on the pipe size.
- Pavement removal and replacement is based on the length of pipe in the street and the street width.
- Diameters of manholes are based on pipe size entered. Cost is based on the Engineer's Estimated Prices and uses the average depth for a vertical foot price.

The user-inputted assumptions for each project site include:

- A manhole every 400 feet, at breaks in grade, and at inlet connections.
- Inlets not meeting current standards would be removed and replaced.
- 3-foot minimum cover over sewer pipes.
- The trench width was assumed to be the depth of pipe x2 for road removal purposes.
- The depths of sewers were based on existing data from record drawings and GIS.

3.5.2 Green Infrastructure Costing

To better reflect the conceptual design of the green infrastructure practices envisioned for the projects, a pay item template was developed and used instead of using the Costing Tool. The pay items were compiled at a conceptual level and do not correlate directly with Omaha standard pay items. The unit costs assigned to each pay item are included in Table 3-6. These unit costs were derived from Omaha bid tabulations and bid tabulations from similar projects in Michigan. The unit costs were adjusted to ENRCCI 9668 (December 2013) and to Omaha using RS Means city factors as

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needed. The adjusted unit costs were further reviewed by local Project Team members as confirmation.

The subsurface storage unit cost is an average of the unit costs quoted to the Project Team by several different vendors of subsurface storage products. The vendors include Triton Stormwater Solutions (open bottom arched pipe), Atlantis (modular rectangular chambers), StormChamber (open bottom arched pipe), and Contech - ChamberMaxx (open bottom arched pipe). The unit costs include the product, excavation to install the product at minimum depth, backfill, aggregate, and installation. Extra excavation required to place the product at the design depth was accounted for in the pay item "Excavation and Fill above Top of Storage Structure." The conceptual design depth for these storage structures to allow discharge back to the sewer system was based on existing data from record drawings and GIS.

One exception to the use of the cost template is the costing for the bioswales in Hanscom Park. The bioswale cost estimates were developed based on the bid tabulation from the Elmwood Park Green Infrastructure Project (part of the Aksarben Village Sewer Separation Project).

Table 3-6 Green Infrastructure Costing Template

Line Item	Item Description	Quantity	Unit	Unit Cost	Total
General Pay Items					
1	Excavation and hauling		Cyd	$18.00	
2	Clearing and Grubbing		Ac	$10,000.00	
3	Pavement Removal		Syd	$6.00	
4	Asphaltic Concrete, 3.5-inch thick, and 6-inch aggregate		Syd	$36.00	
5	Concrete, 6-inch, and 6-inch aggregate		Syd	$48.30	
6	Concrete Sidewalk, 6-inch		Sft	$5.70	
7	Tree Removals, General		Ea	$550.00	
8	Tree		Ea	$550.00	
9	Surface Restoration, sod		Syd	$6.40	
10	Surface Restoration, seed		Syd	$ 2.00	
Surface Storage Pay Items					
11	Machine Grading		Syd	$14.30	
12	Flared End-Section, 24-inch		Ea	$915	
13	Flared End-Section, 60-inch		Ea	$8,000.00	
14	Riprap for Sediment Forebay, grouted		Cyd	$150.00	
15	Cleanout, PVC, 6-inch		Ea	$375.00	
16	Growing Medium		Cyd	$40.60	
17	Aggregate Filter Layer		Cyd	$35.00	
18	Open Graded Aggregate		Cyd	$35.00	
19	Geotextile Separator		Syd	$3.75	
20	Masonry Retaining Wall		Sft	$33.30	
21	Native Plant Plugs		Sft	$5.20	
22	Native Seeds		Syd	$2.00	
23	Underdrain, 6-inch		Ft	$22.00	
24	Gate Valve for Underdrain		Ea	$700.00	
25	Cored opening, 6-inch		Ea	$500.00	
Subsurface Storage Pay Items					
26	Subsurface Storage Unit		Cft	$7.50	
27	Excavation and Fill above Top of Storage Structure		Cyd	$10.00	

3.5.3 Operation & Maintenance and Present Value Costs

Annual maintenance costs for gray infrastructure were estimated by the Costing Tool. The surface storage annual maintenance cost was estimated as 2.5 percent of the capital cost per Erickson *et. al* (noted below). Subsurface storage annual maintenance cost was estimated as $400 for vacuuming out each inlet sump per a Contech sales representative.

- Erickson, A. J., Kang, J., Weiss, P. T., Wilson, C. B., and Gulliver, J. S., (2009). Maintenance of Stormwater BMPs. *World Environmental and Water Resources Congress 2009: Great Rivers, ASCE.* (pp. 1364-1371).

Present value costs were calculated for the green infrastructure practices assuming a 20-year life cycle and a discount rate of 6 percent for the annual maintenance cost. The 6 percent discount rate is in agreement with the rate used in the Costing Tool.

3.6 Project Prioritization

The final green infrastructure opportunities (Section 4.4) were prioritized to help guide the future implementation of the projects. Budget constraints will likely impede the implementation of all of the final sites so a set of ranking criteria were developed to assist in prioritizing the projects.

Two groups of ranking criteria were used to prioritize projects. The first group focused on quantifiable and objective criteria based on the calculated hydrologic performance and costs for each practice. The second group considered subjective ranking of the impacts and benefits, and scoring relied on general consensus amongst the Project Team. The ranking criteria, scales and weighting factors used were based on input received during project meetings and review periods. The methodology used reflects comments received by City departments and the PMT.

The first group included the calculated reduction in CSO volume for the representative year; the cost per annual CSO gallon managed, and what CSO control strategy is being used downstream of the practice. The cost per annual CSO gallon managed is the 20-year life cycle cost estimate for the practice divided by the reduction in the representative year CSO volume with the practice in place. The first group focused on specific quantifiable results based on the conceptual design.

Table 3-7 summarizes the first group of prioritization criteria; the objective criteria based on the conceptual design and modeled impact. The five point ranking scale for the CSO Benefit and Unit Cost information was developed by evenly distributing the range of results. The CSO control strategy, having only two possible answers, was assigned to the two extreme ranking values. A storage tank approach to managing CSO was ranked higher than a tunnel due to the ability to affect the cost of the control strategy.

Table 3-7 Objective Practice Ranking Criteria (Group 1)

Ranking Scale	CSO Control Strategy	CSO Benefit	Unit Cost
Generalized 5 point ranking scale	The overall approach to managing CSOs	Reduction in the Representative Year CSO Volume	Cost per annual CSO gallon managed ($/gal)
1	Tunnel	Reduction < 1MG	Cost ≥ $1/gal
2		1 ≤ Reduction < 4MG	$0.75 ≤Cost < $1.00/gal
3		4 ≤ Reduction < 7MG	$0.50 ≤ Cost < $0.75/gal
4		7 ≤ Reduction < 10MG	$0.25 ≤ Cost < $0.50/gal
5	Tank	Reduction ≥ 10MG	Cost <$0.25/gal

The second group of ranking criteria is subjective in nature and includes the impact to parks; the opportunity to coordinate with other capital improvement projects; whether the practices are visible and can be used to garner support for other similar projects; and if the project provides a unique demonstration opportunity. The subjective second group of ranking criteria was only used as additional information to consider and was not the primary ranking means.

Table 3-8 summarizes the subjective set of ranking criteria used as the second group. The five point ranking scale assumed a strong negative response has a value of 1, a neutral response a value of 3, and a strong positive response a value of 5. Assigning a rank to each practice for each criterion was done by consensus among the Project Team.

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Table 3-8 Subjective Practice Ranking Criteria (Group 2)

Ranking Scale	Parks Improvement	Moments of Opportunity	Drainage / Flooding Benefit	Educational or signature project benefit	Technology Demonstration Information
Generalized 5 point ranking scale	Impact to the parks	Projects can be coordinated with other capital improvement projects	Impact on local drainage or flooding problems	Visible and can be used to garner support for other similar projects	Fills a gap in local project types/ evaluation potential
1	Significant Neg. Impact	Definitely won't	Significant Neg. Impact	Definitely won't	Definitely won't
2	Slight Negative Impact	Probably won't	Slight Negative Impact	Probably won't	Probably won't
3	Neutral	Neutral	Neutral	Neutral	Neutral
4	Slight Positive Impact	Probably will	Slight Positive Impact	Probably will	Probably will
5	Significant Positive Impact	Definitely will	Significant Positive Impact	Definitely will	Definitely will

The five point ranking scale was used for each criterion to assign a ranking score. Equal weight was assumed between the ranking criteria. An example of the scoring is provided in Table 3-9. This is a hypothetical example showing the calculations of the scoring. The total scores for each practice were then used to sort the practices in priority order.

Table 3-9 Example Scoring Calculation

Description	CSO Control Strategy	CSO Benefit (Annual Volume Reduction)	Unit Cost	Score
Hypothetical results	Tunnel	8.3 MG	\$0.67/gallon	-
Rank Category	Tunnel	7 ≤ Reduction < 10MG	\$0.50 ≤ Cost < \$0.75/gal	-
Rank Scale	1	4	3	8

4.0 Project Opportunities

Starting with a list of over 100 opportunities, a series of evaluations and project meetings were conducted over a six month period to discuss and prioritize projects that would be included in the LTCP Update. During the course of this work, project scopes, performance assessments and cost estimates were continually refined based on the collaborative work. . The goal was to narrow the opportunities to ten for project evaluation and then to five for further project development (Section 3.3). This section describes the information gathered to complete the total opportunity set and then the process used to select the five locations for project development (Figure 3-1). Many of the tables and figures referenced in this section are found in Appendices A and B. These appendices include the more extensive lists of opportunities, and tables and figures that indicate the potential of various projects.

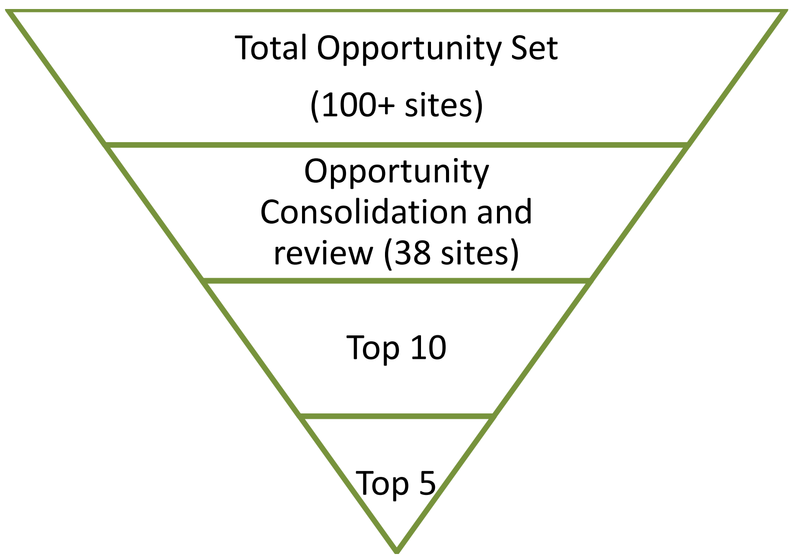

Figure 4-1 Opportunity Narrowing Process Schematic

4.1 Opportunity Identification (Total Opportunity Set)

4.1.1 Methodology

This effort identified and prioritized potential placement opportunities for green infrastructure. Opportunity identification focused on green infrastructure projects that can be implemented as stand-alone projects within the study areas. The proposed opportunity list was developed from many independent analyses each identifying a number of candidates.

Analyses which were used to develop the total opportunity set include the following:

1. Review of opportunities previously identified in Green Solutions Technical Memoranda associated with the Long Term Control Plan (2008 time frame).
2. Opportunities identified through the efforts of the Project Management Team.

3. Opportunities to manage separated stormwater that is tributary to the Combined Sewer System.
4. Opportunities to manage imperviousness on public and privately owned properties.
5. Opportunities that result from motivated landowner or institutional partners.
6. Other opportunities based on a review of other data, land use or sewer system configuration.

4.1.2 Results

Previous Green Solutions Opportunity Identification

Green solutions technical memoranda were originally prepared as part of the LTCP development. The memoranda were prepared in 2008 by the basin consultants. For each study basin the consultant was to evaluate green infrastructure opportunities, with a primary focus on sites identified through the program-wide site suitability evaluation. As part of the current green infrastructure opportunity evaluation, the Project Team reviewed each of the earlier technical memoranda to identify potential locations where green infrastructure may be feasible at this time. The prior data were reviewed and considered from the current perspective of green solutions. The following list summarizes the differences between the current study (2014) and the earlier work (2008):

1. It was assumed that green infrastructure has the potential to reduce the size of other CSO controls. The prior premise was that green infrastructure provides only an enhancement in performance.
2. Where a parcel such as a park or boulevard provides a potential location for green infrastructure, its ability to store / treat runoff from adjacent tributary areas should be maximized. Prior evaluation of using parcels for adjacent tributary area was limited.
3. Potentially feasible green infrastructure sites include private or impervious sites. Prior work focused on publically-owned green space.

The green solutions evaluation performed in 2008 generally began with locations identified in the site suitability tool. These sites were reviewed and specific locations were retained for further assessment as part of the basin consultant evaluation. These sites were then supplemented with additional locations and sumps that provided a potential for implementation of green solutions projects. As part of the current effort, the "opportunity set" was a collection of sites considered in the prior evaluation. This is depicted graphically below.

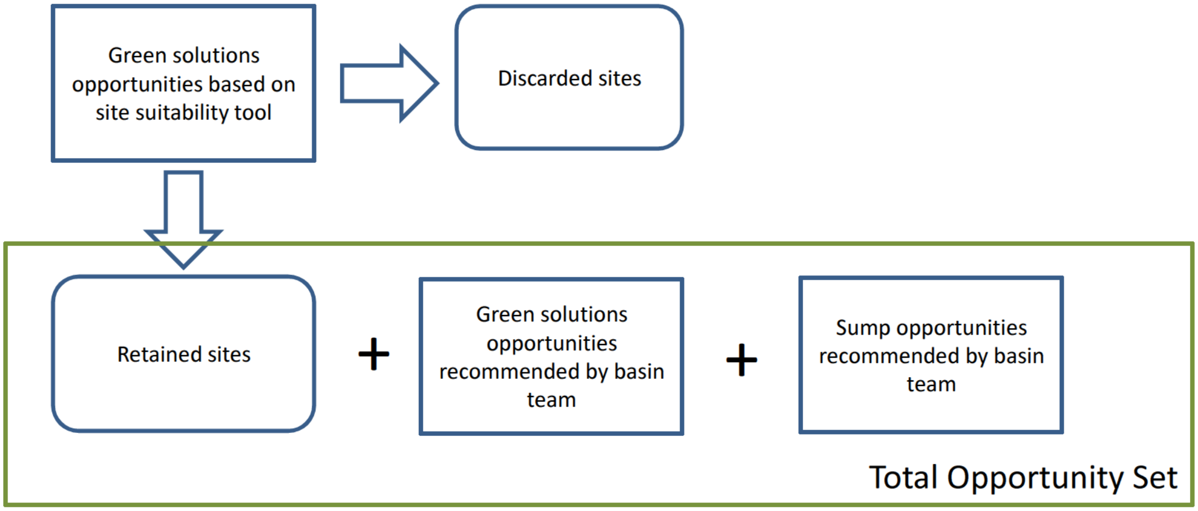

Figure 4-2 Project Opportunity Set Defined from Prior Technical Memoranda

A total of 35 opportunities were identified through this approach. These opportunities were reviewed and 14 opportunity groups remained after this evaluation. These are identified below. The complete list of 35 opportunities is included in Table B-1 and shown in Figure A-1.

Information evaluated for these opportunities included: CSO Basin, identifier, location, description, feasibility comments from prior work, project status, parcel size, drainage area (from original study), review of whether tributary areas to the site were considered (if so, where), available storage volume, ability to control 1 inch of runoff, primary green solutions considered, cost/gallon (prior work), and comments.

Table 4-1 Priority List of Basin Consultant Technical Memoranda Opportunities

Planning Basin	Opportunity Group	Included Sites/ Locations
Burt-Izard	Kountze Park	Kountze Park
Burt-Izard	Turner Blvd Corridor	Dewey, Leavenworth Parks, I-480 Interchange
Burt-Izard	Gifford Park	Gifford Park
Burt-Izard	Bemis Park	Bemis Park
Leavenworth	James F. Lynch Park	James F. Lynch Park
Leavenworth	Hanscom Park	Hanscom Park
Ohern/Monroe	Field Club Trail Corridor	38^{th} & Frances/ Field Club Trail
Ohern/Monroe	Upland Park	Upland Park
Saddle Creek	Schroeder/ Vogel Park	Schroeder/ Vogel Park
Saddle Creek	University of Nebraska Medical Center (UNMC)	UNMC
Saddle Creek	Douglas County Health Center	Douglas County Health Center

Planning Basin	Opportunity Group	Included Sites/ Locations
Saddle Creek	Norris Middle School	Norris Middle School
South Interceptor	Deer Hollow Park South	Deer Hollow Park South
South Interceptor	Henry Doorly Zoo	Henry Doorly Zoo

Locations of opportunities in the project area were mapped and are presented in Figure A-1.

Program Management Team (PMT) Identified Opportunities

The PMT identified a number of potential green infrastructure opportunities based on an updated site suitability tool. Details of the analysis were summarized independently by the PMT in a Technical Memorandum.

The primary result of the analysis by the PMT was a listing of 23 opportunities for consideration. Table B-2 includes the list of the PMT opportunities and corresponding comments from the Parks, Recreation, and Public Property Department and the Project Team. Opportunities recommended for further consideration by the Project Team are included in Table B-2 as well. Figure A-1 shows the location of the PMT identified opportunities.

Concentrated Stormwater Opportunities

As part of the review of existing conditions, portions of the combined sewer system that are served by separated storm sewers were reviewed. Sewers of this type are typically classified as "storm combined" in GIS. These locations could include the following:

- Areas previously separated as part of a Renovation of Combined Sewer (RNC) project, or,
- Areas constructed with separate storm sewers even though located in a combined sewer area.

The Project Team objective was to identify potential areas of separated flow that could be managed prior to re-entry to the combined system.

The Project Team also visually examined sewers classified as "storm" within the CSO basin areas. This GIS classification is intended to apply to storm sewers that discharge through a storm outfall, rather than through the combined sewer system. Despite the classification, some of the "storm" sewers did not appear to discharge through a storm outfall and were therefore further analyzed as a concentrated stormwater opportunity.

Fifty locations of concentrated stormwater were identified and delineated within the project study area. Locations are shown on Figure A-1. These locations represent the vast majority of potential candidates for green infrastructure controls.

Concentrated stormwater opportunities were consolidated into opportunity groups which would correspond to potential projects. For each group, the drainage area associated with the separated stormwater was identified as well as the feasibility of managing that stormwater based on best professional judgment.
Concentrated stormwater opportunities are summarized in Table B-3.

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The potential impact associated with concentrated stormwater opportunities by planning basin is summarized below.

Table 4-2 Concentrated Stormwater Opportunity Drainage Area by Planning Basin

CSO Planning Basin	Basin Area (acres)	Concentrated Stormwater Drainage Area (acres)	Concentrated Stormwater Drainage Area as Percent of Basin
Burt-Izard	3,233	325	10
Cole Creek	4,329	60	1
Leavenworth	2,111	310	15
Ohern/Monroe	3,543	721	20
Saddle Creek	3,632	314	9
South Interceptor	1,657	31	2

Large parcels that are internally separated represent similar opportunities for flow management. Information on site drainage characteristics was not available as part of this effort. Future efforts could include identification of these types of opportunities.

Impervious Management Opportunities

The Project Team defined density of impervious areas on a block scale for the project area. The objective was to identify locations where relatively significant runoff is generated (e.g. volume/acre is higher for that location). This in turn would support an evaluation of whether select source controls or on-site opportunities may exist (either on-site or down gradient).

Because there are numerous incidences in which parcel boundaries cross contiguous impervious footprints, parcels alone were ineffective at defining adjoining, impermeable areas from which stormwater runoff is generated. To better define aggregated impervious areas such as adjacent buildings, parking lots, sidewalks, etc., contiguous areas were defined based on street center lines. This resulted in polygons that identify “blocks”.

This process had some limitations, specifically the following:

1. Street block polygon creation poorly represented areas along rivers and railways, and other areas that are not completely bounded by streets. This artifact results in some tracts along the river which are not bounded by streets to be excluded from block polygons.
2. Areas along some roadways, railways, and parks are aggregated into larger “blocks” when streets do not easily define or impervious area boundaries or create much larger “block” areas. For this reason, rankings were determined based on the percentage of impervious area to the total polygon area. In some instances, the impervious area was grouped with larger pervious areas when a street did not separate these land covers (e.g., between Douglas County Medical Center and the Field Club).
3. Parcels and polygons were not always completely within watershed basin boundaries resulting in some identified blocks overlapping with several basins or outside of the CSS area.

Based on the analysis, the 25 blocks with the highest degree of imperviousness were selected for further analysis. For each location identified the following information was reviewed:

- Location
- Block total size
- Percent impervious
- Number of owners, parcel ownership

Identified imperviousness management opportunities are summarized for the top 10 impervious blocks in Table B-4 with the top 25 blocks shown in Figure A-2. Table B-4 lists the number of parcel owners as a means of understanding the complexity of working on impervious management strategies within the block.

Project Partnership Opportunities

Major landowners represent an opportunity to manage stormwater for the benefit of CSO control. These landowners have the ability to implement infrastructure that can control on-site stormwater in a manner that is consistent with City of Omaha CSO objectives. Based on the knowledge of various institutions in the community (including their potential interest in progressive stormwater management), the following list of possible partners was developed.

- City of Omaha (parcels only)
- Creighton University
- Metropolitan Community College
- University of Nebraska Omaha
- University of Nebraska Medical Center (UNMC)
- Alegent Creighton Health
- Omaha Public Schools
- Omaha Catholic Schools
- Archdiocese of Omaha
- Douglas County
- Henry Doorly Zoo
- Omaha Botanical Center/Lauritzen Gardens
- US Government (federal) facilities

This list of potential partner opportunities resulted in identification of over 2000 parcels. Because of this, the Project Team elected to narrow down the possibilities based on parcel impervious percentage. This was accomplished through the impervious block polygons that were created as part of the impervious area analyses.

A preliminary list of partnership opportunities was compiled. For each of the opportunities, the following information was reported:

- Location, mapped showing CSO basin
- Primary partner ownership
- Partner total area (acres) and imperviousness percentage

Project partnership opportunities are summarized in Table B-5 and Figure A-3.

Additional partnership opportunities that were not identified based on the percentage of impervious area (because of aggregation with the Field Club; see impervious area complications above), but were known to be potential participants include:

- Omaha Veterans Affairs Medical Center
- Douglas County Health Center

The Henry Doorly Zoo was identified as a partner because of its extensive impervious parking lot (as listed in Table B-5). However, the other portions of the zoo also provide an opportunity to apply source control practices to limit the runoff volume and pollutant loads that can contribute to overflow problems.

Special Opportunities

Opportunities for green infrastructure implementation may occur as part of redevelopment on parcels or enhancements within the right-of-way. Opportunities could be identified and implemented in a programmatic approach or could be implemented at the project level. The Project Team identified a number of potential opportunities which the City should consider for further follow-up.

Identified special opportunities include the following:

- Neighborhood enhancements as part of redevelopment plans. The following specific opportunity was identified:
    - 24th Street Area Parking District (roof and parking lot flow management). The parking and community needs in this distinctive South Omaha portion of the City were discussed in the *South Omaha Development Project Master Plan.* In this area private parking lots sheet flow into the street right-of-way and roof drainage discharges onto public alleys. The opportunity would be to pilot management of these flows on public property, not requiring direct involvement with private property owners. See the figure below of the South 24th Street Parking District (excerpted from the *South Omaha Development Project Master Plan)*.

      This area could serve as an example for other locations in the City where site drainage is tributary to rights-of-way and could help establish costs and implementation issues. An analysis of this area was funded separately through the City's stormwater funds.

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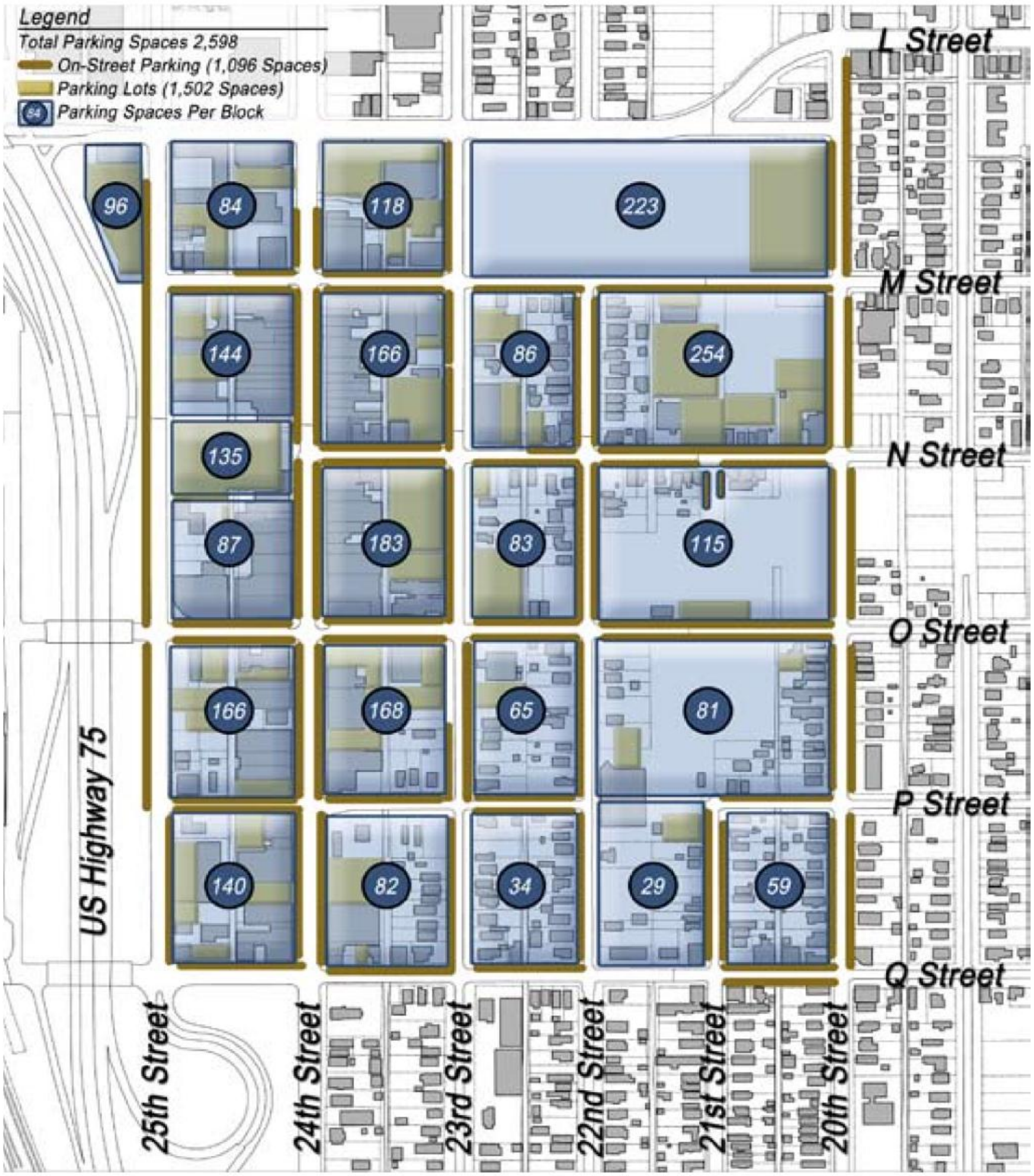

The diagram above summarizes parking availability surrounding the South 24th Street Business District. It includes all parking lots (public and private) and on-street parking. Parking lots are shown in tan. On-street parking is indicated in brown. The number in the middle is the total number of parking spaces available on the indicated block. 25th Street is shown with the proposed re-striped diagonal parking along the west side of the street.

Figure 4-3 Excerpted from the South Omaha Development Project Master Plan (Figure 8.3).

- Green streets opportunities. As streets are reconstructed or included in streetscape enhancement projects, opportunities exist to revise the road configuration to better manage stormwater while improving aesthetics and traffic and pedestrian safety. Some suggested locations to consider:
  - Harney is in the process of an initial-phase alignment study. Saddle Creek, Burt-Izard and Leavenworth basins.
  - Florence/ 20th from Paul to Grace Streets. These one way streets have multiple travel lanes and are fronted by single family homes. Residents need to back into the street to exit their drives. There are limited street trees in this location. Use of green streets for stormwater management and traffic calming could achieve multiple objectives in this location. These streets may be under consideration for conversion to two-way. See street-view image below. Burt-Izard basin.

  - Leavenworth, east of I-480. This street is almost exclusively impervious within and outside of the ROW. Identified as a green street in the City's green streets plan, and located within the Leavenworth basin, development as a green street would stormwater management could aid in the reduction of CSO discharges.
  - Roadways discussed in the *South Omaha Development Project Master Plan.* These locations have been identified as candidates for a revised roadway cross section. Figures presented in the report suggest that curb extension bioretention is desired for traffic calming and aesthetics.
    - Q Street, 27th to 42nd: SODP suggested new road cross section for better pedestrian experience. Addition of center turn lane. Ohern-Monroe basin.

- 13th Street, I-80 to the South: South Interceptor and Ohern-Monroe basins. Wide ROW, several recommendations for "more pedestrian friendly" areas. The report suggested that with the demolition of Rosenblatt Stadium traffic peaks would be less significant.
- L Street, 36th – 24th: Extensive impervious area. Could include frontage properties. Ohern-Monroe basin.

- Management of stormwater generated on NDOR rights-of-way, particularly interstate (or expressway) areas. In multiple locations throughout the combined sewer area, drainage from interstate right of way areas enters the combined sewer system. This stormwater drainage represents large acreages of impervious area. Approaches to manage this flow could be comprehensively explored. The project team identified the following specific location where NDOR drainage could be managed.
  - I-480 parking lots. Between 20th and 14th Streets. At this location, I-480 is an elevated freeway. The area underneath the expressway is developed as parking areas. Flow from these parking lots and the overhead bridge decks generally flows overland to the combined sewer system in the area. Green space is immediately adjacent to the parking lots in most locations, providing an opportunity to manage the runoff on site. Burt-Izard basin.

- Use of vacant/ abandoned properties. The State of Nebraska recently enacted land bank legislation that provides additional opportunities for repurposing of vacant/ blighted parcels. The Omaha Department of Public Works has discussed using these properties to support stormwater management needs. This should be considered as a programmatic approach going forward. It did not identify any specific opportunities as part of this evaluation.

4.2 Opportunity Consolidation and Review (38 Opportunity Candidates)

The large set of opportunities were filtered and evaluated in order to narrow the options for near term implementation.

4.2.1 Methodology

The potential opportunities from the total opportunity set were consolidated to remove duplicates. They then were further reviewed and potentially eliminated using best professional judgment considering the general characteristics described in Table 4-3. More specific criteria describing impact, feasibility, benefits, and financial efficiency are presented in Table B-7.

During this review, notes were made by the Project Team to aid in reducing the total opportunity set and are included in Table B-1 through Table B-3. These tables are presented in Section 4.1.

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Table 4-3 General Characteristics for the Review of Opportunities

Impact	Feasibility	Benefits	Financial Efficiency
This is a quantitative criteria that evaluates the area of runoff and imperviousness that is controlled. It also considers the CSO responsiveness based on stormwater volume potentially removed that can affect the volume of CSO overflow that is traditionally generated.	These criteria can be divided into two subcategories which include technical feasibility and institutional feasibility. Technical feasibility considers whether the site and envisioned management are conducive with the terrain (slope). Institutional feasibility considers whether the project site is on public property, a valued partner, or on private property. Other additional considerations are whether the project site is within a redevelopment planning area, a City ROW priority area, or whether the site has opportunities for repurposing of abandoned and vacant properties.	Benefit considerations include areas that create or enhance a landmark or Omaha signature project, high value demonstration opportunities, areas that include revitalization, alleviate existing residential or community problems such as localized flooding or sanitary sewer issues (e.g. sewer backups).	Financial efficiency includes a cost per volume of potential CSO removed or other City determined cost metric.

4.2.2 Result

The resulting opportunity candidates based on review by the Project Team are presented in Table B-6 along with associated data. There were 38 opportunity candidates. Figures A-4 through A-31 show each opportunity candidate deemed worthy of review in the September 2013 project selection workshop. The figures include the following information overlaid on an aerial image:

- Preliminary tributary drainage area
- Concentrated stormwater tributary drainage area
- potential green infrastructure locations
- existing combined, sanitary, and storm sewers

4.3 Top 10 Opportunities

4.3.1 Methodology

The 38 opportunity candidates were reviewed with the City/PMT at the project selection workshop on September 24, 2013. The group collectively graded projects as A, B, C or D based on judgment related to impact, feasibility, benefits, and financial efficiency (Table B-8 and Table B-9). Category A projects reflected a clear opportunity to manage stormwater with additional benefits. Category D projects included a fatal flaw, typically an environmental concern. Both category B and C projects appeared worthwhile, although category B projects were felt to be more feasible in the context of the Long Term Control Plan Update.

During the workshop, eight of the 38 opportunities were tabled for future evaluation and were not graded. These eight opportunities fell under these categories:

- Expressway flow management. This effort would be coordinated with NDOR and would need to evaluate the specific points of stormwater entry into the combined system and opportunities for stormwater management.
- Green street opportunities. In general, these opportunities require more lead time than is available within the project context and would require significant internal coordination. They were thus excluded from the initial projects identified for evaluation.

At the end of the workshop, 16 opportunities were listed for further evaluation.

4.3.2 Result

Following additional information gathering, the list was refined in a conference call on October 17, 2013 from 16 to ten opportunity candidates. The final ten opportunities are listed in Table B-8. The remaining six of the 16 opportunities were not included for one of the following reasons as noted in Table B-9.

- Partnership opportunities were not included because they can be revisited later in conjunction with the property owner.
- The opportunity will be evaluated in conjunction with a top 10 opportunity candidate.
- The opportunity was selected for evaluation through the City's MS4 funds. This project will be evaluated external to OPW52456.

Table B-9 lists the remaining graded opportunities from the initial list of 38 that will not be evaluated at this time.

4.4 Top 5 Opportunities

4.4.1 Methodology

Ten opportunities were selected to be evaluated for feasibility, performance, and cost. The evaluation process included the following for each opportunity:

- Refining the tributary drainage areas from the September workshop.
- Laying out storm pipe, as needed, to convey stormwater to the green infrastructure practices.
- Placing the green infrastructure practice on the site.
- Proposing the type of green infrastructure practice; surface storage, subsurface storage, or bioswale.
- Drafting pipe and practice profiles in critical locations to confirm feasibility.
- Producing runoff volumes from the tributary drainage area using impervious cover data.
- Comparing the runoff volumes from the impervious cover data to the runoff volumes from the Infoworks model.
- Evaluating the runoff capture efficiency of each green infrastructure practice for a 1.4-inch rain event.
- Estimating project capital, maintenance, and present value costs (Section 3.4).

- Producing drawings in GIS and Civil 3D.

At the November 12, 2013 workshop, preliminary site layout and drainage areas were presented for each of the 10 opportunities. Two of the opportunities, I-480 Parking Lots and Upland Park, were placed on hold and later eliminated from further evaluation due to the limited benefit the project would provide to the combined sewer system. The preliminary drawings for these two opportunities are in Appendix C.

The remaining eight opportunities were presented at the December 17, 2013 workshop for review with drawings, costs, and performance. At the end of the workshop, five opportunities were selected for project development.

4.4.2 Result

Within the five opportunities that were selected for project development are 14 green infrastructure sites. The 14 green infrastructure sites include the following:

- Field Club Trail (Ohern/Monroe Basin)
  - Frances Street
  - Gold Street
  - Frederick Street
  - Vinton Street
- Hanscom Park (Leavenworth Basin)
  - Hanscom Park – north
  - Hanscom Park – west
  - Hanscom Park – east
- Kountze Park (Burt-Izard Basin)
- Schroeder-Vogel Park (Saddle Creek Basin)
- Turner Boulevard (Burt-Izard Basin)
  - North Turner Park
  - Dewey Park
  - Leavenworth – north
  - Leavenworth – south
  - Pacific Avenue

Refer to Appendix D for a location map of the 14 green infrastructure sites.

To avoid confusion, the December workshop meeting review packets for the five selected opportunities are not included in this report. Rather, the final conceptual design packets are included in Appendices E though I; one appendix per opportunity.

The three opportunities plus one green infrastructure site that were not passed on to the project development phase are included in Appendix C. These include Gifford Park, Norris Middle School, Bemis Park, and Mason Street (part of Field Club Trail).

More details regarding the selected 5 opportunities are in Section 5.0.

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5.0 Green Infrastructure Project Development

The objective of the project development phase is to develop the five green infrastructure projects (consisting of 14 site designs) to a conceptual level of detail to be included in the Long Term Control Plan. The site designs produced thus far in the evaluation process were expanded upon in the project development phase. Specific elements included in the development packets for each site include the following:

- Tributary drainage areas to each green infrastructure practice were refined based on curb inlet locations and topography.
- Plan sheets were created in AutoCAD for each site showing an aerial image, proposed green infrastructure practice placement, potential utility conflicts, grading for surface features, and proposed gray infrastructure (i.e. piping, diversion structures, inlets, and manholes).
- Profiles were developed for complicated intersections of pipe and practices to review constructability and feasibility.
- Modeling was performed to assess the impact a practice will have on the downstream combined sewer. This information is presented using flow duration curves and flow exceedance curves.
- Capital and present value costs were compiled for each practice.
- Each site was prioritized based on a set of qualitative and quantitative criteria. This will help direct the implementation of the projects in the future.

The methodology used for developing the elements above is included in Section 3.0.

This section presents the five project sites (groups) with 14 green infrastructure elements within those five project sites. The main body of Section 5.0 is dedicated to describing the key considerations and initial emphases leading to the final conceptual design for each site. The final conceptual designs are presented in a packet in the appendix. The appendices include the following:

- Project "factsheet"
- Green Infrastructure Drainage area map
- Plan view scaled drawing with practice placement and utilities.
- Profiles of storm sewer and practices for complicated areas.
- Surface storage conceptual cross-sections
- Costing (green, gray, total, and present value)
- CSO Performance Evaluation (based on model evaluation)

5.1 Field Club Trail

The Field Club Trail (FCT) is 1.7-mile linear corridor, owned by the City of Omaha, which starts at Leavenworth Street and runs south to Vinton Street. The FCT was historically an old railroad bed that ran through Field Club neighborhood. Green infrastructure opportunities were evaluated along the full length of the FCT and immediately south of I-80 between the freeway and the railroad tracks. The 100-foot wide corridor consists of the paved pedestrian trail and a vegetated/wooded buffer on either side of the trail. The northern portion of the trail, which begins just south of the University of Nebraska Medical Center, sits as much as 30 feet below-grade. In some locations, homes are directly adjacent to the trail right-of-way with little to no vegetated buffer. The trail runs adjacent to Harrison Heights Park before ending at the old grain silos on Vinton Street. Woolworth Street is a CSO basin divide with the area north of Woolworth Street a part of Saddle Creek Basin and the area south of Woolworth Street a part of Ohern/Monroe Basin.

There were a variety of key considerations and discussion points early on when investigating options for Field Club Trail. These key considerations helped mold the final conceptual design. Eleven drainage areas were evaluated for stormwater management and CSO reduction during the early development of this project (Figure 5-1), with a total potential managed area of just over 300 acres. In addition, the VA medical center (west of the trail south of Woolworth); and the Douglas County Hospital (west of the trail, north of Woolworth) are in the Field Club Trail area and were evaluated separately as part of institutional partners.

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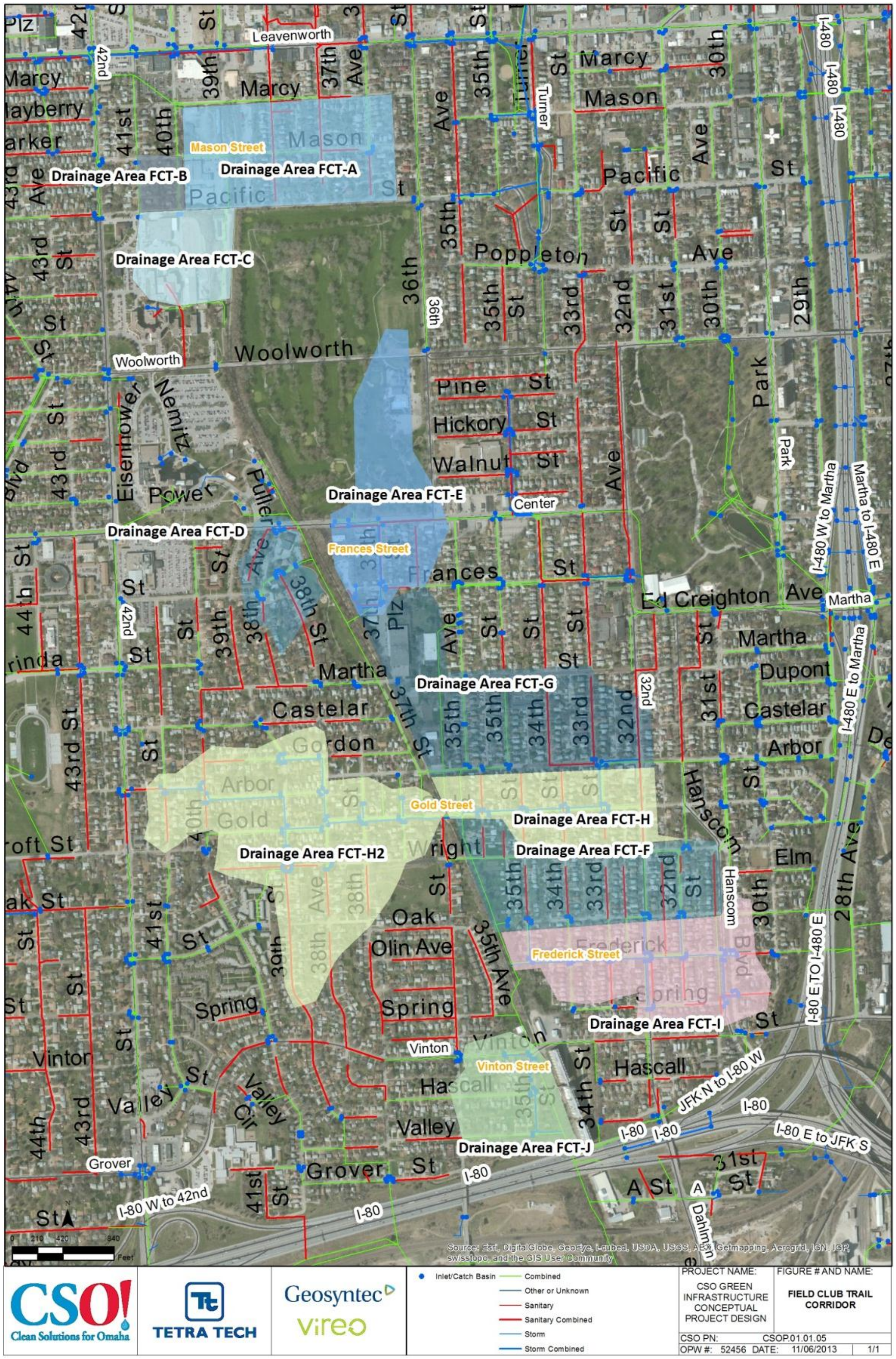

Figure 5-1 Drainage Areas Considered for Management with Green infrastructure

The initial emphasis and considerations along the trail include the following:

- Multiple local separation projects have been completed along the trail corridor. The primary concept of the Field Club Trail project was based on intercepting these concentrated stormwater flows along the trail. This maximizes the prior investment in sewer infrastructure.
- The VA Hospital and Douglas County Hospital are large sites at the north end of the FCT corridor (Drainage Area FCT-C) with extensive parking areas that drain toward the trail. The VA Hospital reportedly is doing some master planning work. In the Saddle Creek basin portion of the trail, the University of Nebraska Medical Center is acquiring a number of parcels, presumably for campus expansion. All of these major landowners represent opportunities to manage stormwater runoff as these sites are improved. Douglas County has previously implemented some green infrastructure on their site. However, because work with these properties is not in the complete control of the City, these opportunities were not included in later concepts.
- Areas adjacent to the trail may provide additional area for green infrastructure practices. This may require some property acquisition/drainage easements adjacent to the trail. Property owners of interest include Omaha Public Housing at Frances Street and the railroad property at Frederick Street.
- Stormwater management south of I-80 was evaluated as this land is open. The Parks, Recreation, and Public Property Department is in the process of acquiring right-of-way for the South Omaha Trail that would continue under the I-80 bridge and extend to the west. This property acquisition is only of sufficient width to accommodate a trail. While the open space south of I-80 could be used for stormwater management, the surface grade, ownership and prior use of the site and the difficulty of conveying stormwater to this made it unattractive. Therefore, this option was abandoned.
- The Mason Street right of way in the vicinity of the trail doesn't include a street. Tributary areas and pipe runs were evaluated to this location (Appendix C.6). This was not a concentrated stormwater location so pipe runs were extensive to pick up runoff. This opportunity was eventually dropped due to the extensive need for pipe.
- The Department prefers subsurface storage along the corridor, although open swales in some areas may be an option. The width of any practice is limited as well in order to preserve the tree canopy along the corridor. During construction, the heavily used trail will need to be rerouted.
- Rail bank for the trail prohibits permanent structures as railroad could technically reclaim the property.
- The grades of the areas adjacent to the trail make some of the depth of the practices challenging. In many locations the trail is lower than adjacent areas, but in some cases the adjacent areas are lower than the trail.

The resulting conceptual design for Field Club Trail is divided into four sites with a total tributary area of 167 acres. The sites are labeled according to their location along the trail. They include Frances Street, Gold Street, Frederick Street, and Vinton Street. All of the final conceptual designs include subsurface storage, the details of which are included in Appendix E. The separated stormwater flows are intercepted near the trail to minimize pipe runs.

An alternative that may be worth more evaluation is the concept of incorporating swale storage in conjunction with subsurface storage within the trail corridor. Stormwater in a sewer entering the trail system would be routed south along the trail in a pipe until the elevations allow the water to be discharged, or daylighted, to a swale; whereby water would filter to the underground storage through an aggregate lens (Figure 5-2). This would only be applicable in certain locations where the grades can accommodate the concept. Stormwater could also be directly connected to the subsurface storage system as is depicted in the final Field Club Trail conceptual designs (Appendix E). Sediment and floatables would need to be removed either through a sediment forebay system or a swirl concentrator.

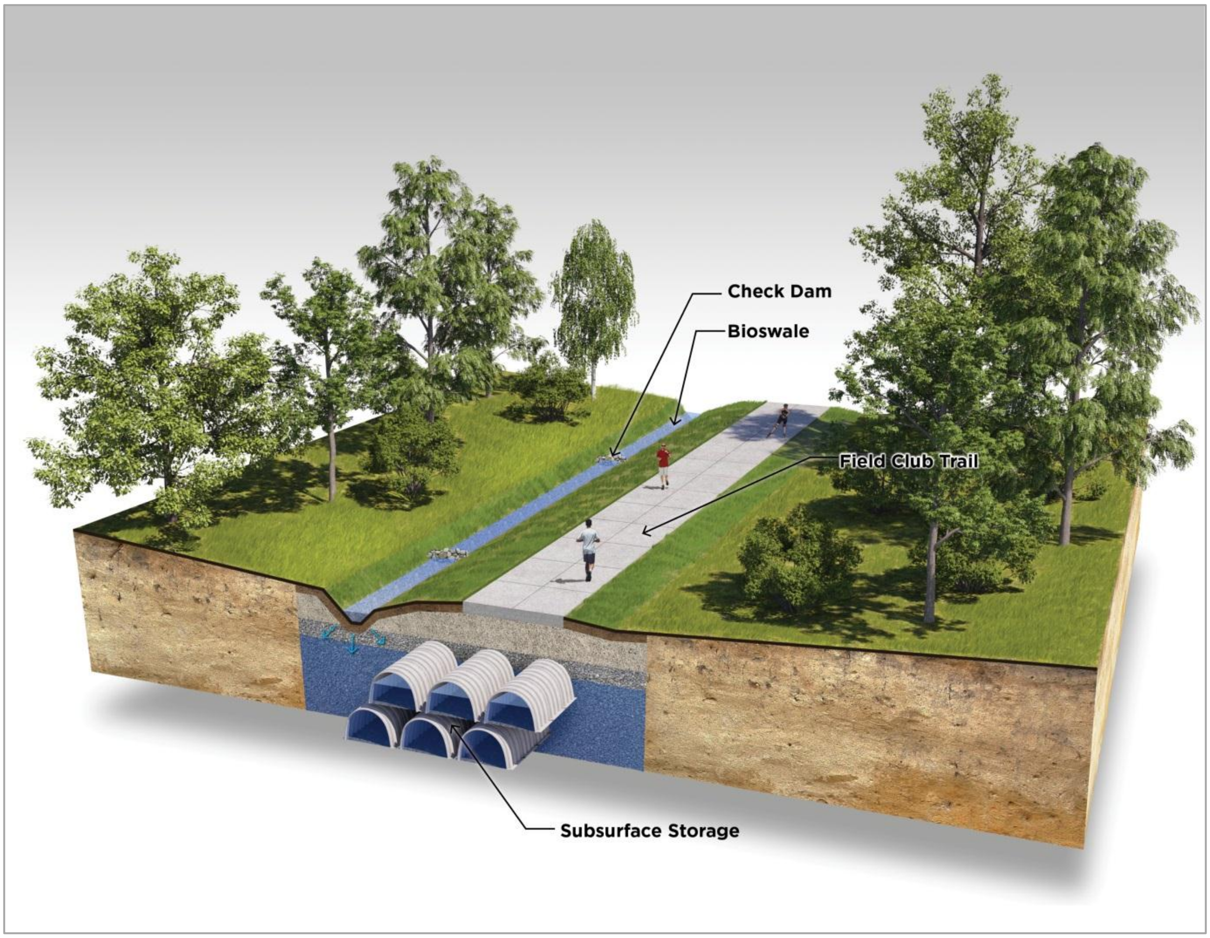

Figure 5-2 Swale and Subsurface Storage Concept

5.1.1 Frances Street

The Frances Street project represents a concentrated stormwater opportunity adjacent to the Field Club Trail where Frances Street dead ends into the trail from the east. Storm sewer is already separated within this approximate 31 acre drainage area. The separated sewer helps minimize the need for new stormwater pipes to divert the flow to an off-line green infrastructure practice beneath the trail.

The following were considered during project evaluation and development:

- A City of Omaha Public Housing Authority-owned parcel extends south of the dead end of Frances Street, immediately east of the trail. Drainage from the cul-de-sac and the adjacent block could be routed to a surface storage feature in the grassy area on this City owned land. However, this concept was not carried forward as the space relative to the drainage area is limited.
- Including subsurface storage beneath the Omaha Public Housing Authority parking lot adjacent to the trail was discussed. The opportunity was abandoned due to the expense of replacing a recently constructed parking lot.
- A variety of configurations for subsurface storage were evaluated. These included maximizing use of the right-of-way as well as narrow linear configurations. Recent comments from the Parks and Recreation Department support a narrow configuration (less than 30 feet wide) to preserve buffer areas and tree canopy.

The final concept is to include subsurface storage within the Field Club Trail right-of-way (Appendix E.5).

5.1.2 Gold Street

The Gold Street project represents a large 84 acre concentrated stormwater opportunity with separated storm sewer running along Gold Street and Arbor Street between S. 41st Street and S. 33rd Street. The separated sewer helps minimize the need for new stormwater pipes to divert the flow to an off-line green infrastructure practice beneath the trail.

The following were considered during project evaluation and development:

- Initial evaluation at Gold Street included determining the feasibility of directing stormwater to surface storage in the green space immediately adjacent to the trail on the south side of Gold Street. The result was that, other than flow slipping a block of Gold Street west of the trail, conveying significant stormwater to the trail open space is challenging. Roadside swales are often employed to do this, but the existing parkway along Gold Street is not wide enough to accommodate swales. Furthermore, the surface grades to the east are lower than the trail right-of-way with a low point at S 35th Avenue. There was also concern that surface storage at this location would be too close to the adjacent house. It was determined that surface storage was not a viable stand-alone solution.
- Based on the storm pipe inverts near the trail, subsurface storage seemed to be the best option. Flow could be diverted from storm pipes east and west of the trail. The pipe inverts from the east are approximately 14 feet deep governing the depth of the storage practice. Because of this, the subsurface storage was designed to surcharge into the upstream pipes but still be well below grade.
- To save on excavation costs, the tributary drainage area east of the trail, driving the storage system to 14 feet deep, could be removed from the total drainage area. With only the westerly portion of the tributary drainage area diverted for storage, the bottom of the system need only be about 11 feet deep.
- A variety of configurations for subsurface storage were evaluated. These included maximizing use of the right-of-way as well as narrow linear configurations. Recent comments from the

Parks, Recreation, and Public Property Department support a narrow configuration (less than 45 feet wide) to preserve buffer areas.

The final concept is to include subsurface storage within the Field Club Trail right-of-way diverting flow from both the eastern and western portions of the drainage area (84 acres). Limiting the drainage area is open for further consideration depending on the desires of the City (Appendix E.7).

5.1.3 Frederick Street

The Frederick Street project represents a 35 acre concentrated stormwater opportunity with separated storm sewer running along Frederick Street between the trail and S. 31st Street. The separated sewer helps minimize the need for new stormwater pipes to divert the flow to an off-line green infrastructure practice beneath the trail.

The following were considered during project evaluation and development:

- Initial evaluation at Frederick Street included determining the feasibility of directing stormwater to surface storage in the green space immediately adjacent to the trail where Frederick Street meets the trail or to the Chicago Central & Pacific Railroad property east of the trail. The result was that, other than flow slipping a block of Frederick Street east of the trail, conveying significant stormwater to the trail open space is challenging. Roadside swales are often employed to do this, but the existing parkway along Frederick Street is not wide enough to accommodate swales. It was determined that surface storage would not perform as needed to reduce CSO volume.
- Based on the storm pipe inverts near the trail, subsurface storage seemed to be the best option. Flow could be diverted from the 48-inch storm pipe east of the trail. The proposed diversion pipe would need to cross through the Chicago Central & Pacific Railroad property in order to circumvent the 99-inch combined sewer. The subsurface storage would then extend southeast of where the 99-inch combined sewer crosses the trail.
- Placement of the subsurface storage within the Chicago Central & Pacific Railroad property was discussed and may be an option if a partnership is desired and can be accommodated. This would reduce the length of proposed storm sewer.
- The pipe inverts from the east are approximately 10 feet deep governing the depth of the storage practice. Because of this, the subsurface storage was designed to surcharge into the upstream pipes but still be well below grade.
- A variety of configurations for subsurface storage were evaluated. These included maximizing use of the right-of-way as well as narrow linear configurations. Recent comments from the Parks, Recreation, and Public Property Department support a narrow configuration (less than 40 feet wide) to preserve buffer areas.

The final concept is to include subsurface storage within the Field Club Trail right-of-way southeast of where the 99-inch combined sewer crosses the trail (Appendix E.9).

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5.1.4 Vinton Street

The Vinton Street project represents a 17 acre concentrated stormwater opportunity with separated storm sewer running along Vinton Street for one block to the west, Valley Street for one block to the west, and S. 35th Street between Valley Street and Vinton Street. The separated sewer helps minimize the need for new stormwater pipes to divert the flow to an off-line green infrastructure practice beneath the trail. The trail has not been constructed in the location between Vinton Street and Interstate-80 but there are plans to construct it in the near future as part of the Field Club Trail extension.

The following was considered during project evaluation and development:

- Five acres of stormwater runoff that flows along the curb line east of the trail on Vinton Street could be captured and stored in the proposed subsurface detention storage chamber. This would require approximately 30 percent more storage, an upstream overflow structure, and storm piping just upstream of the storage chamber to collect the water and convey it to the storage chamber. The site has plenty of available space to increase the size of the subsurface storage. This was not initially included in the analysis as it was not a previously separated area.
- The area west of the proposed trail has surface grades that are lower than the trail alignment. This area has historically had drainage problems. Some of these problems were improved by the RNC project in this location. Further improvement of the drainage in this area is possible, but not included in the project concept.

The final concept is to include subsurface storage within the Field Club Trail right-of-way (Appendix E.11).

5.2 Hanscom Park

Hanscom Park is located near Interstate-480 between Woolworth Avenue and Ed Creighton Avenue. The park was donated to the City of Omaha in 1872 by Andrew J. Hanscom and James Megeath and redeveloped in 1889 by landscape architect H.W.S. Cleveland. Hanscom Park is also adjacent to the Gerald R. Ford birthsite and garden. Present day Hanscom Park is approximately 58 acres and includes a playground, ball field, soccer field, tennis courts, a lagoon, shelters, and a pavilion available for rent by the public. There is also an indoor sports complex including eight tennis courts and a swimming pool at the southwest corner of the park.

Ten drainage areas were evaluated for stormwater management and CSO reduction during the development of the project. Initial screening alternatives were located on the north, south, and west sides of Hanscom Park as well as three internal park drainage areas (Figure 5-3 and Table 5-1). Seven drainage areas are included in the final concept designs.

- Three of the six selected drainage areas are from north and west portions of the park. Drainage Areas A, B, and C were pursued because the existing topography and infrastructure is practical for combined sewer disconnection and routing runoff to the proposed bioswales.
- An east drainage area (Drainage Area J) along Park Avenue was added following the initial screening to capture the area draining the west side of Park Avenue.

- Three internal park drainage areas (Drainage Areas F, G, I) were routed, as feasible, to the stormwater practices to the north, west, and the existing lagoon (included in the east drainage area).
- Collectively, the green infrastructure stormwater management systems will manage runoff from a total of 133 acres of runoff area.

Three drainage areas were eliminated as a part of feasibility investigations. Drainage area D, E, and H were eliminated from project consideration because of the challenges of routing stormwater over the southern hill slope from the adjacent development.

The Hanscom Park project will collect and manage a total of 5.35 ac-ft of runoff volume from 1.4 inches of rain (see figure in Appendix F.1 for drainage area breakdown).

Figure 5-3 Hanscom Park Drainage Areas that were Evaluated for Stormwater Management and CSO Reduction

Table 5-1 Hanscom Park GI Drainage Considerations

Reference Drainage	Description	Was Project Pursued?	Notes
A	North Drainage – Woolworth to Pacific	Y	Pursued because topography and modifications to existing infrastructure are practical in obtaining considerable runoff volume
B	West Drainage – Center to Woolworth, 33rd to 36th	Y	Pursued because topography and existing infrastructure are practical in obtaining considerable runoff volume
C	Southwest Drainage – Frances between Center and Martha	Y	Pursued because topography and modifications to existing infrastructure are practical in obtaining considerable runoff volume
D	Southwest Drainage – Martha to Ed Creighton, 32nd to 31st	N	Eliminated because stormwater conveyance to south side of park is not practical based on topography
E	Southwest Drainage – Martha past Frances, 33rd to 35th	N	Eliminated because stormwater conveyance to southwest side of park is not practical based on topography
F	Park Proper – Drainage to northern bioswale/pond	Y	Pursued because topography is practical to route internal park runoff to storage.
G	Park Proper – Drainage to western bioswale/pond	Y	Pursued because topography is practical to route internal park runoff to storage.
H	Park Proper – Drainage to south bioswale	N	Eliminated because no south bioswale will be implemented
I	Park Proper – Drainage to existing Pond[1]	Y	Pursued because topography and modifications to existing infrastructure are practical in obtaining considerable runoff volume
J	East Drainage – Park Avenue to Park Proper	Y	Added to project based on ease of routing drainage to park

[1]Implementation includes adding lagoon outlet controls, separating storm drainage from combined sewer and adding pretreatment before lagoon.

There were several drainage area assumptions that are included in the analyses.

- The Northern drainage of Hanscom Park project originally conceived of adding separate sewer lines extending in the North drainage to Poppleton Street on 31st Street and to Harris Street on 30th Street. However, to reduce costs these pipes have not been extended in this plan because the existing smaller pipe sizes and surface slope likely allow for some flow to be conveyed to downstream points that are planned for separation (at Woolworth Street and 30th and 31st Streets) in this project routing much of this runoff into the park. Future extension of these sewers will assure this additional drainage area may be captured.

- Separation of sewers along Center Street is feasible by assuring no sanitary contribution to the existing combined line which may have few if any sanitary contributions. Use of this existing line will provide substantial cost savings in capturing Drainage Area B (Figure 5-3).

Cascading bioswales were selected as a conveyance, stormwater management, and combined sewer management practice because they provide essential functions of runoff volume control as well as improve the natural features of the park. Historically, there was a cascade in this park. Re-establishing this as a park feature may be a desirable outcome. The inclusion of ponded areas in the park coincides with approaches to other combined park improvements providing combined sewer benefits within the City of Omaha. Enhancing the existing lagoon as an additional stormwater management improvement takes advantage of present storage within the park while improvements to the outlet can help to reduce discharges to the combined sewer system.

Timing of this project is somewhat critical. The Omaha Parks Department is currently developing a new master plan for Hanscom Park. The timing of this project coordinated with potential park improvements can bring efficiencies with regard to cost and use of park space by limiting inconveniences associated with construction activities within the park.

5.3 Kountze Park

Kountze Park is located in the northeast quadrant of Omaha between N 19th Street and N 21st Street on the east and west and between Pratt Street and Pinkney Street on the north and south. The area surrounding the park is residential. The park was the site of the Trans-Mississippi Exposition and Greater American Exposition in 1899. Buildings, boulevards, and a lagoon were constructed specifically for these events and immediately demolished and filled in afterward. Remnants of the demolition may be encountered during excavation within the park. The 11-acre park now has a pavilion, baseball diamond, playground, tennis courts, basketball courts, and a small water park.

The Kountze Park project represents a concentrated stormwater opportunity with separated storm sewer running primarily along Manderson Street between N 17th Street and N 19th Street, Pratt Street between N 16th Street and N 19th Street, and within Kountze Park between N 19th Street and N 21st Street. The separated sewer helps minimize the need for new stormwater pipes to divert the flow to an off-line green infrastructure practice within the park.

The following were considered during project evaluation and development:

- Kountze Park and the surrounding neighborhood have a fairly flat topography making it challenging to divert storm sewers to a surface feature within the park. Additionally, the Parks, Recreation, and Public Property Department did not want to lose the available space within the park used for recreation. Therefore, surface storage was not further evaluated as an option.
- Intercepting individual storm sewers upstream of the park to maintain a shallower detention storage chamber proved to be too costly due to the extent of pipe needed.
- An overarching objective is to preserve trees within the park. Potential placement of the storage structure on the west side of Florence Blvd in lieu of the east side was investigated to preserve trees. Placement of the storage chamber within the baseball outfield is possible if the existing 15-inch sanitary sewer is relocated. The 15-inch sanitary sewer invert is at the same

invert elevation as the storm sewer making it challenging to freely discharge stormwater to this location.

- A tree survey is recommended to further investigate possible placement of the storage chamber. Potentially, the storage chamber could be divided between the east and west sides of Kountze Park to avoid tree removals/damage. The chambers could be split into smaller cells to fit into the open spaces of the park as well. However, more detention storage chamber sites mean more sewers and manholes necessary to direct flow in and out of the storage system. This would increase costs.

The final concept is to include subsurface storage within Kountze Park (Appendix G.4). This practice type was chosen so as not to affect the current use of the park. Tree preservation should be a key consideration in the final placement of the storage practice(s).

5.4 Schroeder-Vogel Park

Schroeder-Vogel Park is located to the West of Saddle Creek Road south of Pine Street and north of Walnut Street. The park is approximately 4.9 acres and includes a playground, basketball court, picnic area and shelters. The park also has a large grassed area on the northwest side that is frequently used for sports practices.

Five drainage areas near Schroeder-Vogel Park were considered as a part of potential stormwater runoff management using green infrastructure within the park (Table 5-2). Of these five drainage areas, four drainage areas have been included in this project because of the feasibility to route stormwater runoff (through the addition of stormwater pipes or through disconnection) to the park.

Observations used to determine and place stormwater runoff management practices are:

- Subsurface storage is the most feasible stormwater management option to maintain the existing uses of the park (basketball court, playground, open grassed areas).
- The footprint for the subsurface storage is flexible within the park as about a 120-ft by 185-ft area is necessary to achieve the calculated capture volume. The subsurface storage facility footprint along with additional area that could accommodate the subsurface storage is identified in Appendix H.4.
- The geotechnical boring log report for Sewer Separation project (10/19/2006, Job # 6584.0) indicate that there may be a fairly shallow groundwater table in the park (7-10 feet below the surface elevation). Therefore, consideration was given to the depth of the existing and future pipes that will be relied on to passively convey the stormwater to the park's potential stormwater management systems.
- The largest identified drainage area, drainage area B (Figure 5-4), was eliminated from the project due to the lack of area for the necessary volume control in the park and because of the challenges with passively routing flow from the existing stormwater pipe depths. Routing stormwater from drainage area B would require installing new pipes along Saddle Creek Boulevard as the existing pipe inverts are below the expected groundwater table in the park. This would require either pumping or significant infrastructure changes, both costly endeavors.

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The final concept is to include subsurface storage within Schroeder-Vogel Park (Appendix H.4). This practice type was chosen so as not to affect the current use of the park.

Table 5-2 Schroeder-Vogel Park GI Drainage Considerations

Name	Description	Pursued?	Notes
A	Hickory to Poppleton, 52nd to 50th	Y	Pursued because topography and existing and proposed infrastructure are practical
B	Poppleton to Dodge, 52nd to 49th	N	Eliminated because inverts necessary to collect stormwater are too deep, and park area will not support necessary volume of stormwater or passive sewer routing
C	Hickory Cul-de-sac	Y	Added and pursued because topography and existing and proposed infrastructure are practical
D	North portion of Post Office Parking Lot	Y	Added and pursued because topography and existing and proposed infrastructure are practical
E	Saddle Creek b/w Pine and Hickory	Y	Added and pursued because topography and existing and proposed infrastructure are practical

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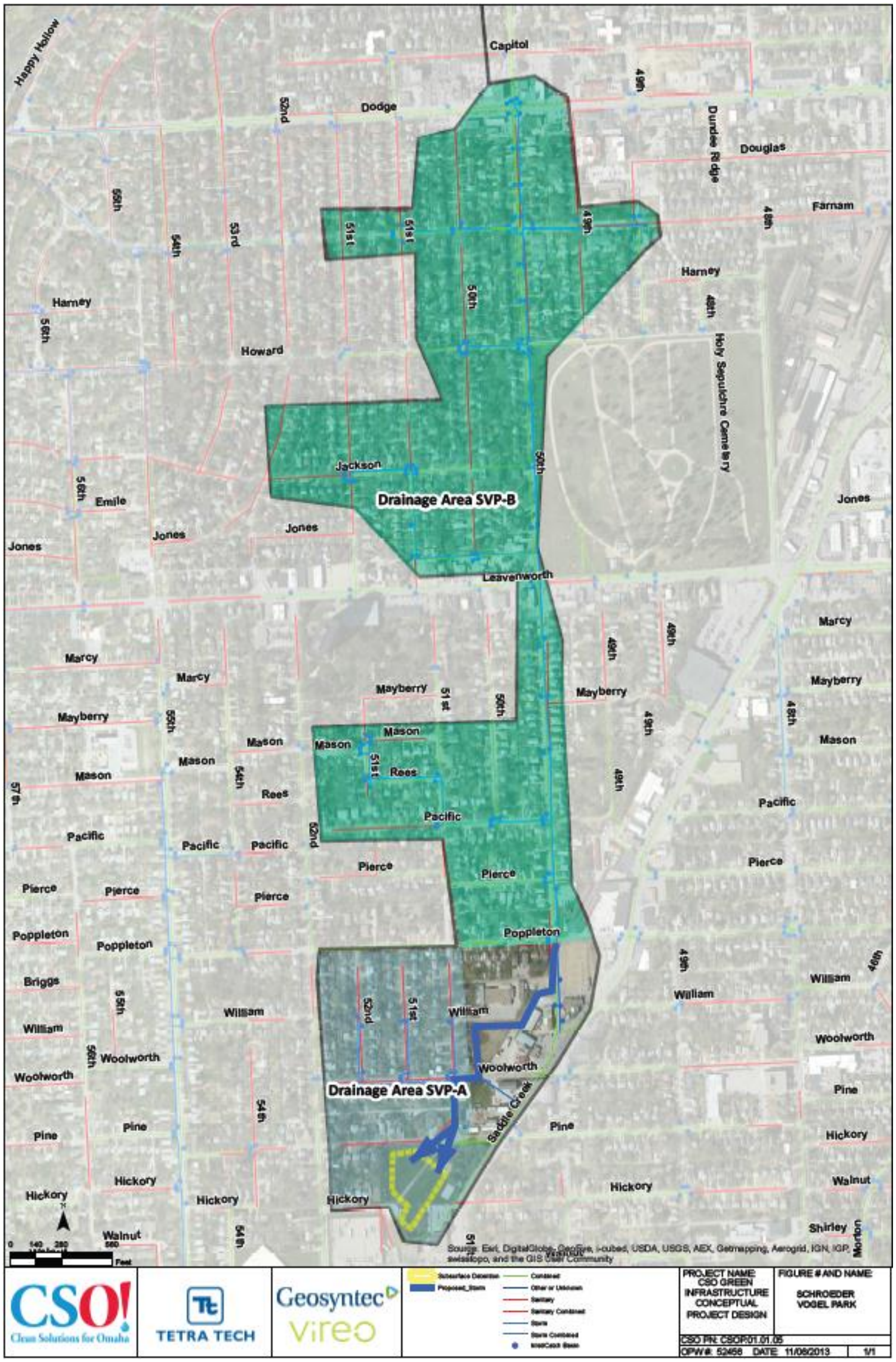

Figure 5-4 Schroeder-Vogel Park Drainage Areas that were Evaluated for Stormwater Management and CSO Reduction

5.5 Turner Boulevard

Turner Boulevard is part of the "park-and-boulevard" system originally designed in 1889 by Horace Cleveland. It runs north-south from the Field Club neighborhood at Woolworth Avenue past Leavenworth Park and is anchored on the south by Hanscom Park (see Figure 5-5). Turner Boulevard is probably one of the more scenic and interesting of the park-and-boulevard systems.

Green infrastructure opportunities were evaluated along Turner Boulevard between Poppleton Avenue and the Interstate-480 interchange. The Turner Boulevard project area includes a series of park spaces approximately one mile long. It is situated within a residential area on the south end transitioning to commercial on the north end and includes Midtown Crossing. A significant amount of park space and green boulevard space lie adjacent to the corridor. The park space includes the open area near Pacific Street and Turner Blvd, Leavenworth Park, Dewey Park, and North Turner Park. The corridor is within the Burt-Izard CSO basin. Twelve drainage areas, totaling 175 acres were considered for this project. The 175-acres of tributary area considered is primarily previously separated stormwater flows. This provides an excellent opportunity to capture the flows at the downstream end of the separated storm sewer system before it enters the combined sewer.

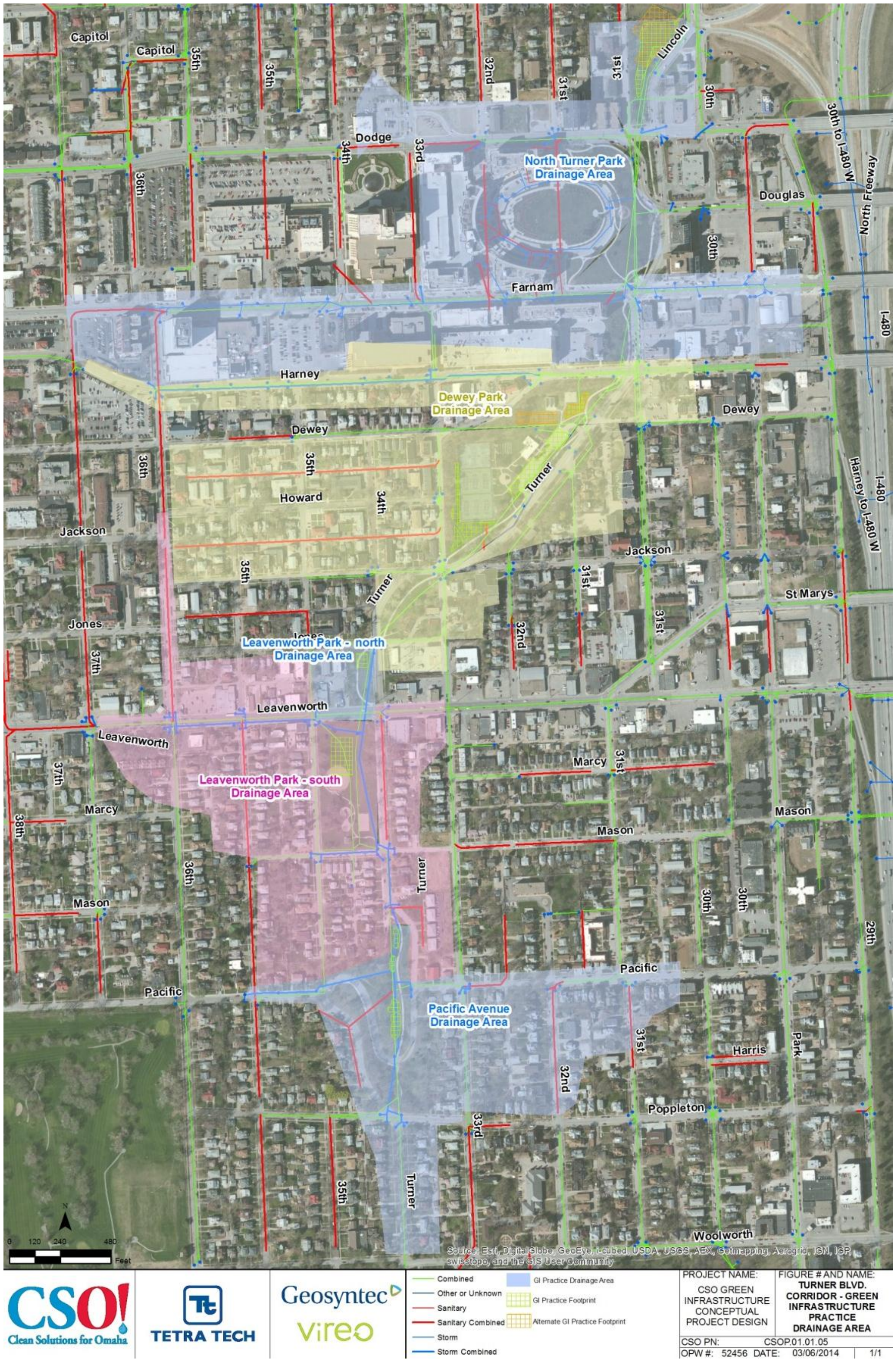

Figure 5-5 Turner Boulevard Drainage Areas that were Evaluated for Stormwater Management and CSO Reduction

There were a variety of key considerations and discussion points early on when investigating options for Turner Boulevard. These key considerations helped mold the final conceptual design. The initial emphases and considerations along the corridor include the following:

- The initial approach was to maximize drainage to the various parks and green space along the corridor. The parks and green space are located down gradient from the surrounding neighborhoods and commercial districts making them strategic locations for capturing and storing stormwater. Because of the topography it is possible in all of the parks within this corridor to daylight storm pipes to a surface feature.
- The Parks, Recreation, and Public Property Department are receptive to green infrastructure within park space. More discussions and comments on preliminary plans determined what types of practices (i.e. surface or subsurface practices) were acceptable within difference areas of the parks. More detail about these sites can be found in the individual sections below.
- The already separated storm sewers in the concentrated stormwater opportunity areas were taken advantage of as much as possible. Additional storm sewer was proposed in a few locations to pick up storm inlets, which would significantly increase the tributary drainage area.
- Midtown Crossing is a separated area picking up parking lot and roof drainage (per sewer drawings). The goal was to run a new storm sewer to pick up this flow. The drainage would be diverted to North Turner Park.

The resulting conceptual design for Turner Boulevard is divided into five sites and incorporates all twelve of the drainage areas initially considered (175 acres). The proposed GI practices are labeled according to their location along the trail. They include North Turner Park, Dewey Park, Leavenworth Park – north, Leavenworth Park –south, and Pacific Street. The final conceptual designs include both subsurface and surface storage.

5.5.1 North Turner Park

North Turner Park is an approximate 2-acre parcel of land bordered by Lincoln Blvd on the east, Dodge Street on the south, and N. 31st Street on the west. It is also adjacent to the Interstate-480 entrance ramp. It is maintained as a mowed grassy area and is used recreationally by local residents. The North Turner Park project represents a 58-acre concentrated stormwater opportunity with separated storm sewer at Midtown Crossing and on Farnum Street between S. 37th Street and Park Avenue. Although separated sewer tends to help minimize the need for new stormwater pipe, a lengthy run of pipe, over 1,500 feet, is needed to divert the flow to the proposed green infrastructure practice within the park.

The following were considered during project evaluation and development:

- Both surface and subsurface storage were considered here. The preliminary concept provided surface storage of as much as 3.9 acre-feet in a 6-foot deep extended detention basin, with 5:1 interior side slopes. However, the surface space is used here for recreational purposes, and potential future uses include a regional trail connection through this location. For these reasons, the Parks, Recreation, and Public Property Department considered surface storage incompatible.

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The final concept is to include subsurface storage within North Turner Park (Appendix I.5). This practice type was chosen so as not to affect the recreational use of the park. Subsurface storage will be complicated by the presence of large sewers in this vicinity.

5.5.2 Dewey Park

Dewey Park is bordered on the north by Harney Street, the southeast by Turner Blvd and the west by S. 33rd Street. The park is nearly 7 acres and has tennis courts, racquetball courts, a playground, a basketball court, a building, a parking lot, and open grassy area. The area surrounding the park is largely residential switching to multi-use buildings on the north. The Dewey Park project represents an opportunity to divert and store 51-acres of previously separated stormwater from Harney Street between S. 36th Street and Dewey Avenue. There is also opportunity to capture and store a large drainage area from the west and southeast through a few proposed storm pipes.

The following were considered during project evaluation and development:

- The initial detention and storage volume target was 2.82 acre-feet (0.92 MG), which would manage design-storm flows from separated areas to the west and southwest of the park. Conceptual designs were created that avoided existing structures, sidewalks, and high-value trees. However, subsurface storage beneath the parking lot was evaluated at the Parks, Recreation, and Public Property Department's request. The following conceptual designs were evaluated, to allow for cost-comparison between surface and subsurface storage, as well as consideration of appropriateness in the park setting.
  - Providing 1.3 acre-feet (0.42 MG) of subsurface storage in a subsurface storage chamber system beneath the existing parking lot.
  - Providing 1.3 acre-feet (0.42 MG) of surface storage in a series of six surface storage basins arranged around the southern end of the tennis courts.
  - Providing 1.2 acre-feet (0.39 MG) of storage in three surface storage basins in the northeastern corner of the park.
- The existing tennis courts were not evaluated as a subsurface storage opportunity due to the potential cost of replacing the facility.
- Clearing trees and brush on the north and west sides of the park was desirable according to the Parks, Recreation, and Public Property Department, which helped dictate the placement of the practices and piping.

The final concept is to include a combination of subsurface and surface storage within Dewey Park (Appendix I.7). Over 90 percent of the design-storm flow is stored within the subsurface storage practices beneath the parking lot and north of the parking lot so as not to affect the current use of the park.

5.5.3 Leavenworth Park – north

Leavenworth Park (north) refers to the open space north of Leavenworth Park at the intersection of Jones Street and S. 34th Street. It provides a walking path surrounded by open space with sporadic tree plantings.

Initial considerations for this project included a surface feature along the road ROW or in the open space adjacent to the walking path to capture stormwater that enters the catch basins on Jones

Street just west of S. 34th Street. Further investigation of the surface contours indicated that this site has a consistent 6-percent slope from south to north and the inlets at the Jones Street/S. 24th Street intersection are 5 feet deep. In order to make a surface feature work at this location, reconstruction of the inlets, constructing new storm sewer pipe from the inlets to the surface feature and constructing a fairly deep feature. As this would be cost ineffective, a surface feature was ruled out and a subsurface storage facility was considered.

The final concept is to include a single-layer subsurface storage underneath the existing walking path and open space, capturing 2-acres of stormwater flows from Jones Street from 35th Street to Turner Street and along Turner Street from Leavenworth Street north to Jones Street (Appendix I.7). The design provides new sewer pipe connecting the inlets that the Jones Street and Turner Street intersection to the subsurface storage and an outlet pipe connecting into the 60-inch separate storm sewer. It should be noted that the 60-inch storm sewer discharges into the combined sewer further downstream.

5.5.4 Leavenworth Park – south

Leavenworth Park (south) is approximately a 4-acre park located in the southwest quadrant of Leavenworth Street and Turner Boulevard. It provides recreational facilities including a baseball field, sand volleyball court, a playground, a picnic pavilion, and open park space. The area surrounding the park is largely residential with commercial on Leavenworth Street on the park's north border. This project represents an opportunity to divert and store previously separated stormwater along Leavenworth Street between S. 36th Street and S. 35th Street and from the storm sewer extending from Poppleton Avenue north to Leavenworth Park.

The following were considered during project evaluation and development:

- A mixture of surface and subsurface storage opportunities were considered in Leavenworth Park. At the request of the City, surface storage was dropped from further analysis as the park is heavily used and surface storage would remove open space for recreational use. Subsurface also allowed flow to be intercepted from the storm pipe from the west along Leavenworth Street. This 42-inch storm sewer drops in elevation quickly at the northwest corner of the park to route beneath an existing duct bank. The depth made surface storage of this flow challenging.
- Avoidance of all buried utilities within the park to create significant storage was challenging. A 36-inch combined sewer and a 60-inch storm sewer cross the park north and south on the east side of the park. A 12-inch combined sewer crosses down the center and toward the west. To implement effective storage, it is recommended that connecting the existing 12-inch combined sewer to the existing 36-inch combined sewer be evaluated. Rerouting the 12-inch sewer would result in adequate space for subsurface storage.
- To minimize excavation, the subsurface storage chamber is designed to surcharge while keeping the hydraulic gradeline below grade. There is a significant drop in grade within the park from south to north. Because of this, the subsurface storage needs to be installed at a depth so that flow will not surcharge onto the park surface on the north side of the park. Care must be taken to design the diversion weir so that the head of the design flow over the weir is below grade. The park grade is well below street grade, so that should not be a concern.

The final concept is to include a 2-layer subsurface storage within Leavenworth Park (Appendix I.9) capturing 37-acres of separated stormwater from Leavenworth Street and from the existing 60-inch storm sewer that traverses the park from the south to the north. The design provides minimal new sewer pipe while maximizing the storage availability in the park.

5.5.5 Pacific Avenue

This site is an open wooded and grassy area north of Poppleton Avenue. Turner Boulevard meanders through this park area and Pacific Avenue dead ends into the park from the east and west. There is a significant drop in elevation from the surrounding residential neighborhood to the center of the park making this location ideal for daylighting storm pipe to a surface storage feature. This project represents an opportunity to divert and store previously separated stormwater from Pacific Avenue to S 35th Street and from the intersection of Turner Blvd and Poppleton Avenue.

The following were considered during project evaluation and development:

- The extent of drainage area to be served in this location considered extension of storm sewer on Pacific Avenue to the east. The storm sewer extension was included in the final concept.
- A series of surface detention features was evaluated in this location, with the intent of managing the design storm from the existing separated areas and the future extension of storm sewer on Pacific Avenue, if possible. The preliminary concept included a series of four bioretention cells with underdrains and overflow structures. The units would be connected together through piping, with the exception of a weir between the third and fourth units. The northernmost unit would discharge into an existing separate storm sewer.
- The initial storage target was 1.32 acre-feet (0.43 MG) for the design storm; total storage provided was 1.02 acre-feet due to topographical relief and site constraints, such as the existing sidewalk, mature trees, and large water main, and the need to provide sufficient cover over the existing storm sewer.
- The parks department is concerned about the extent of green infrastructure practice interfering with some the park uses.

The final concept is to include a series of surface storage within the park interconnected by pipes and weirs (Appendix I.12). However, recent input indicates that surface storage is not supported by the Parks, Recreation, and Public Property Department due to the recreational use of the park. As an alternative, the drainage area intended to be stored within this park could be stored downstream in an expanded subsurface storage practice in Leavenworth Park. This option would need to be further investigated.

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6.0 Summary

6.1 Proposed Practice Combined Sewer Overflow Performance

As part of the project development phase, the five final projects were independently assessed on their performance in reducing combined sewer overflow volume and peak flow rate at the downstream regulator for the design storm (i.e. the 5th largest rainfall event – June 11, 1969) and for the representative year. This assessment was a modeling effort, which is described in Section **Error! Reference source not found.**. In addition, performance costs were calculated (i.e. 20-year life cycle cost/gallon of CSO volume reduced). Cost methodology is described in Section **Error! Reference source not found.**. All of this information was compiled in Table J-1 to facilitate comparisons when reviewing the benefits of each project.

In addition to the performance of each practice, Table J-1 presents information on the characteristics of each practice. Characteristics include the following:

- Type of practice: Surface, Subsurface, or a Combination
- Storage Volume of the practice
- Length of pipe included in the design (gray infrastructure)
- Green infrastructure practice tributary drainage area
- Green infrastructure practice tributary drainage area as a fraction of the regulator drainage area
- Construction cost and contingency (contingency is per Omaha Costing Tool)
- Capital cost (multipliers are per Omaha Costing Tool)
- 20-year life cycle cost

Performance information is presented in terms of the 5th largest rainfall event and also the representative year. Both were presented because each analysis is significant in its own way. The 5th largest rainfall event signifies limiting the number of overflows to four per year if the entire regulator drainage area retained that rainfall event. The representative year signifies a typical annual performance. The information presented in Table J-1 includes the following:

- CSO flow rate at the regulator with green infrastructure in place (for the 5th largest event only)
  - Peak flow rate at the regulator
  - The change in peak flow rate due to green infrastructure
    This change is based on CSO peak flow rate at each regulator (Table J-3).
- CSO volume at the regulator with green infrastructure in place
  - Overflow volume at the regulator
  - The change in overflow volume due to green infrastructure
    This change is based on CSO volume at each regulator (Table J-3).
- Volume of runoff managed by each practice (for the representative year only)
  Volume managed includes all runoff that enters the green infrastructure practice (excluding bypass/volume in excess of available volume).

For each of the five project areas, the model results were read at the downstream regulator. This means that the results are recorded for Field Club Trail, Hanscom Park, and Turner Boulevard as a whole as opposed to the individual sites that make up these areas. As a means to understanding the performance of the individual sites, the results for the representative year were proportioned between the individual sites. For example, within Field Club Trail, the total change in volume due to green infrastructure is -25.5 MG. This number was proportioned out to each of the four sites based on volume of the practice. Therefore, the Frances Street practice contributes a change in CSO volume of -6.0 MG. By doing this, a performance cost is proportioned out as well.

North Turner Park in Turner Boulevard and Vinton Street in Field Club Trail were sites where more resolution was desired on their performance. North Turner Park may not be a feasible site for a green infrastructure practice as discussed in Section 5.0, so the model was run without North Turner Park to see how the remaining four practices would perform. The performance information provided in Table J-1 for North Turner Park is actually the difference between a model run with all five of the practices in place and a model run with just the remaining four practices in place. Conversely, the Vinton Street green infrastructure practice may be more feasible (as a result of trail disruption) than the other Field Club Trail practices. Therefore, a model run was done with just Vinton Street. The results shown for Frances Street, Gold Street, and Frederick Street are based on a model run with all four practices in place minus the Vinton Street-only run.

6.2 Prioritization

As described in Section **Error! Reference source not found.**, criteria and a ranking process were used to facilitate prioritization of the projects. Table J-2 provides the results of the ranking process and Table 6-1 is shown below as a summary of the results with 1 being a project most likely to proceed to design. The projects were ranked using all of the criteria (quantitative and qualitative), quantitative criteria only, and qualitative criteria only.

Table 6-1 Comparison of Performance Ranking

Practice ID	Quantitative and Qualitative	Quantitative Only	Qualitative Only
Frances Street	12	7	11
Gold Street	7	1	11
Frederick Street	12	7	11
Vinton Street	10	13	4
Hanscom-north	2	7	1
Hanscom-west	1	2	1
Hanscom-east	5	12	1
Kountze Park	8	6	10
SVP	6	7	5
Pacific Avenue	11	7	9
Leavenworth-south	3	2	8
Leavenworth-north	14	14	5
Dewey Park	3	2	5
North Turner Park	9	2	14

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7.0 Recommendations

The City of Omaha has initiated a Green Infrastructure Program of which the current evaluation is a critical component. Over the next five years, the City should both implement these green infrastructure projects and pursue other programmatic elements that will enable additional implementation of green infrastructure and stormwater management. Next steps should include the following efforts.

7.1 Recommended Projects

The list of recommended projects is summarized in Table 7-1. Costs are identified as construction (with contingency), capital and life-cycle. The construction budget for recommended projects is within the City's target budget of $15 million. The capital cost for these projects includes construction, engineering, contingency, administration and other markups.

Table 7-1 Recommended Projects and Cost Summary Table

Practice Location	Practice ID	Construction (with Contingency)	Capital	20-Year Life Cycle	Implementation Recommendation
Field Club Trail	Frances Street	$1,269,546	$1,680,000	$1,687,000	Implement all or portions of these projects. Projects could be reduced in scale to meet overall City budget objectives or to further limit the impact of the projects on the trail. Implement Vinton practice prior to trail construction.
	Gold Street	$2,169,445	$2,899,000	$2,921,000	
	Frederick Street	$1,344,914	$1,728,000	$1,744,000	
	Vinton Street	$606,903	$803,000	$819,000	
	Subtotal	$5,390,807	$7,110,000	$7,171,000	
Hanscom Park	Hanscom-north	$1,401,900	$1,873,000	$2,119,000	Implement all of the Hanscom Park Projects. Projects need to be coordinated with the Hanscom Park Master Plan which is scheduled for 2014.
	Hanscom-west	$809,567	$1,040,000	$1,182,000	
	Hanscom-east	$478,869	$634,000	$686,000	
	Subtotal	$2,690,336	$3,547,000	$3,987,000	
Kountze Park	Kountze Park	$1,211,292	$1,603,000	$1,621,000	Implement. Coordinate final placement with parks department.
	Subtotal	$1,211,292	$1,603,000	$1,621,000	
Schroeder-Vogel Park	SVP	$1,356,677	$1,795,000	$1,845,000	Implement project if the groundwater conditions are satisfactory for subsurface storage. Coordinate placement with
	Subtotal	$1,356,677	$1,795,000	$1,845,000	

Practice Location	Practice ID	Construction (with Contingency)	Capital	20-Year Life Cycle	Implementation Recommendation
					other parks uses.
Turner Boulevard	North Turner Park	$3,124,018	$4,174,000	$4,206,000	Modify Pacific Avenue / Leavenworth-south to address final parks comments. Do not implement North Turner at this time. Consider implementation of the North Turner project if configuration of the intersection changes or if other modifications are made to the park space in this vicinity.
	Dewey Park	$2,484,879	$3,320,000	$3,725,000	
	Leavenworth-north	$215,525	$283,000	$293,000	
	Leavenworth-south	$1,088,797	$1,441,000	$1,460,000	
	Pacific Avenue	$1,125,854	$1,490,000	$1,566,000	
	Subtotal	$8,039,074	$10,708,000	$11,250,000	
All Projects	**Total**	**$18,688,186**	**$24,763,000**	**$25,874,000**	
All Projects other than North Turner	**Total**	**$15,564,148**	**$20,589,000**	**$21,668,000**	

7.2 Recommended Implementation Plan

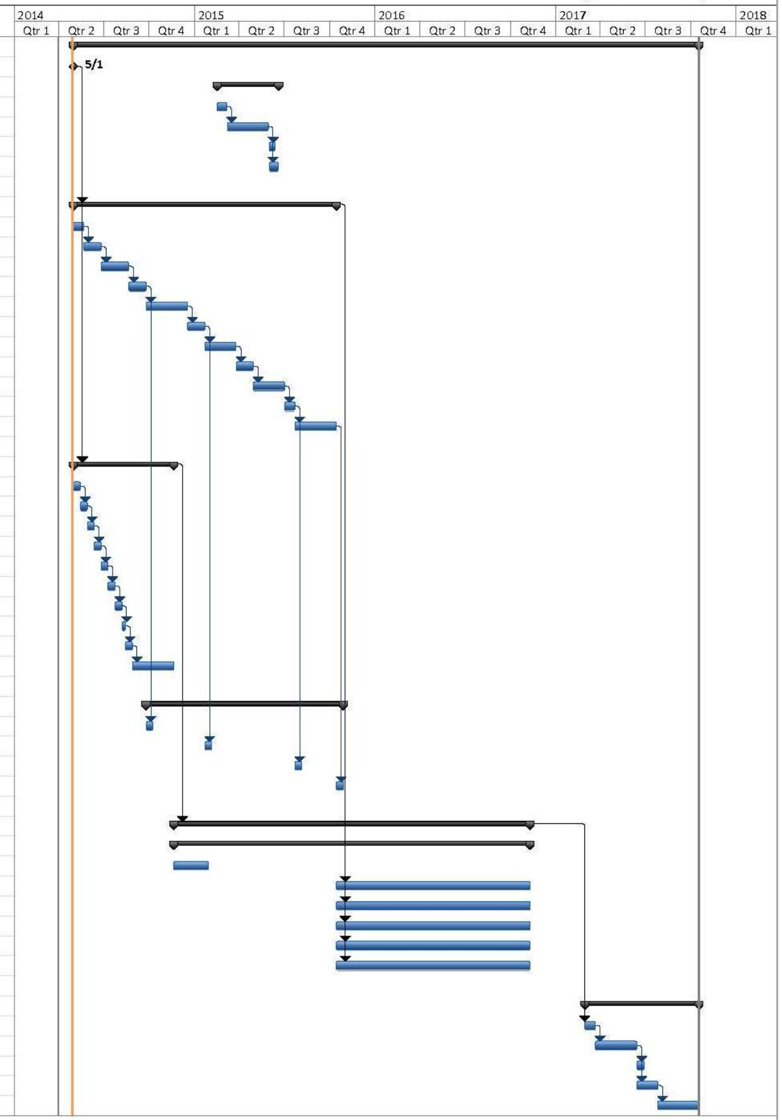
The recommended implementation plan for the green infrastructure projects is based on a schedule that will inform the next update to the LTCP, which will be due in 2019. This therefore requires a milestone schedule as follows:

a. Preliminary and Final Design, Permitting: 2014 – 2015
b. Construction duration: Fall 2015 – Fall 2016
c. Monitoring and Evaluation: 2017
d. Identification and conceptual development of Green Infrastructure projects to include in next CSO Plan Update: 2018
e. Preparation of CSO Plan Update: 2018 – 2019.

A proposed project schedule has been developed and is presented in Figure 7-2.

Omaha Green Infrastructure
Final Design/Construction Conceptual Schedule

ID		Task Name	Duration	Start	Finish	Predecessors
1		**Green Infrastructure Monitoring, Final Design and Construction**	**904 days**	**Thu 5/1/14**	**Tue 10/17/17**	
2		Notice to Proceed	0 days	Thu 5/1/14	Thu 5/1/14	
3		**Task 1 - Pre-Construction Monitoring**	**90 days**	**Mon 2/16/15**	**Fri 6/19/15**	
4		Install Monitoring Devices (10)	15 days	Mon 2/16/15	Fri 3/6/15	
5		Monitoring Period	60 days	Mon 3/9/15	Fri 5/29/15	4
6		Removal Monitoring Devices	10 days	Mon 6/1/15	Fri 6/12/15	5
7		Evaluate Data	15 days	Mon 6/1/15	Fri 6/19/15	5
8						
9		**Task 2 - Final Design of Selected Sites**	**380 days**	**Thu 5/1/14**	**Wed 10/14/15**	2
10		Final selection of sites	15 days	Thu 5/1/14	Wed 5/21/14	
11		Field Investigation, Survey, Geotechnical	25 days	Thu 5/22/14	Wed 6/25/14	10
12		Perform 30% Design	40 days	Thu 6/26/14	Wed 8/20/14	11
13		30% Design Review	25 days	Thu 8/21/14	Wed 9/24/14	12
14		Perform 60% Design	60 days	Thu 9/25/14	Wed 12/17/14	13
15		60% Design Review	25 days	Thu 12/18/14	Wed 1/21/15	14
16		Perform 90% Design	45 days	Thu 1/22/15	Wed 3/25/15	15
17		90% Design Review	25 days	Thu 3/26/15	Wed 4/29/15	16
18		Final Design	45 days	Thu 4/30/15	Wed 7/1/15	17
19		Final Design Review	15 days	Thu 7/2/15	Wed 7/22/15	18
20		Bidding (Includes Pre-Con and Contract Award)	60 days	Thu 7/23/15	Wed 10/14/15	19
21						
22		**Task 2A - Final Design (Vinton)**	**145 days**	**Thu 5/1/14**	**Wed 11/19/14**	2
23		Field Investigation, Survey, Geotechnical	10 days	Thu 5/1/14	Wed 5/14/14	
24		Perform 30% Design	10 days	Thu 5/15/14	Wed 5/28/14	23
25		30% Design Review	10 days	Thu 5/29/14	Wed 6/11/14	24
26		Perform 60% Design	10 days	Thu 6/12/14	Wed 6/25/14	25
27		60% Design Review	10 days	Thu 6/26/14	Wed 7/9/14	26
28		Perform 90% Design	10 days	Thu 7/10/14	Wed 7/23/14	27
29		90% Design Review	10 days	Thu 7/24/14	Wed 8/6/14	28
30		Final Design	5 days	Thu 8/7/14	Wed 8/13/14	29
31		Final Design Review	10 days	Thu 8/14/14	Wed 8/27/14	30
32		Bidding (Includes Pre-Con and Contract Award)	60 days	Thu 8/28/14	Wed 11/19/14	31
33						
34		**Task 3 - Public Involvement**	**285 days**	**Thu 9/25/14**	**Wed 10/28/15**	
35		Initial Public Meetings (Following 30% Design)	10 days	Thu 9/25/14	Wed 10/8/14	13
36		Second Public Meetings (Following 60% Design)	10 days	Thu 1/22/15	Wed 2/4/15	15
37		Final Design Public Meetings	10 days	Thu 7/23/15	Wed 8/5/15	19
38		Pre-Construction Public Meetings	10 days	Thu 10/15/15	Wed 10/28/15	20
39						
40		**Task 4 - Services During Construction**	**515 days**	**Thu 11/20/14**	**Wed 11/9/16**	22
41		**Construction**	**515 days**	**Thu 11/20/14**	**Wed 11/9/16**	
42		Field Club Trail (Vinton Only)	50 days	Thu 11/20/14	Wed 1/28/15	
43		Hanscom Park	280 days	Thu 10/15/15	Wed 11/9/16	9
44		Field Club Trail	280 days	Thu 10/15/15	Wed 11/9/16	9
45		Kountze Park	280 days	Thu 10/15/15	Wed 11/9/16	9
46		Schroeder-Vogel Park	280 days	Thu 10/15/15	Wed 11/9/16	9
47		Turner Boulevard	280 days	Thu 10/15/15	Wed 11/9/16	9
48						
49		**Task 5 - Post-Construction Monitoring**	**165 days**	**Wed 3/1/17**	**Tue 10/17/17**	
50		Install Monitoring Devices (10)	15 days	Wed 3/1/17	Tue 3/21/17	40
51		Monitoring Period	60 days	Wed 3/22/17	Tue 6/13/17	50
52		Removal Monitoring Devices	10 days	Wed 6/14/17	Tue 6/27/17	51
53		Evaluate Data	30 days	Wed 6/14/17	Tue 7/25/17	51
54		Prepare Final Report	60 days	Wed 7/26/17	Tue 10/17/17	53



Page 1

Figure 7-2 Proposed Project Schedule

Critical determinations and decisions that will need to be made relative to implementation of the green infrastructure projects include:

1. Feasibility of some proposed projects. All of the identified projects are believed feasible as identified, with the potential exception of Schroeder-Vogel Park subsurface storage. The uncertainty related to this project has to do with the groundwater conditions in the area, and whether groundwater observed on historic borings reflected perched groundwater (as is typical in Omaha) or whether it reflects more significant groundwater associated with the historic Saddle Creek location. This issue will be resolved through geotechnical investigations of the site.
2. Number of projects implemented versus proposed City budget for green infrastructure. The City has identified a tentative budget of $15 million for implementation and monitoring of the proposed projects. The estimated construction costs of projects identified for implementation (with contingency) is $15.6 million, which is comparable to the City budget. It is recommended that all projects (other than North Turner) proceed into further development so that a more informed decision on the deferment or elimination of any of these projects can be made.
3. Flow monitoring for design and assessment. Based on the anticipated schedule necessary to complete work for the next CSO Update, there is not sufficient time to perform flow monitoring to support design during spring conditions. The schedule shows a "prior to implementation monitoring period" of spring 2015. Nevertheless, implementing some flow monitoring could begin in summer of 2014 which would allow for more informed sizing of the proposed practices. It is expected that the flow monitoring for green infrastructure evaluation can not only support the design and evaluation of the practices, but also that monitoring at the local scale within the project areas will help better define the local hydrology, and that can be
4. Coordination with Parks. These projects will all require extensive coordination with parks to determine final placement and appearance, as well as maintenance of park uses during construction. In particular, the Hanscom Park Master Plan is scheduled for 2014, and green infrastructure practices will need to be coordinated with that planning effort.
5. Subsurface storage design and permitting. Options for subsurface storage design include many vendor supplied storage products as well as use of standard pipe materials. While this study based a number of the layouts on a particular manufactured product, this was primarily to ensure that conceptual layout configurations included sufficient footprint for the desired storage. The City may (or may not) wish to evaluate the various options on the market so that a standard manufacturer or design could be used. Other aspects of the subsurface storage that should be discussed in more detail include allowable surcharging (hydraulic gradeline constraints) and dewatering approaches. Additionally, it is expected that these subsurface facilities will require permitting as Class V injection wells. Specific requirements of that permitting process should be clearly defined in order to ensure that project schedules are met.

7.3 Green Infrastructure Program and Policies

The City has initiated a Green Infrastructure Program of which implementation of the five proposed projects is but one component. The City should continue to pursue other project types and programmatic elements that will enable additional implementation of green infrastructure and stormwater management. Recommended future actions include:

1. Develop and maintain working relationships with institutional partners to encourage and facilitate green infrastructure projects. Specific institutions to explore include: Creighton University, Henry Doorly Zoo, UNMC campus, Douglas County and Omaha Public Schools.
2. Maintain the list of potential green infrastructure opportunities (as identified in this report or through other identification methods) and pursue implementation of representative projects to better assess performance in Omaha.
3. Consider a financial incentive program to stimulate investment and retrofits on private property
4. Review standards for redevelopment and define strategies for encouraging green infrastructure use while not discouraging reinvestment in the City. Evaluate redevelopment standards for combined areas of the City.
5. Develop standards for greening of streets, including “road diets”, green streets details, and project flow processes. Develop standards for additional stormwater management and green infrastructure implementation.
6. Identify points of connection of NDOR roadway drainage to the City’s combined sewer system and the associated tributary area characteristics. Evaluate potential stormwater management options for these points of connection.
7. Continue investment in tools that will support local scale hydrologic evaluation and complete cost evaluations for green infrastructure. These tools include: small drainage area flow monitoring (preferably that supports other projects), enhancements to the InfoWorks model, and development of a library of local costs for green infrastructure construction and maintenance.

Appendix A – Figures for Identification of Project Opportunities

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Appendix B – Tables for Identification of Project Opportunities

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Appendix C – Opportunities Not Advanced to Top 5 List

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Appendix D – Top 5 Green Infrastructure Practice Location Map

Appendix E – Field Club Trail

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Field Club Trail

Frances Street

Tributary to: Regulator 118
Practice Type: Subsurface
Proposed Storage Volume: 0.56 MG
Proposed Pipe Length: 104 ft
Tributary Drainage Area: 31 ac
Fraction of Regulator Area: 5%

Project Description:

The Field Club Trail Corridor includes four green infrastructure projects: Frances, Gold, Frederick and Vinton. The objective for this location is to pick up separated stormwater from the storm pipe along 37th Street near Frances. The basic project components include:

- A subsurface detention storage chamber with open bottom is proposed within the trail right-of-way. An arch-type storage chamber was evaluated and the resulting footprint is depicted in the conceptual design drawings. The foot print is 30 ft x 987 ft.
- A 24-inch storm sewer is proposed to redirect stormwater flow from the existing separated storm sewer that is south of Frances Street and runs along the 2106 S. 37th Plaza property. This storm sewer is over ten feet below grade at the storage chamber. To avoid further excavation, the subsurface storage system is designed to surcharge into the upstream pipes while keeping the hydraulic gradient below grade.
- A diversion manhole is proposed on the existing separated storm sewer. This manhole directs storm water to the subsurface detention storage chamber, but allows bypass of the subsurface storage during large storm events. During those events, flow can directly enter the existing combined sewer.
- Stormwater flow exits the storage chamber and flows into the existing 21-inch combined sewer which crosses the Field Club Trail and later connects to the 42-inch combined sewer running parallel to the trail.

Basis for Selection:

The tributary area to this practice was previously separated, which takes advantage of the prior investment in storm sewers that are needed to convey the runoff from the tributary area to the practice.

Additional Evaluation Required:

- Final determination of subsurface storage limits and configuration, including type of subsurface storage system.
- Complete geotechnical investigations to confirm soil stability and groundwater characteristics for the placement of the subsurface storage chamber.
- Field verification of existing sewer location and depth. Confirmation of proposed sewer alignments.
- Design of diversion/ control structures to ensure adequate hydraulic capacity, limit surcharging and prevent backup of combined sewage into the stormwater chamber.
- Finalize hydraulic profile including consideration of routine and infrequent conditions.

- Evaluation of tree canopy and landmark and mature trees in areas where subsurface storage and construction access are planned to determine what adjustments must be made to preserve these assets.
- Evaluation of construction access to the site. The site is linear in nature and is constrained along the perimeter by trees and limits of the right-of-way. Access should be limited to reduce the effects on the tree line and the neighboring properties.
- Establish a trail detour based on input from the neighborhood, appropriate traffic and roads staff from the Public Works Department, and Parks, Recreation, and Public Property Department. An initial review shows that routing pedestrians through Harrison Heights Park may be feasible.
- Identification of easements and coordination with adjacent properties. Specific properties impacted include Omaha Public Housing and 3626 Martha Street.

Schedule Constraints:

There are no known schedule constraints.

Cost Opinion:

Capital Cost: $1,680,000
20-Year Life Cycle Cost: $1,687,000

Performance Results: (Appendix J, Table J-1)

CSO Volume Change for the Representative Year: -6.0 MG
Cost per Volume Managed: $0.29/gal

Prioritization Ranking Results: (Appendix J, Table J-2)

Projects were ranked using three different methods. The first method resulted in a rank based on independently weighted quantitative and qualitative criteria. The second method was based on equally-weighted quantitative criteria only and the third method was based on equally-weighted qualitative criteria only. Projects were ranked 1 through 14 with 1 being the project most likely to be implemented based on the ranking criteria.

Quantitative Criteria:
CSO Benefit
Unit Cost

Qualitative Criteria:
Parks Improvements
Moments of Opportunity
Drainage/Flood Benefit
Educational Benefit
Technology Demonstration

	Quantitative and Qualitative Rank	**Quantitative Only Rank**	**Qualitative Only Rank**
Frances Street	12	7	11

Modification Notes:

The configuration (length and width) of the subsurface storage footprint can be modified without impacting performance as long as the proposed storage volume stays the same. This will allow for consideration of other types of subsurface storage products. Inlet and outlet invert elevations should remain as noted in order for the system to work hydraulically.

Field Club Trail
Gold Street

Tributary to: Regulator 118
Practice Type: Subsurface
Proposed Storage Volume: 1.21 MG
Proposed Pipe Length: 172 ft
Tributary Drainage Area: 84 ac
Fraction of Regulator Area: 14%

Project Description:

The Field Club Trail Corridor includes four green infrastructure projects: Frances, Gold, Frederick and Vinton. The objective for this location is to pick up separated stormwater that is collected in a storm sewers east and west of the trail along Gold Street. The basic project components include:

- A subsurface detention storage chamber with open bottom is proposed within the trail right-of-way. An arch-type storage chamber was evaluated and the resulting footprint is depicted in the conceptual design drawings. The foot print is 38 ft x 913 ft for a 2-layer system. The footprint length includes 30 extra feet to cross under Wright Street.
- To collect flow from the separated storm sewer in Gold Street east of 36th Street, a 42-inch storm sewer is proposed from the existing separated storm sewer to the detention storage chamber. This storm sewer is approximately 14 feet below grade at the storage chamber. To avoid further excavation, the subsurface storage system is designed to surcharge into the upstream pipes while staying well below grade.
- To collect flow from the separated storm sewer in Gold Street west of 36th Street, an overflow manhole is proposed on the existing separated storm sewer. This manhole directs stormwater to the subsurface storage chamber but allows overflows during large storm events to flow into the existing storm/combined sewer.
- Stormwater flow exits the storage chamber on the southeast end and discharges into the existing 90-inch combined sewer running parallel to the Field Club Trail.

To avoid installing subsurface storage under Wright Street, connector pipes are proposed across Wright Street to connect the north and south chamber systems.

Basis for Selection:

The tributary area to this practice was previously separated, which takes advantage of the prior investment in storm sewers that are needed to convey the runoff from the tributary area to the practice. This tributary area is also fairly extensive with 84 acres available for stormwater management.

Additional Evaluation Required:

- Confirmation of drainage area to the practice. Areas west of the trail have more favorable grades. In order to reduce the depth/ cost of this practice, the areas east of the trail may be eliminated from the practice tributary area.

- Final determination of subsurface storage limits and configuration, including type of subsurface storage system.
- Complete geotechnical investigations to confirm soil stability and groundwater characteristics for the placement of the subsurface storage chamber.
- Field verification of existing sewer location and depth. Confirmation of proposed sewer alignments.
- Design of diversion/ control structures to ensure adequate hydraulic capacity, limit surcharging and prevent backup of combined sewage into the stormwater chamber.
- Finalize hydraulic profile including consideration of routine and infrequent conditions.
- Evaluation of tree canopy and landmark and mature trees in areas where subsurface storage and construction access are planned to determine what adjustments must be made to preserve these assets.
- Evaluation of construction access to the site. The site is linear in nature and is constrained along the perimeter by trees and limits of the right-of-way. Access should be limited to reduce the effects on the tree line and the neighboring properties.
- Establish a trail detour based on input from the neighborhood, appropriate traffic and roads staff from the Public Works Department, and Parks, Recreation, and Public Property Department. During construction on the northern portion of the system between Gold Street and Wright Street, the detour could be for pedestrians to use S. 36th Street. During construction on the southern portion of the system between Wright Street and Oak/Frederick Street, the detour could be for pedestrians to use 35th Street. A temporary sidewalk from Oak Street to the trail would need to be constructed.

Schedule Constraints:

There are no known schedule constraints.

Cost Opinion:

Capital Cost: $2,899,000
20-Year Life Cycle Cost: $2,921,000

Performance Results: (Appendix J, Table J-1)

CSO Volume Change for the Representative Year: -12.8 MG
Cost per Volume Managed: $0.23/gal

Prioritization Ranking Results: (Appendix J, Table J-2)

Projects were ranked using three different methods. The first method resulted in a rank based on independently weighted quantitative and qualitative criteria. The second method was based on equally-weighted quantitative criteria only and the third method was based on equally-weighted qualitative criteria only. Projects were ranked 1 through 14 with 1 being the project most likely to be implemented based on the ranking criteria.

Quantitative Criteria:
CSO Benefit
Unit Cost

Qualitative Criteria:
Parks Improvements
Moments of Opportunity
Drainage/Flood Benefit
Educational Benefit

Technology Demonstration

	Quantitative and Qualitative Rank	Quantitative Only Rank	Qualitative Only Rank
Gold Street	7	1	11

Modification Notes:

As described in Section 5.0, to divert flow from the tributary drainage area east of the trail, the bottom of the storage system needs to be 14 feet deep. If only the tributary drainage area west of the trail is diverted for storage, the bottom of the system need only be about 11 feet deep. By capturing and storing just the westerly portion of the tributary drainage area, the potential volume removed from the combined sewer system will be reduced by about one third. The cost per gallon will decrease as the system becomes shallower.

The configuration (length and width) of the subsurface storage footprint can be modified without impacting performance as long as the proposed storage volume stays the same. This will allow for consideration of other types of subsurface storage products. Inlet and outlet invert elevations should remain as noted in order for the system to work hydraulically.

Field Club Trail
Frederick Street

Tributary to: Regulator 118
Practice Type: Subsurface
Proposed Storage Volume: 0.64 MG
Proposed Pipe Length: 361 ft
Tributary Drainage Area: 35 ac
Fraction of Regulator Area: 6%

Project Description:

The Field Club Trail Corridor includes four green infrastructure projects: Frances, Gold, Frederick and Vinton. The objective for this location is to pick up separated stormwater that is collected in a storm pipe along Frederick Street. The basic project components include:

- A subsurface detention storage chamber with open bottom is proposed within the trail right-of-way. An arch-type storage chamber was evaluated and the resulting footprint is depicted in the conceptual design drawings. The foot print is 38 ft x 470 ft for a 2-layer system. The subsurface detention storage chamber will need to be located southeast of the 99-inch combined sewer.
- A proposed 48” storm sewer will redirect stormwater flow from the existing 48” separated storm sewer that resides along Frederick Street. This proposed sewer will need to be installed within the adjacent Chicago Central & Pacific Railroad property.
- An overflow manhole will be constructed on the existing separated storm sewer. This manhole will direct stormwater to the detention storage chamber, but will allow overflows during large storm events to flow into the existing storm/combined sewer.
- Stormwater flow will exit the storage chamber and flow into the existing 99” combined sewer which runs parallel to the Field Club Trail.

Basis for Selection:

The tributary area to this practice was previously separated, which takes advantage of the prior investment in storm sewers that are needed to convey the runoff from the tributary area to the practice.

Additional Evaluation Required:

- Final determination of subsurface storage limits and configuration, including type of subsurface storage system. Coordination with the Vinton location which may be constructed earlier.
- Complete geotechnical investigations to confirm soil stability and groundwater characteristics for the placement of the subsurface storage chamber.
- Field verification of existing sewer location and depth. Confirmation of proposed sewer alignments.
- Design of diversion/ control structures to ensure adequate hydraulic capacity, limit surcharging and prevent backup of combined sewage into the stormwater chamber.
- Finalize hydraulic profile including consideration of routine and infrequent conditions.

- Easements will be needed through the Chicago Central & Pacific Railroad property for the proposed 48-inch storm pipe.
- Evaluation of tree canopy and landmark and mature trees in areas where subsurface storage and construction access are planned to determine what adjustments must be made to preserve these assets.
- Evaluation of construction access to the site. The site is linear in nature and is constrained along the perimeter by trees and limits of the right-of-way. Access should be limited to reduce the effects on the tree line and the neighboring properties.
- Establish a trail detour based on input from the neighborhood, appropriate traffic and roads staff from the Public Works Department, and Parks, Recreation, and Public Property Department. Initial review shows a possible pedestrian detour from Vinton Street to S. 36th Street to Wright Street.

Schedule Constraints:

There are no known schedule constraints.

Cost Opinion:

Capital Cost: $1,728,000
20-Year Life Cycle Cost: $1,744,000

Performance Results: (Appendix J, Table J-1)

CSO Volume Change for the Representative Year: -6.7 MG
Cost per Volume Managed: $0.26/gal

Prioritization Ranking Results: (Appendix J, Table J-2)

Projects were ranked using three different methods. The first method resulted in a rank based on independently weighted quantitative and qualitative criteria. The second method was based on equally-weighted quantitative criteria only and the third method was based on equally-weighted qualitative criteria only. Projects were ranked 1 through 14 with 1 being the project most likely to be implemented based on the ranking criteria.

Quantitative Criteria:
CSO Benefit
Unit Cost

Qualitative Criteria:
Parks Improvements
Moments of Opportunity
Drainage/Flood Benefit
Educational Benefit
Technology Demonstration

	Quantitative and Qualitative Rank	Quantitative Only Rank	Qualitative Only Rank
Frederick Street	12	7	11

Modification Notes:

The configuration (length and width) of the subsurface storage footprint can be modified without impacting performance as long as the proposed storage volume stays the same. This will allow for consideration of other types of subsurface storage products. Inlet and outlet invert elevations should remain as noted in order for the system to work hydraulically.

Field Club Trail

Vinton Street

Tributary to: Regulator 118
Practice Type: Subsurface
Proposed Storage Volume: 0.11 MG
Proposed Pipe Length: 345 ft
Tributary Drainage Area: 17 acres
Fraction of Regulator Area: 3%

Project Description:

The Field Club Trail Corridor includes four green infrastructure projects: Frances, Gold, Frederick and Vinton. The objective for this location is to pick up separated stormwater from Vinton Street and along S. 35th Street which captures additional stormwater from both Hascall Street and Valley Street. The basic project components include:

- A subsurface detention storage chamber with open bottom is proposed within the trail right-of-way. An arch-type storage chamber was evaluated and the resulting footprint is depicted in the conceptual design drawings. The foot print is 12 ft x 485 ft.
- A proposed 21-inch storm sewer will redirect stormwater flow from the existing separated storm sewer that resides along Vinton Street.
- A proposed 24-inch storm sewer will redirect stormwater flow from the existing separated storm sewer that resides along Valley Street.
- Overflow manholes will be constructed on the existing separated storm sewers. These manholes will direct stormwater to the detention storage chamber, but will allow overflows during large storm events to flow into the existing storm/combined sewer.
- Stormwater flow will exit the storage chamber and flow into the existing 102-inch combined sewer which runs parallel to the Field Club Trail.

Basis for Selection:

The tributary area to this practice was previously separated, which takes advantage of the prior investment in storm sewers that are needed to convey the runoff from the tributary area to the practice. This project would also further alleviate local flooding that occurs. In addition, this area is in the design stages to be paved for an extension of the Field Club Trail south of Interstate-80.

Additional Evaluation Required:

- Final tributary area, including collection of runoff from areas east of the trail, which may impact the size and configuration of the practice. Revised practice volume and modeling to accommodate.
- Provision for later construction of the Frederick subsurface storage facility.
- Final determination of subsurface storage limits and configuration, including type of subsurface storage system.
- Complete geotechnical investigations to confirm soil stability and groundwater characteristics for the placement of the subsurface storage chamber.

- Field verification of existing sewer location and depth. Confirmation of proposed sewer alignments.
- Design of diversion/ control structures to ensure adequate hydraulic capacity, limit surcharging and prevent backup of combined sewage into the stormwater chamber.
- Finalize hydraulic profile including consideration of routine and infrequent conditions.
- Evaluation of tree canopy and landmark and mature trees in areas where subsurface storage and construction access are planned to determine what adjustments must be made to preserve these assets.
- Evaluation of construction access to the site. The site is linear in nature and is constrained along the perimeter by trees and limits of the right-of-way. Access should be limited to reduce the effects on the tree line and the neighboring properties.
- Establish a trail detour based on input from the neighborhood, appropriate traffic and roads staff from the Public Works Department, and Parks, Recreation, and Public Property Department.

Schedule Constraints:

The Field Club Trail extension is planned for construction in the next year. This project needs to be coordinated with the construction of the trail extension in order to optimize resources.

Cost Opinion:

Capital Cost: $803,000
20-Year Life Cycle Cost: $819,000

Performance Results: (Appendix J, Table J-1)

CSO Volume Change for the Representative Year: -1.3 MG
Cost per Volume Managed: $0.63/gal

Prioritization Ranking Results: (Appendix J, Table J-2)

Projects were ranked using three different methods. The first method resulted in a rank based on independently weighted quantitative and qualitative criteria. The second method was based on equally-weighted quantitative criteria only and the third method was based on equally-weighted qualitative criteria only. Projects were ranked 1 through 14 with 1 being the project most likely to be implemented based on the ranking criteria.

Quantitative Criteria:
CSO Benefit
Unit Cost

Qualitative Criteria:
Parks Improvements
Moments of Opportunity
Drainage/Flood Benefit
Educational Benefit
Technology Demonstration

	Quantitative and Qualitative Rank	Quantitative Only Rank	Qualitative Only Rank
Vinton Street	11	13	4

Modification Notes:

The configuration (length and width) of the subsurface storage footprint can be modified without decreasing performance as long as the proposed storage volume does not decrease. This will allow for consideration of other types of subsurface storage products. Inlet and outlet invert elevations should remain as noted in order for the system to work hydraulically.

Section 5.0 discusses the possibility of capturing some surface runoff along Vinton Street to the east of the trail. If this runoff were added to the system, the cost/gallon would remain about the same or would slightly increase due to the need for additional storm pipes to divert the flow. The volume removed from the combined sewer system at this location would increase by approximately 30 percent.

Appendix F – Hanscom Park

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Hanscom Park

Hanscom Park - north

Tributary to: Regulator 109/121
Practice Type: Cascading bioswale and pond storage
Proposed Storage Volume: 0.48 MG
Proposed Pipe Length: 614 ft
Tributary Drainage Area: 33 acres
Fraction of Regulator Area: 2%

Project Description:

The Hanscom Park project includes three green infrastructure projects: North, West and East. The objective of for this location is to capture stormwater runoff from drainage areas north of the park between Woolworth Avenue to Pacific Street and Park Avenue to 32nd Street.

- Proposed 24-inch and 27-inch sewers at the intersections of 30th Street and Woolworth Avenue and 31st Street and Woolworth Avenue will redirect stormwater flow from the existing combined storm sewer to separate storm pipes that convey runoff to the cascading bioswales in the park.
- Cascading bioswales will convey runoff to the proposed stormwater pond.
- Pond slopes may be adjusted from current grading to match current slopes, requiring less grading and potential impacts on trees.
- The current plan does not include new storm sewers north of Woolworth, it relies on “flow slipping” (essentially bypassing) of inlets north of Woolworth Avenue in order to collect runoff from north of Poppleton Street.

Basis for Selection:

The drainage area north of the park is steeply sloped and conveys runoff toward Woolworth. The existing “piano” inlet suggests that there are significant surface drainage issues at this location during large events. This project would help alleviate surface drainage issues while providing a feature in an available area of the park. The runoff volume controlled by the proposed cascading bioswales and pond stormwater management features combine to provide additional flow control and park enhancements. This project can collect stormwater runoff from up to 33 acres of tributary area.

Additional Evaluation Required:

It is recommended that all improvements to the park be coordinated with the Hanscom Park Master Plan developed by the Parks, Recreation, and Public Property Department. Additional evaluations to be addressed in the design phase include, but may not be limited to:

- Further evaluation of storm sewer design from the existing inlets on Woolworth Avenue at 30th and 31st Streets to new manhole structures adjacent to Woolworth Avenue in the park.
- Final placement and orientation for the pond for this system. Because of the existing steep slopes in the park, grading to limit slope presented some challenges in the concept design. Various approaches could be used to limit the area of disturbance.

- Field verification of existing sewer location and depth. In particular, there are two combined sewers that traverse the park along the proposed alignment of this system. The function of these sewers needs to be evaluated to determine if both should be retained.
- Design of diversion/ control structures to ensure adequate hydraulic capacity, and limit surcharging.
- Finalize hydraulic profile including consideration of routine and infrequent conditions.
- Additional evaluation may be necessary to allow “flow slipping” by reducing the volume allowed to enter the upstream inlets along these streets.
- Evaluation of tree canopy and landmark and mature trees in areas where the cascading bioswale and piped infrastructure is planned to protect critical assets.
- Complete geotechnical investigations to confirm soil stability and groundwater characteristics for the placement of the cascading bioswale and pond controls.

Schedule Constraints:

The Omaha Parks Department is developing a master plan for Hanscom Park. Improvements based on this document should be coordinated with the master planning effort.

Cost Opinion:

Capital Cost: $1,873,000
20-Year Life Cycle Cost: $2,119,000

Performance Results: (Appendix J, Table J-1)

CSO Volume Change for the Representative Year: -5.6 MG
Cost per Volume Managed: $0.38/gal

Prioritization Ranking Results: (Appendix J, Table J-2)

Projects were ranked using three different methods. The first method resulted in a rank based on independently weighted quantitative and qualitative criteria. The second method was based on equally-weighted quantitative criteria only and the third method was based on equally-weighted qualitative criteria only. Projects were ranked 1 through 14 with 1 being the project most likely to be implemented based on the ranking criteria.

Quantitative Criteria:
CSO Benefit
Unit Cost

Qualitative Criteria:
Parks Improvements
Moments of Opportunity
Drainage/Flood Benefit
Educational Benefit
Technology Demonstration

	Quantitative and Qualitative Rank	**Quantitative Only Rank**	**Qualitative Only Rank**
Hanscom Park - north	2	7	1

Hanscom Park

Hanscom Park - west

Tributary to: Regulator 109/121
Practice Type: Cascading bioswale and pond storage
Proposed Storage Volume: 0.85 MG
Proposed Pipe Length: 740 ft
Tributary Drainage Area: 62 acres
Fraction of Regulator Area: 4%

Project Description:

The Hanscom Park project includes three green infrastructure projects: North, West and East. The objective for this location is to pick up separated stormwater from Center Street north to Woolworth Avenue between 32nd and 36th Streets and Center Street South to Martha Street between 32nd and 33rd Streets.

- The northwestern portion will make use of already separated storm sewers along 35th Street draining to Center Street.
- Use of the existing combined line from 34th Street to 32nd street will minimize additional pipe infrastructure needs. The current plan assumes this can be converted to a storm sewer and that buildings are served by rear lot sewers.
- Stormwater from the southwestern section which is currently separated will be piped northeast within the park adjoining the Center Street pipe near the proximity of the outfall to the cascading bioswale.
- Stormwater will be infiltrated in the bioswale and the volume not infiltrated in the bioswale will be held in ponded areas to reduce CSO volume.
- At the terminus of the cascading bioswale is a storage pond that provides 1.7 ac-ft for additional volume control.

Basis for Selection:

The drainage area west and southwest of the park was selected because of the ease and cost-effectiveness of routing stormwater runoff from existing inlets and previously separate stormwater pipe network to the park. This area can collect stormwater runoff from up to 62 acres. The runoff volume controlled by the proposed cascading bioswales and pond stormwater management features combine to provide additional flow control and park enhancements. These features are a means to provide water quality treatment and potential overflow reduction.

Additional Evaluation Required:

It is recommended that all improvements to the park be coordinated with Hanscom Park Master Plan developed by the Parks, Recreation, and Public Property Department. Investigations in this report suggest additional evaluations may be necessary. These include, but may not be limited to:

- Confirmation of the use of the Center Street Sewer as a storm sewer without additional sewer construction. Investigation of this sewer including CCTV work would be required between 32nd to 34th Streets to determine whether any laterals are present.

- The project assumed that the depth of the sewer at the intersection of Center and 32nd Streets dictated the depth of daylighting into the cascading bioswale on the west side of the park. If pipe depths are less, the cascading swale can be longer in length. Actual future sewer elevations need to be determined.
- Field verification of existing sewer locations and depth.
- Design of diversion/ control structures to ensure adequate hydraulic capacity, and limit potential for surcharging.
- Finalize hydraulic profile including consideration of routine and infrequent conditions.
- Evaluation of tree canopy and landmark and mature trees in areas where the cascading bioswale and piped infrastructure is planned to determine if minor adjustments will allow for retention of these assets.
- Complete geotechnical investigations to confirm soil stability and groundwater characteristics for the placement of the cascading bioswale and pond controls.

Schedule Constraints:

The Omaha Parks Department is developing a master plan for Hanscom Park. Improvements based on this document should be coordinated with the master planning effort.

Cost Opinion:

Capital Cost: $1,040,000
20-Year Life Cycle Cost: $1,182,000

Performance Results: (Appendix J, Table J-1)

CSO Volume Change for the Representative Year: -9.8 MG
Cost per Volume Managed: $0.12/gal

Prioritization Ranking Results: (Appendix J, Table J-2)

Projects were ranked using three different methods. The first method resulted in a rank based on independently weighted quantitative and qualitative criteria. The second method was based on equally-weighted quantitative criteria only and the third method was based on equally-weighted qualitative criteria only. Projects were ranked 1 through 14 with 1 being the project most likely to be implemented based on the ranking criteria.

Quantitative Criteria:
CSO Benefit
Unit Cost

Qualitative Criteria:
Parks Improvements
Moments of Opportunity
Drainage/Flood Benefit
Educational Benefit
Technology Demonstration

	Quantitative and Qualitative Rank	**Quantitative Only Rank**	**Qualitative Only Rank**
Hanscom Park - west	1	2	1

Hanscom Park
Hanscom Park - east

Tributary to: Regulator 109/121
Practice Type: Surface storage
Proposed Storage Volume: 0.19 MG (0.41 MG if additional volume is used within the lagoon)
Proposed Pipe Length: 1,164
Tributary Drainage Area: 38 acres
Fraction of Regulator Area: 2%

Project Description:

The Hanscom Park project includes three green infrastructure projects: North, West and East. This project will collect conveyed stormwater from the park road, the overflow from the west pond, and runoff from the western portion of Park Avenue and route these flows into the existing lagoon.

- Northern portion of Park Avenue will be routed through two curb cuts into the park.
- Proposed pipe will route runoff from the west side of Park Avenue to a gross solids separation unit and then to the existing lagoon.
- Existing and new pipe will route the west drainage area to the existing lagoon.
- Proposed pipe will route drainage from inlets on the park road to a gross solids separation unit and then to the existing lagoon.
- A retrofit of the existing outlet of the lagoon that includes a real-time control is proposed for the project to allow for greater volume retention in the lagoon by allowing drawdown of surface water prior to a storm event.

Basis for Selection:

The drainage area from the park proper and the east side of the park along Park Avenue was selected because of the ease and cost-effectiveness of routing stormwater runoff from existing inlets using a proposed separate stormwater pipe network to the park. This area can collect stormwater runoff from up to 38 acres. Internal stormwater pipe networks are proposed for this project which will provide additional volume control to internal drainage of the park. The runoff volume managed by the existing lagoon with outlet modifications provides a substantial increase of volume control using existing park infrastructure and can provide potential overflow reduction.

Additional Evaluation Required:

It is recommended that all improvements to the park be coordinated with Hanscom Park Master Plan developed by the Parks, Recreation, and Public Property Department. Investigations in this report suggest additional evaluations may be necessary. These include, but may not be limited to:

- Modeling and survey of the existing lagoon outlet to determine the most appropriate outlet control devices and controls to provide the greatest benefit to the existing lagoon. Confirmation of the allowable surface elevation range in the lagoon to support park purposes.
- An evaluation of the type, size, and placement of gross solids pretreatment prior to entering into the existing lagoon.

- An assessment of new pipe infrastructure alignments, and whether abandoning existing CSO pipes (or using existing pipes and an overflow point) is practical.
- Field verification of existing sewer locations and depth. Confirmation of localized drainage areas in the park to maximize flow controlled.
- Design of diversion/ control structures to ensure adequate hydraulic capacity, and limit potential for surcharging.
- Finalize hydraulic profile including consideration of routine and infrequent conditions.
- Evaluation of tree canopy and landmark and mature trees in areas where the cascading bioswale and piped infrastructure is planned to determine if minor adjustments will allow for retention of these assets.
- Complete geotechnical investigations to confirm soil stability and groundwater characteristics for the placement of the cascading bioswale and pond controls.

Schedule Constraints:

The Omaha Parks, Recreation, and Public Property Department is developing a master plan for Hanscom Park. Improvements based on this document should be coordinated with the master planning effort.

Cost Opinion:

Capital Cost: $634,000
20-Year Life Cycle Cost: $686,000

Performance Results: (Appendix J, Table J-1)

CSO Volume Change for the Representative Year: -2.2 MG
Cost per Volume Managed: $0.32/gal

Prioritization Ranking Results: (Appendix J, Table J-2)

Projects were ranked using three different methods. The first method resulted in a rank based on independently weighted quantitative and qualitative criteria. The second method was based on equally-weighted quantitative criteria only and the third method was based on equally-weighted qualitative criteria only. Projects were ranked 1 through 14 with 1 being the project most likely to be implemented based on the ranking criteria.

Quantitative Criteria:
CSO Benefit
Unit Cost

Qualitative Criteria:
Parks Improvements
Moments of Opportunity
Drainage/Flood Benefit
Educational Benefit
Technology Demonstration

	Quantitative and Qualitative Rank	**Quantitative Only Rank**	**Qualitative Only Rank**
Hanscom Park - east	5	12	1

Appendix G – Kountze Park

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Kountze Park

Tributary to: Regulator 107
Practice Type: Subsurface
Proposed Storage Volume: 0.67 MG
Proposed Pipe Length: 236 ft
Tributary Drainage Area: 54 acres
Fraction of Regulator Area: 7%

Project Description:

The objective for this location is to pick up separated stormwater from the storm pipe at the intersection of Evans Street and N. 19th Street.

- A subsurface detention storage chamber with open bottom is proposed within the park. An arch-type storage chamber was evaluated and the resulting footprint is depicted in the conceptual design drawings. The foot print is 58 ft x 325 ft for a 2-layer system.
- A diversion structure will be constructed on the existing 48-inch storm sewer to redirect low flows into the subsurface storage chamber. Large flows will overtop a weir into the existing 48-inch storm sewer.
- A proposed 15-inch storm sewer will redirect stormwater flow from the existing separated storm sewer that resides along Florence Blvd between Pinkney Street and Pratt Street.
- A proposed 15-inch storm sewer will redirect stormwater flow from the existing inlets in Florence Blvd.
- Diversion structures will be constructed on the existing separated storm sewers. These manholes will direct storm water to the subsurface storage chamber, but will allow overflows during large storm events to flow into the existing storm sewer.
- To avoid deep excavation and to be able to discharge into the existing storm sewer, the subsurface storage chamber will be constructed at an elevation to allow surcharging in the upstream system. The diversion structure will need to be carefully designed so that the head over the weir does not cause excessive surcharging in the upstream pipes.
- Stormwater flow will exit the storage chamber and flow into the existing 48-inch storm sewer which runs East-West through Kountze Park.

Basis for Selection:

This tributary area was previously separated which provides a cost efficiency in that minimal new pipe is needed to convey the runoff from the tributary area to the practice.

Additional Evaluation Required:

- Further evaluation is needed to determine the final placement of the subsurface storage chamber. The Parks, Recreation, and Public Property Department would like to preserve trees as much as possible. A tree survey is needed to confirm the location, size, health, and type of trees. This will help determine storage placement. The conceptual design results and cost in this appendix reflect the storage being placed in the center of the eastern portion of the park. Alternatively, the storage could be located on the western side. The baseball outfield is a possible location, although it would require relocation of the existing 15-inch sanitary sewer.

- A geotechnical investigation will be needed to evaluate the effects that the suspected debris buried within the park might have on excavation and groundwater from leaching contaminants. This would help determine if subsurface storage should have a solid bottom to prevent infiltration. A geotechnical investigation will also need to confirm soil stability and groundwater characteristics.
- The as-built location and depth of the existing storm and sanitary pipes within the park need to be confirmed.
- Design of diversion/ control structures to ensure adequate hydraulic capacity, and limit potential for surcharging.
- Finalize hydraulic profile including consideration of routine and infrequent conditions.

Schedule Constraints:

There are no known schedule constraints.

Cost Opinion:

Capital Cost: $1,603,000
20-Year Life Cycle Cost: $1,621,000

Performance Results: (Appendix J, Table J-1)

CSO Volume Change for the Representative Year: -6.5 MG
Cost per Volume Managed: $0.24/gal

Prioritization Ranking Results: (Appendix J, Table J-2)

Projects were ranked using three different methods. The first method resulted in a rank based on independently weighted quantitative and qualitative criteria. The second method was based on equally-weighted quantitative criteria only and the third method was based on equally-weighted qualitative criteria only. Projects were ranked 1 through 14 with 1 being the project most likely to be implemented based on the ranking criteria.

Quantitative Criteria:
CSO Benefit
Unit Cost

Qualitative Criteria:
Parks Improvements
Moments of Opportunity
Drainage/Flood Benefit
Educational Benefit
Technology Demonstration

	Quantitative and Qualitative Rank	**Quantitative Only Rank**	**Qualitative Only Rank**
Kountze Park	9	6	10

Modification Notes:

The configuration (length and width) and location of the subsurface storage footprint can be modified without impacting performance as long as the proposed storage volume stays the same.

This will allow for consideration of other types of subsurface storage products. Inlet and outlet invert elevations should remain as noted in order for the system to work hydraulically.

Appendix H – Schroeder-Vogel Park

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Schroeder-Vogel Park

Tributary to: Regulator 205
Practice Type: Subsurface
Proposed Storage Volume: 0.38 MG
Proposed Pipe Length: 2,040 ft
Tributary Drainage Area: 30 acres
Fraction of Regulator Area: 1%

Project Description:

This project would include installation of new storm sewer to divert flow to the park for storage. The tributary drainage area includes the area north of Hickory Street, south of Poppleton Avenue, west of 51st Street and east of 52nd Street. Some drainage can be captured with minor stormwater pipe additions along Saddle Creek Boulevard. Additional drainage is recommended to capture parking lot and roof runoff from the US Postal Service building at 1718 S 51st St. The total drainage area that can be captured and routed to the Park is 54 acres.

Basis for Selection:

The relative ease of routing stormwater runoff from pipes that were previously disconnected from the combined sewer system makes the opportunities in Schroeder-Vogel Park appealing. Similarly, surface runoff managed prior to entry into the combined sewer may provide an increased level of service in the downstream areas southwest of the park in addition to reducing hydraulic overloading in the combined system. Both the increased level of service in the park and reduction in hydraulic overloading to the system are desirable outcomes.

Additional Evaluation Required:

There are several evaluations that are recommended before committing to design of subsurface stormwater management within the park. They are as follows:

- Geotechnical investigations are recommended to determine nature and depth of groundwater in this location.
- A refinement of tributary area based on field survey and analysis is recommended to determine the feasibility of separate stormwater pipe routing towards and within the park.
- Because the Omaha Parks, Recreation, and Public Property Department is planning improvements for the park, specific placement of subsurface storage practices in the park should consider existing and future park facilities.

Schedule Constraints:

The Omaha Parks, Recreation, and Public Property Department is planning improvements in Schroeder-Vogel Park. These are expected to commence prior to any stormwater runoff management implementation. Care will be needed in order to coordinate effort so that new park facilities are not disturbed by future stormwater work.

Cost Opinion:

Capital Cost: $1,795,000
20-Year Life Cycle Cost: $1,845,000

Performance Results: (Appendix J, Table J-1)

CSO Volume Change for the Representative Year: -4.2 MG
Cost per Volume Managed: $0.43/gal

Prioritization Ranking Results: (Appendix J, Table J-2)

Projects were ranked using three different methods. The first method resulted in a rank based on independently weighted quantitative and qualitative criteria. The second method was based on equally-weighted quantitative criteria only and the third method was based on equally-weighted qualitative criteria only. Projects were ranked 1 through 14 with 1 being the project most likely to be implemented based on the ranking criteria.

Quantitative Criteria:
CSO Benefit
Unit Cost

Qualitative Criteria:
Parks Improvements
Moments of Opportunity
Drainage/Flood Benefit
Educational Benefit
Technology Demonstration

	Quantitative and Qualitative Rank	Quantitative Only Rank	Qualitative Only Rank
Schroeder-Vogel Park	6	7	5

Modification Notes:

The configuration (length and width) and location of the subsurface storage footprint can be modified without impacting performance as long as the proposed storage volume stays the same. This will allow for consideration of other types of subsurface storage products. Inlet and outlet invert elevations should remain as noted in order for the system to work hydraulically.

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Appendix I – Turner Boulevard

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Turner Boulevard

North Turner Park

Tributary to: Regulator 108
Practice Type: Subsurface
Proposed Storage Volume: 1.27 MG
Proposed Pipe Length: 1,525 ft
Tributary Drainage Area: 58 acres
Fraction of Regulator Area: 3%

Project Description:

The Turner Blvd project includes a number of green infrastructure components. The objective for the North Turner location is to pick up previously separated stormwater from Midtown Crossing and from Farnum Street. Runoff from a portion of Dodge Street can also be collected. The Farnum Street storm sewer extends from S. 37th Street to Park Avenue.

- A subsurface detention storage chamber with open bottom is proposed within the park. An arch-type storage chamber was evaluated and the resulting footprint is depicted in the conceptual design drawings. The foot print is 150 ft x 247 ft for a 2-layer system. Subsurface storage was selected over surface storage in order to maintain the space as a recreational area.
- A proposed 42-inch storm sewer will be installed along Turner Blvd. The storm sewer will redirect stormwater flow from the existing separated storm sewers that reside in Farnam Street at Turner Blvd. and from Midtown Crossing between Farnam Street and Dodge Street.
- An overflow manhole will be constructed on the proposed storm sewer. This manhole will direct storm water to the detention storage chamber, but will allow overflows during large storm events to flow into the existing 72-inch combined sewer.
- Stormwater flow will exit the storage chamber and discharge into the existing 15-inch combined sewer which then discharges into the existing 72-inch combined along N. 30th Street.
- To be able to store the desired volume, the subsurface storage footprint needs to be maximized within the space. It may not fully manage the design event used for sizing of other practices identified in this report.
- For the subsurface storage to properly drain into the downstream combined sewer, the final grade of the park will need to be higher than the current grade. This should create more flat surface for recreation.

Basis for Selection:

A majority of the tributary area was previously separated which provides a cost efficiency in that minimal new pipe is needed to convey the runoff from the tributary area to the practice.

Additional Evaluation Required:

- The site is relatively challenging due to the large amount of tributary area relative to the site footprint, the significant number of sewers under the proposed location and the sewers that would be required to convey flow from the separate sewers to this location. There is some potential that the roadways will be reconfigured in this area and a trail connection included which may impact the site. This potential needs to be better defined. If road reconfiguration or a trail is likely, the green infrastructure project and the road project should be coordinated.

- If this practice moves forward, the following information will need to be collected:
  - The as-built location and depth of the existing combined sewer pipes and utilities within the park need to be confirmed. The condition of the sewers will also need to be assessed, especially if storage for stormwater is located above the existing sewers.
  - Assuming the project is coordinated with other infrastructure improvements, the configuration of the revised intersection or development of adjacent park space will influence the design.
  - Complete geotechnical investigations to confirm soil stability and groundwater characteristics for the placement of the subsurface storage chamber.
  - Design of diversion/ control structures to ensure adequate hydraulic capacity, and limit potential for surcharging.
  - Finalize hydraulic profile including consideration of routine and infrequent conditions.
  - Determine if existing CSO pipes should be used as relief points through control structures within the pipes to allow overflow volume or higher capacity for larger flows to enter into the combined sewer system at an earlier point.
  - Evaluation of tree canopy and landmark and mature trees in areas where subsurface storage and construction access are planned to determine what adjustments can be made to preserve these assets.

Schedule Constraints:

The schedule should be coordinated with the potential roadway reconfiguration.

Cost Opinion:

Capital Cost: $4,174,000
20-Year Life Cycle Cost: $4,206,000

Performance Results: (Appendix J, Table J-1)

CSO Volume Change for the Representative Year: -13.9 MG
Cost per Volume Managed: $0.30/gal

Prioritization Ranking Results: (Appendix J, Table J-2)

Projects were ranked using three different methods. The first method resulted in a rank based on independently weighted quantitative and qualitative criteria. The second method was based on equally-weighted quantitative criteria only and the third method was based on equally-weighted qualitative criteria only. Projects were ranked 1 through 14 with 1 being the project most likely to be implemented based on the ranking criteria.

Quantitative Criteria:
CSO Benefit
Unit Cost

Qualitative Criteria:
Parks Improvements
Moments of Opportunity
Drainage/Flood Benefit

Educational Benefit Technology Demonstration

	Quantitative and Qualitative Rank	Quantitative Only Rank	Qualitative Only Rank
North Turner Park	10	2	14

Modification Notes:

The configuration (length and width) of the subsurface storage footprint can be modified without impacting performance as long as the proposed storage volume stays the same. This will allow for consideration of other types of subsurface storage products. Inlet and outlet invert elevations should remain as noted in order for the system to work hydraulically. A surface storage facility could also be considered if it can be coordinated with the park use.

Turner Boulevard

Dewey Park

Tributary to: Regulator 108
Practice Type: Subsurface
Proposed Storage Volume: 1.02 MG
Proposed Pipe Length: 2,644 ft
Tributary Drainage Area: 51 acres
Fraction of Regulator Area: 3%

Project Description:

The Turner Boulevard project includes a number of green infrastructure components. The objective at Dewey Park is to manage stormwater from adjacent areas. West of the park, there is a significant amount of sheet flow along the gutter prior to entering inlets. This provides for a relatively large tributary area that is cost effective to capture. In addition, an existing storm sewer on Harney would be connected to the green infrastructure practices on the north side of the park. New storm sewers and inlets would be constructed on Harney, Howard, and Jackson Streets and Turner Boulevard. The new sewers and inlets would capture additional surface flow from the west and southeast of the park. The separated flow would be directed into a system of interconnected surface and subsurface practices.

- A 0.09 acre-foot (a.f.) surface storage basin is proposed east of 33rd Street and west of the tennis courts. Inlets at 33rd and Howard Street would discharge into a bioretention cell constructed on the hillside with modular block retaining wall. An underdrain and overflow structure would tie into a manhole immediately to the south, which would consolidate flow from new storm sewer on Jackson Street and inlets at Jackson and Turner Boulevard. The basin could be vegetated with native vegetation or non-native turf, as appropriate.
- Subsurface detention storage is proposed below and adjacent to the existing parking lot, which would be removed and replaced with permeable pavement. The system is split into two parts, the western parking lot and eastern parking lot, with a divide where the existing combined sewer runs along the parking lot. The western parking lot would have a double-stacked storage chamber system (15,200 square feet) beneath it and adjacent to the parking lot. The eastern side of the parking lot would have a single-stacked storage chamber (5,700 square feet) to provide adequate separation distance between the combined sewer and the detention system. The permeable pavement system, along with the subsurface detention storage chamber system under and adjacent to the parking lot provides a total of 2.0 acre-feet of storage for stormwater flows from the proposed basin west of the tennis courts, and new storm sewer on Jackson Street and inlets at Jackson and Turner Boulevard. Overflow would be directed to a 54-inch manhole to the northeast.
- A double-stacked, subsurface detention storage chamber system with open bottom would be installed north of the main park facility building. With a footprint of 7,750 s.f., this system would provide 0.85 a.f. (0.28 MG) of storage for the separate storm sewer on Harney via a new storm sewer and inlets on the northern side of the park. A connection with the parking lot subsurface storage system would allow for overflow from larger storm events.
- A 0.15 a.f. (0.05 MG) surface storage basin north of the large parking lot would store flow captured by new inlets on Harney Street at Turner Boulevard. An underdrain and overflow

structure would tie into the new 54-inch manhole on the eastern side of the basin. The basin would be vegetated with non-native turf to allow for it to be regularly mowed by the Parks, Recreation, and Public Property Department.

Basis for Selection:

The system of practices would manage flows from the tributary area in a manner that would preserve and improve the existing park function and appearance. In addition, existing local flooding would potentially be reduced. The practices would be able to provide stormwater management for local areas which have known drainage problems. The combination of both surface and subsurface detention in close proximity would provide a public education opportunity for park users and other interested parties.

Additional Evaluation Required:

- The routing of flow among the surface and subsurface storage needs to be further investigated to ensure proper hydraulic connections.
- Incorporating green infrastructure practices within the street right-of-way to the west of the park along Dewey Avenue, Howard Street, and Jackson Street should be investigated. Stormwater management for areas to the west of the park may impact the slope west of the tennis courts. Modification of the slope, including a retaining wall, may need to be considered.
- The as-built location and depth of the existing combined sewer pipes and utilities within the park need to be confirmed. There are several existing sewers within the park footprint. The condition of the sewers will also need to be assessed, especially if storage for stormwater is located above the existing sewers.
- Investigation of flooding issues in and around the park to ensure that ample inlets and conveyance are provided to facilitate drainage in those areas.
- Complete geotechnical investigations to confirm soil stability and groundwater characteristics for the placement of the subsurface storage chamber.
- Design of diversion/ control structures to ensure adequate hydraulic capacity, and limit potential for surcharging.
- Finalize hydraulic profile including consideration of routine and infrequent conditions.
- Evaluation of tree canopy and landmark and mature trees in areas where subsurface storage and construction access are planned to determine what adjustments must be made to preserve these assets.

Schedule Constraints:

There are no known schedule constraints.

Cost Opinion:

Capital Cost: $3,320,000
20-Year Life Cycle Cost: $3,725,000

Performance Results: (Appendix J, Table J-1)

CSO Volume Change for the Representative Year: -12.1 MG
Cost per Volume Managed: $0.31/gal

Prioritization Ranking Results: (Appendix J, Table J-2)

Projects were ranked using three different methods. The first method resulted in a rank based on independently weighted quantitative and qualitative criteria. The second method was based on equally-weighted quantitative criteria only and the third method was based on equally-weighted qualitative criteria only. Projects were ranked 1 through 14 with 1 being the project most likely to be implemented based on the ranking criteria.

Quantitative Criteria:
CSO Benefit
Unit Cost

Qualitative Criteria:
Parks Improvements
Moments of Opportunity
Drainage/Flood Benefit
Educational Benefit
Technology Demonstration

	Quantitative and Qualitative Rank	**Quantitative Only Rank**	**Qualitative Only Rank**
Dewey Park	3	2	5

Modification Notes:

The configuration (length and width) of the subsurface storage footprint can be modified without impacting performance as long as the proposed storage volume stays the same. This will allow for consideration of other types of subsurface storage products.

Turner Boulevard

Leavenworth Park - north

Tributary to: Regulator 108
Practice Type: Subsurface
Proposed Storage Volume: 0.04 MG
Proposed Pipe Length: 299 ft
Tributary Drainage Area: 2 acres
Fraction of Regulator Area: 0.1%

Project Description:

The objective for this location is to pick up stormwater inlets from Jones Street between 35th Street and Turner Street and from Turner Street from Leavenworth Street to Jones Street.

- A single-stacked subsurface detention storage chamber with an open bottom is proposed at the north end of open space block between Leavenworth and Jones Street. An arch-type storage chamber was evaluated and the resulting footprint is depicted in the conceptual design drawings. The footprint is 40 ft x 55 ft.
- A proposed 15-inch storm sewer will redirect stormwater flow from the inlets on Jones Street to the subsurface storage system.
- A proposed 15-inch storm sewer will redirect stormwater flow from the inlets on Turner Street to the subsurface storage system.
- Stormwater flow will exit the storage chamber and flow, via a new 15-inch storm sewer, into the existing 60-inch separated storm sewer that runs along the east side of the Leavenworth-north space to the north.

Basis for Selection:

This is an opportunity to capture stormwater that ties directly into the combined sewer and redirect it to a storage facility. However, this proposed design provides the least amount of benefit relative to cost.

Additional Evaluation Required:

- Complete geotechnical investigations to confirm soil stability and groundwater characteristics for the placement of the subsurface storage chamber.
- An assessment of new pipe infrastructure alignments.
- The as-built location and depth of the existing combined and storm sewer pipes and other buried utilities within the area need to be confirmed.

Schedule Constraints:

There are no known schedule constraints.

Cost Opinion:

Capital Cost: $283,000
20-Year Life Cycle Cost: $293,000

Performance Results: (Appendix J, Table J-1)

CSO Volume Change for the Representative Year: -0.5 MG
Cost per Volume Managed: $0.63/gal

Prioritization Ranking Results: (Appendix J, Table J-2)

Projects were ranked using three different methods. The first method resulted in a rank based on independently weighted quantitative and qualitative criteria. The second method was based on equally-weighted quantitative criteria only and the third method was based on equally-weighted qualitative criteria only. Projects were ranked 1 through 14 with 1 being the project most likely to be implemented based on the ranking criteria.

Quantitative Criteria:
CSO Benefit
Unit Cost

Qualitative Criteria:
Parks Improvements
Moments of Opportunity
Drainage/Flood Benefit
Educational Benefit
Technology Demonstration

	Quantitative and Qualitative Rank	Quantitative Only Rank	Qualitative Only Rank
Leavenworth Park - north	14	14	5

Modification Notes:

The configuration (length and width) of the subsurface storage footprint can be modified without impacting performance as long as the proposed storage volume stays the same. This will allow for consideration of other types of subsurface storage products.

Turner Boulevard

Leavenworth Park - south

Tributary to: Regulator 108
Practice Type: Subsurface
Proposed Storage Volume: 0.64 MG
Proposed Pipe Length: 271 feet
Tributary Drainage Area: 37 acres
Fraction of Regulator Area: 2%

Project Description:

The Turner Blvd project includes a number of green infrastructure components. The objective for this location is to pick up separated stormwater from Leavenworth Street and from the existing 60-inch separated storm sewer that traverses the park and conveys stormwater from areas south of the park.

- A double-stacked subsurface detention storage chamber with an open bottom is proposed on the northwest quadrant of Leavenworth Park. An arch-type storage chamber was evaluated and the resulting footprint is depicted in the conceptual design drawings. The footprint is 100 ft x 177 ft.
- A proposed 42-inch storm sewer will redirect stormwater flow from the existing 60-inch separated storm sewer that flows north through Leavenworth Park.
- A proposed 24-inch storm sewer will redirect stormwater flow from the existing separated storm sewer that is on Leavenworth Street.
- Diversion manholes will be constructed on the existing separated storm sewers. These manholes will direct storm water to the detention storage chamber, but will allow bypass of stormwater during large storm events to the existing storm/combined sewer.
- Stormwater flow will exit the storage chamber and flow into the existing 60-inch separated storm sewer that runs along the east side of Leavenworth Park to the north.
- Based on the current layout of the proposed subsurface storage, it is likely that the baseball diamond will require removal and replacement.

Basis for Selection:

There is a significant tributary area to Leavenworth Park that was previously separated which provides for a more cost-effective design with minimal new piping needed to convey the runoff from the tributary area to the practice. This project would also further alleviate local flooding that occurs.

Additional Evaluation Required:

- In the final phases of this evaluation, use of the Pacific area bioretention was deleted based on comments from Parks staff. Since the area was previously separated, the proposed plan would be to increase the size of storage in Leavenworth Park. The size and configuration of the enlarged footprint will need to be determined.
- The as-built location and depth of the existing combined and storm sewer pipes and other buried utilities within the park need to be confirmed. The objective of the subsurface storage is

to avoid conflict with these sewers. The existing 12-inch combined sewer that crosses the park should be evaluated to determine whether it can be abandoned or relocated.

- Investigation of flooding issues in and around the park to ensure that ample inlets and conveyance are provided to facilitate drainage in those areas.
- Complete geotechnical investigations to confirm soil stability and groundwater characteristics for the placement of the subsurface storage chamber.
- Design of diversion/ control structures to ensure adequate hydraulic capacity, and limit potential for surcharging.
- Finalize hydraulic profile including consideration of routine and infrequent conditions.
- Evaluation of tree canopy and landmark and mature trees in areas where subsurface storage and construction access are planned to determine what adjustments must be made to preserve these assets.

Schedule Constraints:

There are no known schedule constraints.

Cost Opinion:

Capital Cost: $1,441,000
20-Year Life Cycle Cost: $1,460,000

Performance Results: (Appendix J, Table J-1)

CSO Volume Change for the Representative Year: -7.6 MG
Cost per Volume Managed: $0.19/gal

Prioritization Ranking Results: (Appendix J, Table J-2)

Projects were ranked using three different methods. The first method resulted in a rank based on independently weighted quantitative and qualitative criteria. The second method was based on equally-weighted quantitative criteria only and the third method was based on equally-weighted qualitative criteria only. Projects were ranked 1 through 14 with 1 being the project most likely to be implemented based on the ranking criteria.

Quantitative Criteria:
CSO Benefit
Unit Cost

Qualitative Criteria:
Parks Improvements
Moments of Opportunity
Drainage/Flood Benefit
Educational Benefit
Technology Demonstration

	Quantitative and Qualitative Rank	**Quantitative Only Rank**	**Qualitative Only Rank**
Leavenworth Park - south	3	2	8

Modification Notes:

As noted previously, the configuration of this subsurface storage practice may be impacted by the changes at the Pacific site. As with other subsurface storage, the specific product type used is open to evaluation.

Turner Boulevard

Pacific Avenue

Tributary to: Regulator 108
Practice Type: Subsurface
Proposed Storage Volume: 0.33 MG
Proposed Pipe Length: 2,579 ft
Tributary Drainage Area: 27 acres
Fraction of Regulator Area: 1%

NOTE: The information provided in this fact sheet reflects the concept of surface storage within the park. Recent feedback indicates that this is not acceptable due to the extensive recreational use of the park.

In lieu of placing surface storage within the park, the following could be evaluated:

-Ability to implement proposed storm sewers on Pacific and connect them to the existing storm system without overloading the system capacity.
-The existing separated stormwater, and potentially additional areas from Pacific could be conveyed to Leavenworth Park. This would require an expanded subsurface storage chamber within Leavenworth Park. The footprint would likely extend into the baseball diamond and would need to be further reviewed with the Parks, Recreation, and Public Property Department.

-Subsurface storage could be investigated within this portion of the park.

Project Description:

The Turner Blvd project includes a number of green infrastructure components. The objective of this location is to capture and store separated stormwater from previously separated areas and additional stormwater separation areas as site constraints permit.

Basis for Selection:

There is a significant tributary area to this park at Pacific Avenue that was previously separated which provides for a more cost-effective design with minimal new piping needed to convey the runoff from the tributary area to the practice.

Additional Evaluation Required:

- Complete geotechnical investigations to confirm soil stability and groundwater characteristics for the placement of the surface storage.
- An assessment of new pipe infrastructure alignments.
- Determine if existing storm pipes should be used as relief points through control structures within the pipes to allow overflow volume to enter into the storm sewer system directly.
- The as-built location and depth of the existing sewer pipes and utilities needs to be investigated.
- Evaluation of tree canopy and landmark and mature trees in areas where surface storage and construction access are planned to determine what adjustments must be made to preserve these assets.

Cost Opinion:

Capital Cost: $1,490,000
20-Year Life Cycle Cost: $1,566,000

Performance Results: (Appendix J, Table J-1)

CSO Volume Change for the Representative Year: -4.0

Cost per Volume Managed: $0.39/gal

Prioritization Ranking Results: (Appendix J, Table J-2)

Projects were ranked using three different methods. The first method resulted in a rank based on independently weighted quantitative and qualitative criteria. The second method was based on equally-weighted quantitative criteria only and the third method was based on equally-weighted qualitative criteria only. Projects were ranked 1 through 14 with 1 being the project most likely to be implemented based on the ranking criteria.

Quantitative Criteria:
CSO Benefit
Unit Cost

Qualitative Criteria:
Parks Improvements
Moments of Opportunity
Drainage/Flood Benefit
Educational Benefit
Technology Demonstration

	Quantitative and Qualitative Rank	**Quantitative Only Rank**	**Qualitative Only Rank**
Pacific Avenue	11	7	9

Modification Notes:

Major modifications will be required relative to this design. See sidebar notes on first page of the fact sheet.

Appendix J – Summary Tables for Project Development

CITY OF OMAHA PUBLIC WORKS
COMBINED SEWER OVERFLOW (CSO) CONTROL PROGRAM

DRAFT
CONCEPTUAL GREEN INFRASTRUCTURE PROJECT DEVELOPMENT TECHNICAL MEMORANDUM

GREEN INFRASTRUCTURE CONCEPTUAL PROJECT DEVELOPMENT
OPW-52456

Prepared by:

TETRA TECH Geosyntec vireo

April 2014

Table of Contents

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1.0 Executive Summary

Executive summary needs to address the following:

1) *Purpose and scope of study – context is to identify projects that the City can commit to in their LTCP update*
   a) *Constraints on the program – readily implementable as identified above; defined funding and pilot nature of the program. Objective of first projects implemented is to learn and better understand the benefits for future CSO control.*
   b) *Constraints on the program (continued) – provide background on why the project primarily resulted in "ponds and parks" versus other practice types.*
2) *Project Scope - opportunity identification, selection of initial projects, project development*
3) *Project Narrowing – discuss general approach to narrowing list of candidate projects; prioritization criteria and metrics, cost data, participation by parks*
4) *Results – provide prioritized list of projects based on criteria and cost. Include consultant team recommendations for projects to be implemented. Indicate that the city/PMT will identify those projects to be carried forward into the LTCP update.*
5) *Implementation Plan – identify next steps in implementation. Include a schedule for work generally culminating in completion of implementation and post construction monitoring it in a timely manner for the subsequent CSO plan update. Discuss the objectives and elements associated with a pilot program.*

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2.0 Introduction

2.1 Study and Project Area

CSO basins included in the study area (list).

2.2 General Project Approach

Project objectives and constraints.

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3.0 Background/ Methodology

3.1 Information Sources

Start with what was included in the Opportunity Identification TM. Update with additional information received during further project effort. ~3 pages

3.1.1 Overview and Approach

3.1.2 Previous Reports and Studies

3.1.3 GIS Data

3.1.4 Site Suitability Evaluation

3.1.5 Costing

3.1.6 Input from City Departments and Stakeholders

City of Omaha Parks Department

City of Omaha Planning Department

Creighton University

3.1.7 Other Data

Quarter Section Maps

Record Drawings

Site Plans

Geotechnical Reports

3.2 Hydrologic and Hydraulic Modeling

Reference Model Approach TM (draft), include this document into the outline.

3.2.1 Overview

Objectives of Modeling

3.2.2 Existing CSO Model Framework

Model Platform

CSO Model Description

Project Team Assumption

Quality Assurance for Model Consistency

3.2.3 Green Infrastructure Sizing Criterion

Control Objectives

Sizing Criterion Approach

City of Omaha Storm Design Standards

3.2.4 Green Infrastructure Modeling Approach

Drainage Areas and Imperviousness

Other Modeling Considerations

Evaluation Modeling

3.3 Opportunity Identification and Narrowing

Discuss general processes used in opportunity identification.

Describe the workshop structure that was employed to narrow the list of opportunities to continually smaller lists. Indicate the collaborative nature of the process.

Leave details of the analysis for Section 4.

3.4 Capital and O&M Costing

This section describes the use of the Omaha costing tool for gray costs and the customized unit costs for the green costs. For the gray, identify assumptions made based on Roger's comments. The green costs should describe data sources and how these were adjusted to Omaha costs if not directly from Omaha project costs (RS Means location factors and ENR for the year). It should also be noted what contingency was used (i.e. the entire project multiplier from the costing tool). Discuss what all is included in the project contingencies in the Omaha costing tool.

3.4.1 Gray Infrastructure Costing

3.4.2 Green Infrastructure Costing

Identify specific sources of information and reference projects

3.5 Project Prioritization

Describe approach for prioritizing projects. What criteria were used and why. These need to provide a definition for the various categories. Some of the metrics are rather subjective and this needs to be clarified. Identify that rankings are based on input received during project meetings and that they are intended to reflect comments by parks and the City.

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Clarify that specifics about CSO control methodology were not available to the project team in order to assess the impacts on potential CSO costs. Indicate that the City/PMT will make this assessment as part of the LTCP update.

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4.0 Project Opportunities

This section includes text from the Opportunity Identification TM. ~14 pages. Also included is new text describing the selection process for the top 5 sites.

Re: tables and figures – it is expected that the tables and figures will display the final concept for various locations. These will not include the multiple revisions along the way, as this is likely to cause confusion within the document.

4.1 Opportunity Identification (Total Opportunity Set)

Multiple lists were made from various sources. Reference what methodologies were used to develop the lists. (Tables B-1 thru B-5 from Appendix B)

4.1.1 Methodology

Previous Green Solutions Opportunity Identification

Program Management Team Identified Opportunities

Concentrated Stormwater Opportunities

Impervious Management Opportunities

Project Partnership Opportunities

Special Opportunities

4.1.2 Result

4.2 Opportunity Consolidation (38 Unique Opportunities)

The lists of opportunities were consolidated to 38 unique opportunities. Many of the potential opportunities from the various selection methodologies were duplicative. Table B-6 will include the resultant outcome for each of these opportunities. These categories may include: 'included in recommended plan', 'City to pursue as an institutional partner opportunity', 'consider for further evaluation'.

4.2.1 Methodology

4.2.2 Result

4.3 Top 10 Opportunities

Thirty of the 38 unique opportunities were ranked at the September workshop, A, B, C, and D, which led to the selection of 10 opportunities for further *evaluation, Tables B-7, B-8, and B-9 from Appendix B. Eight of the 38 unique opportunities were tabled for future evaluation including expressway flow management and green street opportunities.*

4.3.1 Methodology

4.3.2 Result

4.4 Top 5 Opportunities

Eight of the ten opportunities were evaluated for feasibility, performance, and cost. Two of the 10 were removed from the study because they were partnership opportunities and may be pursued later. Appendix C includes the drawings and tables developed for the three opportunities that did not move on to the top 5 list (Gifford Park, Norris Middle School, Bemis Park).

At the December workshop, the 5 final sites were selected to be developed to a conceptual stage. More details regarding the selected 5 are in the next section.

4.4.1 Methodology

4.4.2 Result

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5.0 Green Infrastructure Project Development

This section should begin with a brief introduction of the objectives for this stage of project development. Reference will be made back to the methodology portion of the report. An introduction will also be provided for the structure of the information.

A description of alternatives evaluated for each site will be included in the main body of the report below.

An appendix for each of the 5 sites will include a conceptual design packet as follows:

-Project 1-page "factsheet"
-Green Infrastructure Drainage area map (GIS)
-Plan view scaled drawing (Civil 3D) with practice placement and utilities. Turner and FCT will continue to have "zoomed in" maps.
-Profiles of storm sewer and practices for complicated areas. (Civil 3D)
-Practice conceptual cross-sections
-Costing (green, gray, total, and present value)
-CSO Performance Evaluation (based on model evaluation)

The site appendices are organized into sub-appendices rather than individual figures and tables. The thought is this is how someone would actually study the material.

A number of the project fact sheets have some thoughts captured in this outline. Other locations would be similarly completed.

5.1 Field Club Trail

5.1.1 Frances Street

Document the thought process associated with the definition of the project in the final version. Such items would include: extent of drainage areas, type of practice, placement, etc. Provide a bulleted list of what was thought about.

Also, indicate variations of the projects that could be considered in implementation. In a number of cases the projects were scaled back or sewer was omitted in order to reduce the cost. Potential sewer extensions should be identified in the text. Similarly, the extent of tributary area that the practices are based on should be noted. (This is accomplished in the figures.)

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5.1.2 Gold Street

A variety of configurations for subsurface storage were evaluated. These included maximizing use of the right of way as well as narrow linear configurations. The surface grades for areas east of Field Club Trail are lower than the trail itself and may be more challenging to serve.

5.1.3 Frederick Street

Include discussion of alternatives evaluated over the course of project development.

5.1.4 Vinton Street

Include discussion of alternatives evaluated over the course of project development.

5.2 Hanscom Park

Include discussion of alternatives evaluated over the course of project development.

5.3 Kountze Park

Maintaining shallower practice depth by intercepting individual storm sewers – discounted due to the sewer cost.
Placement of subsurface storage on West side of Florence. Difficult due to location of existing sanitary and storm sewers.

5.4 Schroeder-Vogel Park

Larger tributary area including separated sewers to 50th and Poppelton - discounted due to lack of area in Schroeder Vogel Park and challenges with routing of flow. Also would make practices deeper.

5.5 Turner Boulevard

5.5.1 North Turner Park

Both surface and subsurface storage were considered here. Surface space is used for recreational purposes. Subsurface storage would be complicated by presence of large sewers in this vicinity.

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5.5.2 Dewey Park

The site considered both surface and subsurface facilities. Preliminary layout is based on information received from parks department in terms of restricted surface use.

5.5.3 Leavenworth Park – north

Surface storage – which was ruled out for the reasons noted above.

5.5.4 Leavenworth Park – south

Using a mix of surface and subsurface storage was considered in the park. Parks Department was concerned about using surface storage as the park is heavily used.

5.5.5 Pacific Avenue

The extent of drainage area to be served in this location considered extension of storm sewer on Pacific to the East. The storm sewer extension was included in the final concept. A variety of configurations of the green infrastructure practices were looked at in this space. The parks department is concerned about the extent of green infrastructure practice interfering with some casual park uses.

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6.0 Summary

6.1 Proposed Practice Combined Sewer Overflow Performance

Describe performance results and refer to the tables in Appendix J.

6.2 Prioritization

Describe results of the prioritization ranking. Refer to Appendix J for tables.

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7.0 Recommendations

This section includes Tetra Tech's recommendation for moving projects and the Omaha green infrastructure program ahead.

7.1 Recommended Projects

Identification of selecting green infrastructure practices that the project team recommends for implementation.

7.2 Recommended Implementation Plan

Additional actions:
Develop clear implementation plan (a suggested schedule is provided)
Develop and implement a flow monitoring program that will support the information gathering objectives of the program

7.3 Green Infrastructure Program and Policies

Items the City needs to keep under consideration going forward with their green infrastructure program based on what other cities of the same scale as Omaha are doing pertaining to green infrastructure in a CSO area.

The list may include:

- *Develop and maintain working relationships with institutional partners in order to stimulate investment*
- *Maintain a list of potential green infrastructure opportunities and pursue implementation*
- *Consider a financial incentive program to stimulate investment and retrofits on private property*
- *Review standards for redevelopment and define strategies for encouraging green infrastructure use while not discouraging reinvestment in the city*
- *Develop standards for greening of streets, including "road diets", green streets details, and project flow processes.*

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Appendix A – Figures for Identification of Project Opportunities

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Appendix B – Tables for Identification of Project Opportunities

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Appendix C – Opportunities Not Advanced to Top 5 List

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Appendix D – Top 5 Green Infrastructure Practice Location Map

Appendix E – Field Club Trail

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Field Club Trail

Frances Street

Tributary to: Regulator 118
Practice Type: Subsurface
Proposed Storage Volume: 0.56 MG
Proposed Pipe Length: 104 ft
Tributary Drainage Area: 31 ac
Fraction of Regulator Area: 5%
Appendix Reference:

Project Description:
The objective for this location is to pick up separated stormwater from Frances Street.

Basis for Selection:
Area was previously separated.

Additional Evaluation Required:
Need to know tree limits, flow monitoring, trail detour and alignment, geotechnical investigation

Schedule Constraints:

Cost Opinion:

Capital Cost: $1,729,000
20-Year Life Cycle Cost: $1,736,000

Performance Results:
Comments on what changes to the projects will affect the modeling results based on observations thus far. Additional modeling is not expected.

Field Club Trail

Gold Street

Tributary to:
Practice Type:
Proposed Storage Volume:
Proposed Pipe Length:
Tributary Drainage Area:
Fraction of Regulator Area:
Appendix Reference:

Project Description:

This project would pick up stormwater from storm sewers installed in prior separation projects.

Basis for Selection:

There are approximately XX acres of stormwater available for management at this location.

Additional Evaluation Required:

Need to know tree limits, flow monitoring, trail detour and alignment, geotechnical investigation. Consider picking up Westerly tributary area only versus both East and West. Assess impacts on depth of subsurface storage and extent. (This might be done as part of current study.)

Schedule Constraints:

Cost Opinion:

Capital Cost:
20-Year Life Cycle Cost:

Performance Results:

Comments on what changes to the projects will affect the modeling results based on observations thus far. Additional modeling is not expected.

Field Club Trail

Frederick Street

Tributary to Regulator ##:
Waterway:
Tributary Drainage Area:
Existing Overflows:
Existing Overflow Volume:
Figure Reference:

Project Description:

This project would pick up stormwater from storm sewers installed in prior separation projects.

Basis for Selection:

See prior discussion (typical)

Additional Evaluation Required:

Need to know tree limits, flow monitoring, trail detour and alignment, geotechnical investigation

Schedule Constraints:

Cost Opinion:

Capital Cost:
20-Year Life Cycle Cost:

Performance Results:

Comments on what changes to the projects will affect the modeling results based on observations thus far. Additional modeling is not expected.

Field Club Trail
Vinton Street

Tributary to:
Practice Type:
Proposed Storage Volume:
Proposed Pipe Length:
Tributary Drainage Area:
Fraction of Regulator Area:
Appendix Reference:

Project Description:

This project would pick up stormwater from storm sewers installed in prior separation projects.

Basis for Selection:

Discuss opportunities with trail extension and problems with local drainage.

Additional Evaluation Required:

Need to know tree limits, flow monitoring, trail detour and alignment, geotechnical investigation

Schedule Constraints:

The Vinton Street portion of the Field Club Trail is planned for construction in the next year.

Cost Opinion:

Capital Cost:
20-Year Life Cycle Cost:

Performance Results:

Comments on what changes to the projects will affect the modeling results based on observations thus far. Additional modeling is not expected.

Appendix F – Hanscom Park

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Hanscom Park

Hanscom Park - north

Tributary to:
Practice Type:
Proposed Storage Volume:
Proposed Pipe Length:
Tributary Drainage Area:
Fraction of Regulator Area:
Appendix Reference:

Project Description:

This project would pick up stormwater from storm sewers installed in prior separation projects.

Basis for Selection:

See prior discussion (typical)

Additional Evaluation Required:

Sewer configuration on Center Street. Coordination with Hanscom Park Master plan.

Schedule Constraints:

Hanscom Park is developing a master plan.

Cost Opinion:

Capital Cost:
20-Year Life Cycle Cost:

Performance Results:

Comments on what changes to the projects will affect the modeling results based on observations thus far. Additional modeling is not expected.

Hanscom Park

Hanscom Park - west

Tributary to:
Practice Type:
Proposed Storage Volume:
Proposed Pipe Length:
Tributary Drainage Area:
Fraction of Regulator Area:
Appendix Reference:

Project Description:
This project would pick up stormwater from storm sewers installed in prior separation projects.

Basis for Selection:
See prior discussion (typical)

Additional Evaluation Required:
Site-specific issues.

Schedule Constraints:
Hanscom Park is developing a master plan.

Cost Opinion:

Capital Cost:
20-Year Life Cycle Cost:

Performance Results:
Comments on what changes to the projects will affect the modeling results based on observations thus far. Additional modeling is not expected.

Hanscom Park

Hanscom Park - east

Tributary to:
Practice Type:
Proposed Storage Volume:
Proposed Pipe Length:
Tributary Drainage Area:
Fraction of Regulator Area:
Appendix Reference:

Project Description:
This project would pick up stormwater from the park and from Park Avenue.

Basis for Selection:
See prior discussion (typical)

Additional Evaluation Required:
Site-specific issues.

Schedule Constraints:
Hanscom Park is developing a master plan.

Cost Opinion:

Capital Cost:
20-Year Life Cycle Cost:

Performance Results:
Comments on what changes to the projects will affect the modeling results based on observations thus far. Additional modeling is not expected.

Appendix G – Kountze Park

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Kountze Park

Tributary to:
Practice Type:
Proposed Storage Volume:
Proposed Pipe Length:
Tributary Drainage Area:
Fraction of Regulator Area:
Appendix Reference:

Project Description:

This project would pick up stormwater from storm sewers installed in prior separation projects.

Basis for Selection:

See prior discussion (typical)

Additional Evaluation Required:

Geotechnical investigation, tree survey, sewer location and as constructed depth

Schedule Constraints:

None identified

Cost Opinion:

Capital Cost:
20-Year Life Cycle Cost:

Performance Results:

Comments on what changes to the projects will affect the modeling results based on observations thus far. Additional modeling is not expected.

Appendix H – Schroeder-Vogel Park

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Schroeder-Vogel Park

Tributary to:
Practice Type:
Proposed Storage Volume:
Proposed Pipe Length:
Tributary Drainage Area:
Fraction of Regulator Area:
Appendix Reference:

Project Description:

This project would include installation of new storm sewer to divert flow to the park for storage.

Basis for Selection:

See prior discussion (typical)

Additional Evaluation Required:

Geotechnical investigation to determine nature of groundwater in this location, refinement of tributary area based on field survey and analysis. Specific placement of practices in the park - relative to park facilities.

Schedule Constraints:

The parks department is implementing some improvements in Schroeder Vogel Park. These are expected to commence prior to this project. Care will be needed in order to coordinate effort so that new park facilities are not disturbed by future stormwater work.

Cost Opinion:

Capital Cost:
20-Year Life Cycle Cost:

Performance Results:

Comments on what changes to the projects will affect the modeling results based on observations thus far. Additional modeling is not expected.

Appendix I – Turner Boulevard

Turner Boulevard

North Turner Park

Tributary to:
Practice Type:
Proposed Storage Volume:
Proposed Pipe Length:
Tributary Drainage Area:
Fraction of Regulator Area:
Appendix Reference:

Project Description:
This project would include installation of new storm sewer to divert flow to the park for storage.

Basis for Selection:
See prior discussion (typical)

Additional Evaluation Required:
Geotechnical investigation, tree survey, sewer location and as constructed depth, utility locations

Schedule Constraints:
Some potential of reconfiguration of the roadways in this area may impact the site. This potential needs to be better defined. If likely, work should be coordinated.

Cost Opinion:

Capital Cost:
20-Year Life Cycle Cost:

Performance Results:
Comments on what changes to the projects will affect the modeling results based on observations thus far. Additional modeling is not expected.

Turner Boulevard

Dewey Park

Tributary to:
Practice Type:
Proposed Storage Volume:
Proposed Pipe Length:
Tributary Drainage Area:
Fraction of Regulator Area:
Appendix Reference:

Project Description:

This practice would pick up stormwater from storm sewers installed in prior separation projects. It will also include installation of new storm sewer to pick up additional flow.

Basis for Selection:

See prior discussion (typical)

Additional Evaluation Required:

Multiple sewers cross the site and green infrastructure practices will need to be placed to consider the location of those sewers and other utilities. Drainage is a concern in the local area and the project should be designed to facilitate that drainage. Gutter flow in streets to the west of Dewey Park will need to be considered. Some green infrastructure practices on the streets west of the Park could be evaluated. Geotechnical evaluation is needed.

Schedule Constraints:

None identified

Cost Opinion:

Capital Cost:
20-Year Life Cycle Cost:

Performance Results:

Comments on what changes to the projects will affect the modeling results based on observations thus far. Additional modeling is not expected.

Turner Boulevard

Leavenworth Park - north

Tributary to:
Practice Type:
Proposed Storage Volume:
Proposed Pipe Length:
Tributary Drainage Area:
Fraction of Regulator Area:
Appendix Reference:

Project Description:
The practice is intended to pick up local drainage generated at the intersection of Jones and Turner, as well as areas to the west.

Basis for Selection:
The practice is a subsurface storage due to grades of the existing catch basin leads and because of the parks concerns about surface facilities.

Additional Evaluation Required:
Means of drainage/ service to the area to the west need to be better defined through field evaluation. Geotechnical investigation, tree survey, sewer location and as constructed depth

Schedule Constraints:
None identified

Cost Opinion:

Capital Cost:
20-Year Life Cycle Cost:

Performance Results:
Comments on what changes to the projects will affect the modeling results based on observations thus far. Additional modeling is not expected.

Turner Boulevard

Leavenworth Park - south

Tributary to:
Practice Type:
Proposed Storage Volume:
Proposed Pipe Length:
Tributary Drainage Area:
Fraction of Regulator Area:
Appendix Reference:

Project Description:

Pick up concentrated stormwater from the south (60" storm sewer through the park), west (separate storm sewer on Leavenworth), and east (local intersection drainage).

Basis for Selection:

There is significant tributary area to Leavenworth Park. Much of this is separated storm water. The plan is shown assumes that most of the tributary area to the separated storm line will be managed in the South Turner/Pacific Avenue area. This was done so that the depth of the subsurface storage would be shallower.

Additional Evaluation Required:

Geotechnical investigation, tree survey, sewer location and as constructed depth. Methodology for directing flows to the subsurface facility. Function of existing small diameter sewer in Leavenworth Park – this may be abandoned potentially. Issues of snow storage in the park during the winter.

Schedule Constraints:

None identified

Cost Opinion:

Capital Cost:
20-Year Life Cycle Cost:

Performance Results:

Comments on what changes to the projects will affect the modeling results based on observations thus far. Additional modeling is not expected.

Turner Boulevard

Pacific Avenue

Tributary to:
Practice Type:
Proposed Storage Volume:
Proposed Pipe Length:
Tributary Drainage Area:
Fraction of Regulator Area:
Appendix Reference:

Project Description:

Provide surface level practice for separated stormwater at the southern end of the Turner Boulevard corridor. Intercepting a portion of the flow at this location allows for a smaller subsurface facility in Leavenworth Park. The surface features have the potential to be aesthetic amenities in the corridor.

Basis for Selection:

This location intercepts separated stormwater flow from the south and from the Pacific Avenue alignment to the West. Practices are shown as surface features as existing stormwater can be day-lighted and the green infrastructure can provide an attractive park feature.

Additional Evaluation Required:

The presence of large water mains in this area is understood. Practice locations are shown based on estimated water main extents. Detailed utility investigations will be required in order to fully evaluate this design. In addition, geotechnical investigation, tree survey, sewer location and as constructed depth will be required.

Schedule Constraints:

None identified

Cost Opinion:

Capital Cost:
20-Year Life Cycle Cost:

Performance Results:

Comments on what changes to the projects will affect the modeling results based on observations thus far. Additional modeling is not expected.

Appendix J – Summary Tables for Project Development

Appendix D
Summary of Estimated Construction Costs Tunnel Evaluated Alternatives

Tunnel Aternative Summary Table (Updated July 22, 2014)

Tunnel System Alternative	1 - LTCP - Same Tunnel Size and Length				2 - Tunnel Extended to CSO 119		3 - Modify Tunnel and RTB Size			4 - Storage Tunnel	
	1a	1b	1c	1d	2a	2b	3a	3b	3c	4a	4b
Parameter	LTCP Size (2024 Model)	LTCP Size (2027 Model)	LTCP Tunnel Size - RTB Increased to Achieve 4 Watershed CSOs (2027 Model)	LTCP Size - No Flow from 118 & 119 (2027 Model)	Flows from All CSOs Captured by Tunnel	All Flows Except CSO 118 and 119 Captured by Tunnel	Smaller Tunnel Option 1	Smaller Tunnel and Smaller RTB	Smaller Tunnel Option 2	Dewater in 48 hours - Meets Individual CSO 85% Capture Conditions	Dewater in 72 Hours - Meets Individual CSO 85% Capture Conditions
Tunnel Diameter (ft)	17	17	17	17	16	14.5	12	15	14	18	16.5
Tunnel Length (ft)	28,600	28,600	28,600	28,600	32,700	32,700	28,600	28,600	28,600	28,600	28,600
No. of Drop Shafts[1]	5	5	5	5	6	4	4	4	4	4	4
RTB Size (MGD)	52	52	68	52	63	60	50	22	50	NA	NA
Lift Station (MGD)	52	52	68	52	63	60	50	22	50	27	15
CSO 118 Control	Tunnel System	Tunnel System	Tunnel System	Storage or RTB[3]	Tunnel System	Storage or RTB[3]	Storage or RTB[3]	4.1 MG Storage	Storage or RTB[3]	Storage or RTB[3]	Storage or RTB[3]
CSO 119 Control	Tunnel System	Tunnel System	Tunnel System	Storage or RTB[4]	Tunnel System	Storage or RTB[4]	Storage or RTB[4]	2.9 MG Storage	Storage or RTB[4]	Storage or RTB[4]	Storage or RTB[4]
Watershed - No. of Overflows	4	7	4	4	4	4	8	8	7	8	10
System Percent Capture (Not Including CSO 105)[2]	92.8%	92.0%	92.4%	91.9%	92.4%	91.0%	87.7%	89.2%	89.4%	88.9%	88.8%
Deep Tunnel	$139,624,000		$139,624,000	$139,624,000	$152,847,000	$142,431,000	$108,768,000	$127,640,000	$121,479,000	$145,465,000	$136,667,000
Deep Tunnel Drop Shafts	$42,526,000		$42,526,000	$42,526,000	$47,208,000	$37,844,000	$37,844,000	$37,844,000	$37,844,000	$37,844,000	$37,844,000
Conveyance to Tunnel Drop Shafts	$18,629,000		$18,629,000	$18,629,000	$8,485,000	$6,096,000	$6,096,000	$6,096,000	$6,096,000	$6,096,000	$6,096,000
MRWWTP RTB + Conveyance to CSO Outfall	$8,138,000		$9,931,000	$8,138,000	$9,502,000	$9,244,000	$8,338,000	$5,515,000	$8,338,000	$0	$0
Deep Tunnel Lift Station	$21,828,000		$23,321,000	$21,828,000	$22,868,000	$22,591,000	$21,632,000	$18,392,000	$21,362,000	$19,202,000	$17,791,000
CSO 118 Alternative Cost	$0		$0	$19,285,000	$0	$19,285,000	$16,714,000	$16,714,000	$16,714,000	$16,714,000	$16,714,000
CSO 119 Alternative Cost	$0		$0	$17,841,000	$0	$17,841,000	$14,064,000	$14,064,000	$14,064,000	$14,064,000	$14,064,000
Total Cost (ENR 7888)	$230,745,000		$234,031,000	$267,871,000	$240,910,000	$255,332,000	$213,456,000	$226,265,000	$225,897,000	$239,385,000	$229,176,000
Total Cost (ENR 8528)	$249,467,000		$253,019,000	$289,605,000	$260,456,000	$276,049,000	$230,775,000	$244,623,000	$244,225,000	$258,808,000	$247,770,000
Cost Difference Compared to LTCP	$0		$3,552,000	$40,138,000	$0	$15,593,000	-$29,681,000	-$15,833,000	-$16,231,000	-$1,648,000	-$12,686,000
% Difference Compared to LTCP	**0.0%**		**1.4%**	**16.1%**	**0.0%**	**6.0%**	**-11.4%**	**-6.1%**	**-6.2%**	**-0.6%**	**-4.9%**
Grit Basin Adder (ENR 8528)	$25,000,000		$25,000,000	$25,000,000	$25,000,000	$25,000,000	$25,000,000	$25,000,000	$25,000,000	$25,000,000	$25,000,000
Subtotal	$274,467,000		$278,019,000	$314,605,000	$285,456,000	$301,049,000	$255,775,000	$269,623,000	$269,225,000	$283,808,000	$272,770,000
25% Contingency	$68,617,000		$69,505,000	$78,651,000	$71,364,000	$75,262,000	$63,944,000	$67,406,000	$67,306,000	$70,952,000	$68,193,000
Budgetary Total	**$343,084,000**		**$347,524,000**	**$393,256,000**	**$356,820,000**	**$376,311,000**	**$319,719,000**	**$337,029,000**	**$336,531,000**	**$354,760,000**	**$340,963,000**

	1a		1b		1c		1d			2a		2b		3a			3b			3c			4a			4b		
CSO	CSO Volume (MG)	% Capture	CSO Volume (MG)	% Capture	CSO Volume (MG)	% Capture	CSO Volume (MG)	% Capture	No. of CSOs	CSO Volume (MG)	% Capture	CSO Volume (MG)	% Capture	CSO Volume (MG)	% Capture	No. of CSOs	CSO Volume (MG)	% Capture	No. of CSOs	CSO Volume (MG)	% Capture	No. of CSOs	CSO Volume (MG)	% Capture	No. of CSOs	CSO Volume (MG)	% Capture	No. of CSOs
106	31.1	95.7%	30.3	95.9%	26.8	96.3%	24.9	96.6%	4	26.8	96.3%	26.8	96.3%	42.0	94.2%	8	40.4	94.5%	8	35.0	95.2%	7	50.7	93.1%	8	51.6	92.9%	10
107	14.6	95.7%	44.0	87.1%	41.4	87.8%	36.0	89.4%	4	41.4	87.8%	41.4	87.8%	60.8	82.1%	8	51.2	84.9%	8	50.7	85.1%	7	50.8	85.1%	8	50.9	85.0%	9
108	69.7	91.4%	79.1	90.2%	75.1	90.7%	65.1	92.0%	4	75.1	90.7%	75.1	90.7%	113.0	86.0%	8	92.8	88.5%	8	91.9	88.7%	7	94.6	88.3%	8	95.6	88.2%	10
109	97.6	88.6%	92.5	89.2%	88.1	89.7%	74.4	91.3%	4	88.1	89.7%	88.1	89.7%	131.6	84.6%	8	106.0	87.6%	8	106.3	87.5%	7	108.7	87.3%	8	107.9	87.3%	9
110	0.01	100.0%	0	100.0%	0	100.0%	0	100.0%	0	0	100.0%	0	100.0%	0	100.0%	0	0	100.0%	0	0	100.0%	0	0	100.0%	0	0	100.0%	0
111	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	0	100.0%	0	100.0%	0	100.0%	0	0	100.0%	0	0	100.0%	0	0	100.0%	0	0	100.0%	0
112	0.02	99.9%	0	100.0%	0	100.0%	0	100.0%	0	0	100.0%	0	100.0%	0	100.0%	0	0	100.0%	0	0	100.0%	0	0	100.0%	0	0	100.0%	0
114	0.9	94.3%	1.1	93.0%	1.0	93.7%	0.9	94.3%	4	1.0	93.7%	1.0	93.7%	1.4	91.1%	8	1.2	92.4%	8	1.2	92.4%	7	1.0	93.7%	7	1.1	93.0%	7
115	7.5	92.8%	7.8	92.6%	7.5	92.8%	6.2	94.1%	4	7.5	92.8%	7.5	92.8%	11.2	89.3%	8	8.8	91.6%	8	8.9	91.5%	7	8.9	91.5%	8	8.9	91.5%	9
117	2.0	97.2%	0	100.0%	0	100.0%	0	100.0%	0	0	100.0%	0	100.0%	0	100.0%	0	0	100.0%	0	0	100.0%	0	0	100.0%	0	0	100.0%	0
118	27.5	91.9%	29.5	91.3%	28.1	91.7%	28.1	91.7%	4	28.1	91.7%	28.1	91.7%	40.8	88.0%	8	40.8	88.0%	8	40.8	88.0%	8	40.8	88.0%	8	40.8	88.0%	8
119	30.5	94.9%	29.6	95.0%	28.5	95.2%	84.5	85.8%	23	28.5	95.2%	84.5	85.8%	84.5	85.8%	23	84.5	85.8%	23	84.5	85.8%	23	84.5	85.8%	23	84.5	85.8%	?
121	5.1	91.5%	5.0	91.6%	4.9	91.8%	4.3	92.8%	3	4.9	91.8%	4.9	91.8%	5.6	90.6%	3	5.1	91.5%	3	5.2	91.3%	3	4.3	92.8%	3	4.9	91.8%	3
Total	**286.5**	**92.8%**	**318.9**	**92.0%**	**301.4**	**92.4%**	**324.4**	**91.9%**	**4**	**301.4**	**92.4%**	**357.4**	**91.0%**	**490.9**	**87.7%**	**8**	**430.8**	**89.2%**	**8**	**424.5**	**89.4%**	**7**	**444.3**	**88.9%**	**8**	**446.2**	**88.8%**	**10**

1 'No. of Drop Shafts' does not include the 21' Screening and 30' Pump Station drop shafts. Locations for other drop shafts are 106/107, 108, 109/121, 114/115, and 117/118/119. For alternatives where 118 and 119 flow is not being collected by the tunnel, this drop shaft has been eliminated. For the 'New Baseline Alternative', the number of drop shafts was increased to account for a drop shaft at CSO 119.

2 CSO 105 volume included in LTCP Size (2024 Model) alternative. CSO 105 volume not included in all other alternatives. When CSO 105 is taken into consideration, watershed percent capture is approximately 2 percent less than tunnel system percent capture shown in table.

3 CSO 118 storage alternative with 4 CSOs (5.6 MG) used for alternatives with 4 Watershed CSOs. CSO 118 storage alternative with 8 CSOs (4.1 MG) used for alternatives with 8 and 10 Watershed CSOs.

4 CSO 119 storage alternative with 4 CSOs (5.1 MG) used for alternatives with 4 Watershed CSOs. CSO 119 storage alternative with 8 CSOs (2.9 MG) used for alternatives with 8 and 10 Watershed CSOs.

Original Baseline Alternative

New Baseline Alternative

Selected Alternative

Appendix E
Rate Model Study

REDOAK CONSULTING
an ARCADIS group

ARCADIS U.S., Inc.
222 South Main Street
Suite 300
Akron
Ohio 44308
Tel 330 434 1995
Fax 330 374 1095
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Red Oak Consulting
www.redoakconsulting.com

Marty Grate
Environmental Services Manager
City of Omaha
1819 Farnam Street, Suite 601
Omaha, NE 68183

Subject:
Addendum to Sewer Revenue Fund 2011 Cost-of-Service Rate Study Final Report – May 2013 Study Update

Date:
May 28, 2013

Contact:
Carol Malesky

Phone:
330-515-5696

Email:
Carol.malesky@arcadis-us.com

Our ref:
05836005.0000

Dear Marty:

Red Oak Consulting has been working with you and your staff since October 2012 to update the 2011 Cost-of-Service Rate Study (2011 Study) for proposing rates for the 2015 – 2018 rate period. The process, principles, and approach followed in the 2011 Study were also followed in this May 2013 Study Update. This addendum serves as documentation of the analysis, review, and results of the May 2013 Study Update.

The addendum includes:

1. Assumptions followed and data used in updating the Wastewater Financial Plan
2. Assumptions and data used in updating the individual cost-of-service (COS) Models for 2015 through 2018
3. Revised combined sewer overflow (CSO) related charges for non-residential customers
4. Proposed rates for 2015 – 2018

Red Oak would like to thank the significant contributions you and your staff made to ensure the success of this study. It was a pleasure working with the City. Please contact me with questions.

Sincerely,

ARCADIS U.S., Inc.

Carol F. Malesky

Carol Malesky
Principal Consultant

Addendum to the Sewer Revenue Fund 2011 Cost-of-Service Rate Study Final Report – May 2013 Study Update for 2015 – 2018 Rate Period

Introduction

In September 2012, the City of Omaha (City) authorized Red Oak Consulting (Red Oak) to conduct a cost-of-service study (Study) and analysis of the City's wastewater rates. The City and Red Oak updated the long-term financial plan and cost-of-service rates. The intent was to update capital improvement program costs, operation and maintenance costs, and customer account and usage data to maintain the relevance and sustainability of the City's wastewater rates. This addendum outlines the results of the May 2013 Study and describes assumptions used in obtaining the results.

Updated Assumptions

The 2011 Study projected the City's annual revenue requirements and customer flows and loadings for 2011 through 2014. Since that period, the City has negotiated a longer term for its Long Term Control Plan (LTCP) to comply with its combined sewer overflow (CSO) Consent Decree. More refined cost estimates for the LTCP as well as the City's capital asset replacement program (CARP) and other capital expenditures were also developed. Actual operating results through 2012 and updated 2013 budget values necessitated updating the City's long-term financial plan and cost-of-service (COS) models. The following assumptions were updated for this May 2013 Study.

Sources for the updated information include the City's Public Works Department and Finance Department.

Capital Improvement Program (CIP)

The City's Sewer Revenue Fund continues to expand infrastructure investment, primarily for the CSO Program. Major investment requirements updated for the May 2013 Study are grouped into two main categories:

Sewer Revenue Improvements – projects include those in CARP, combined sewer separation (non-CSO), and sewer reconstruction and rehabilitation. For 2015 through 2018, costs are expected to total $83.9 million (inflation included); for the future, these projects are expected to require approximately $14.5 million (uninflated) annually.

CSO Capital Improvements – this category includes the LTCP. For 2015 through 2018, CSO-related project costs are expected to total $604.8 million (inflated). From 2012 through 2031, LTCP is expected to cost approximately $1.89 billion (uninflated).

Operation and Maintenance (O&M) Expenses

Two components of annual O&M were updated in the May 2013 Study. First, review and analysis by Public Works required revisions to the LTCP-related O&M projections first developed in the 2011 Study. Based on discussions with Public Works staff, the categorization of these CSO-related expenses was changed in the financial plan. O&M impacts are now fully represented by the values in the following CSO Divisions: Interceptor, Retention Basins, Collection, and Wastewater Treatment.

Second, Division Allocations in the financial plan represent the most recent (2012) and current (2013) fiscal year budgets. Total O&M expenses include the basic costs to operate, maintain, and manage the wastewater system. Expenses are projected to be $41.5 million in 2015, escalating to $50.6 million in 2018. Out of these totals, CSO-related O&M is projected to be $1.5 million in 2015 and $4.1 million in 2018.

Fund Balances

The City maintains two primary Sewer Revenue Funds – 21121 for operations and debt service and 21124 for capital improvements. Beginning fund balances for 2012 were updated and year-end balances validated with trial balances by fund.

Customer Service (Usage) Characteristics

Customer service or usage characteristics are those requirements demonstrated by each customer class that cause the wastewater utility to incur its various costs. Customer service characteristics of the City's system include:

- Flows
- BOD
- TSS
- Number of Customers

The 2011 Study forecasted customer service characteristics based on actual customer counts, flows, and loadings from 2007. Given more recent account and usage data, the May 2013 Study used actual data from 2011 and historical averages to project 2015 – 2018 characteristics.

Cost Allocations

Equitably allocating the wastewater system's user charge revenue requirements to customer classes involves a multi-step process as described in Section 4 of the 2011 Study Final Report. The same cost allocations were used in the May 2013 Study with one exception. Further analysis of the equitable allocation of costs to the bulk users justified a change in the allocation of combined sewer separation (non-CSO) project costs to non-bulk users only. Bulk customers are not assigned any portion of these costs in the May 2013 Study.

Fixed Assets

Allocating capital costs to each customer class is accomplished by allocating the wastewater system's net fixed assets (i.e. fixed assets net of depreciation and contributions). Net fixed assets are allocated to unit processes, cost pools, cost categories, and customer service characteristics as described in the 2011 Study Final Report. System fixed assets had not been updated since 2007.

Significant research and analysis was completed by Public Works staff to ensure the net fixed assets used in the May 2013 Study were current and complete. Oracle database records were compared against the 2007 list used in the 2011 Study. System assets were updated through year-end 2012 and also included construction in progress.

Staff reviewed each asset for primary functional cost allocations to be used in the COS analysis. Given the update, net fixed assets changed from $276 million in the 2011 Study to $554 million in the May 2013 Study.

Non-Residential CSO Charges

Since the 2011 Study, concerns presented by the Coalition of Industries in Omaha regarding rate increases related to CSO revenue requirements resulted in an alternative approach to recovering the non-residential share of CSO-related revenue requirements from three non-residential classes: general commercial, large commercial, and industrial. Water meter sizes and number of sewer accounts by meter size were summarized from available billing data. Using published hydraulic meter size equivalencies from the American Water Works Association (AWWA), the total number of equivalent meters was determined. Equivalent meters were calculated by applying a set of ratios that define the relative size or demand of a specific meter. The City's larger sewer customers were reassigned to a maximum water meter size of 4 inches for purposes of calculating CSO charges.

The May 2013 Study incorporates the updated methodology to calculating CSO charges for non-residential customers. The rate schedule presented below includes these charges by meter size.

May 2013 Study Rate Results

The City's current wastewater rate design and rates consist of a monthly service charge per account, a flow charge per one hundred cubic feet (Ccf), a CSO-related service charge by meter size for commercial and industrial customers, and an abnormal strength surcharge per ton of abnormal BOD and/or TSS discharged. The monthly service charges vary by customer class. The flow charge differs for residential, commercial/industrial, and bulk customers. Abnormal strength is defined as BOD discharged at concentrations greater than 240 milligrams per liter (mg/l) and TSS discharged at greater than 300 mg/l.

Given the updated information outlined in this addendum, the proposed rate revenue increases and rates for 2015 – 2018 are presented below.

Table 1. Schedule of Charges 2014 – 2018

Item	2014	2015	2016	2017	2018
(a) The customer charge is as follows:					
(1) a. For residential sewer service users per month	$23.45	$26.27	$28.50	$30.93	$33.52
b. For commercial residential sewer service users per month	23.45	26.27	28.50	30.93	33.52
(2) For general commercial sewer service users, per month	12.33	13.74	14.40	15.04	15.88
(3) For large commercial sewer service users, per month	12.38	13.78	14.46	15.10	15.95
(4) For general industrial sewer service users, per month	695.07	744.56	782.80	822.28	868.38
(5) For large industrial sewer service users, per month	695.07	744.56	782.80	822.28	868.38
(6) For bulk I sewer service users, per account, per month	396.31	499.72	526.21	553.75	585.52
(7) For bulk II sewer service users, per account, per month	3.53	3.99	4.24	4.48	4.80
(b) The flow charge for all residential sewer service users shall be, per 100 cubic feet	1.97	2.23	2.45	2.68	2.94
The flow charge for all commercial and industrial sewer service users shall be, per 100 cubic feet	1.24	1.31	1.40	1.48	1.60
The flow charge for all bulk sewer service users shall be, per 100 cubic feet	1.55	1.64	1.80	1.99	2.18
(c) The CSO charge for all commercial and industrial sewer service users, per account, per month, by meter size:					
(1) 5/8 inch meter	$23.08	$24.18	$27.47	$31.28	$35.13
(2) 3/4 inch meter	34.45	36.08	41.00	46.68	52.44
(3) 1 inch meter	57.53	60.26	68.46	77.96	87.57
(4) 1.5 inch meter	114.71	120.16	136.52	155.46	174.62
(5) 2 inch meter	183.60	192.32	218.51	248.83	279.49
(6) 3 inch meter	401.99	421.09	478.43	544.80	611.94
(7) 4 inch meter	723.38	757.74	860.93	980.36	1,101.18
(d) The abnormal charge for all sewer service users shall be the sum of the following					
(1) For abnormal suspended solids, per ton	$239.68	$215.96	$226.93	$238.01	$250.83
(2) For abnormal BOD, per ton	399.73	340.53	357.69	374.84	394.68
(3) For abnormal grease, per ton	0.00	0.00	0.00	0.00	0.00
(e) The charge per day for extra sampling days shall be	618.90	637.47	656.59	676.29	696.58
(f) The charge for installation of a temporary primary device shall be	1,213.66	1,250.07	1,287.57	1,326.20	1,365.99
(g) Industrial pretreatment monitoring charge, per month	74.01	76.23	78.52	80.87	83.30
(h) The charge for septic tank contents disposal shall be, per 1,000 gallons	28.61	24.60	25.88	27.15	28.65
(i) City of Omaha hand billing charge	10.12	10.42	10.74	11.06	11.39

Supporting Model Tables

The May 2013 Study updated the long-term financial plan and six individual COS models. The following model tables are provided to summarize the steps in developing rates for 2015 - 2018.

Appendix A includes the financial plan tables used to develop annual user charge revenue requirements.

Projected Customer Usage Characteristics
Annual user charge revenue requirements are allocated to each customer class based on each class' proportion of flows, loadings, and number of customers. Table 2 below presents the proportions of each characteristic that are used initially to determine the cost responsibility of each customer class. For example, while residential customers (Class 1 & 2) are projected to comprise 92.4 percent of the total number of customers the City serves, these customers contribute less than 22 percent of total flows. Residential customers are allocated approximately 92 percent of customer-related costs and 22 percent of flow-related costs in 2015.

Table 2. Summary of Customer Usage Characteristics for 2015

Customer Class	Flows	BOD	TSS	Customer	I&I Customer	I&I Flows
Inside City Gen. Residential (Class 1 & 2)	16.85%	18.08%	24.32%	71.71%	61.27%	16.85%
Inside City General Commercial (Class 3)	15.54%	16.67%	22.43%	7.03%	6.01%	15.54%
Inside City Large Commercial (Class 4)	2.63%	2.82%	3.79%	0.04%	0.04%	2.63%
Inside City Large Industrial (Class 6 & 7)	5.87%	6.30%	8.48%	0.02%	0.01%	5.87%
Outside City Gen. Residential (Class 1 & 2)	4.84%	5.20%	6.99%	20.69%	17.68%	4.84%
Outside City General Commercial (Class 3)	1.31%	1.41%	1.90%	0.48%	0.41%	1.31%
Outside City Large Commercial (Class 4)	0.46%	0.49%	0.66%	0.00%	0.00%	0.46%
Outside City Large Industrial (Class 6 & 7)	0.13%	0.14%	0.19%	0.00%	0.00%	0.13%
Bulk 1	5.91%	6.35%	8.54%	0.01%	0.01%	5.91%
Bulk 2	6.30%	6.76%	9.10%	0.00%	14.56%	6.30%
Pretreatment NPP	0.00%	0.00%	0.00%	0.01%	0.01%	0.00%
Extra Monitoring	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Inflow & Infiltration Treated	22.78%	0.00%	0.00%	0.00%	0.00%	22.78%
Inflow & Infiltration Untreated	17.38%	0.00%	0.00%	0.00%	0.00%	17.38%
Extra-Strength Surcharge	0.00%	35.78%	13.61%	0.00%	0.00%	0.00%
	---------------	---------------	---------------	---------------	---------------	---------------
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Table 3 summarizes the cost responsibility by customer class excluding CSO-related expenses. CSO-related cost responsibility for 2015 is presented in Table 4. Finally,

Table 3.Summary of Unit Costs and Revenues for 2015 (Excluding CSO Costs)

Customer Class	Flow (CCF)	$/CCF	Total Flow Revenue	No. of Bills	Charge/Bill	Service Charge Revenue	Total Revenue (Non-CSO)
General Residential	10,718,360	1.311	$14,049,396	1,902,240	$13.01	$24,751,817	$38,801,213
General Commercial	8,327,147	1.311	10,915,045	154,788	$13.74	2,126,934	13,041,979
Large Commercial	1,522,361	1.311	1,995,478	912	$13.78	12,570	2,008,048
Large Industrial	2,967,099	1.311	3,889,210	324	$744.56	241,237	4,130,446
Bulk 1	2,922,386	0.713	2,083,190	132	486.47	64,214	2,147,404
Bulk 2	3,113,845	0.713	2,219,670	350,712	3.99	1,398,813	3,618,483
Pretreatment NPP	0	0.00	0	240	73.75	17,701	17,701
Extra-Strength Surcharge		0.00	0	0	0.00	0	5,146,222
Totals	**29,571,198**		**$35,151,988**	**2,409,349**		**$28,613,285**	**$68,911,495**

Table 4. Summary of CSO Unit Costs and Revenues for 2015

Customer Class	Flow (CCF)	CSO Related Flow Charges ($/CCF)	CSO Related Flow Revenues	No. of Bills	CSO Related Charge per Bill	CSO Related Service Charge Revenues	Total CSO Revenue[1]
General Residential	10,718,360	$0.923	$9,889,589	1,902,240	13.26	$25,214,192	$35,103,781
General Commercial	8,327,147	NA	NA	154,788	NA	NA	
Large Commercial	1,522,361	NA	NA	912	NA	NA	13,893,692
Large Industrial	2,967,099	NA	NA	324	NA	NA	
Bulk 1	2,922,386	0.923	2,696,420	132	13.26	1,750	2,698,169
Bulk 2	3,113,845	0.923	2,873,074	350,712	0.00	636	2,873,711
Pretreatment NPP	0	0.000	0	240	0.00	0	0
Extra-Strength Surcharge	0	0.000	0	0	0.00	0	0
Totals	**29,571,198**		**$15,459,083**	**2,409,349**		**$25,216,578**	**$54,569,353**

[1] Combined CSO revenues for General Commercial, Large Commercial, and Large Industrial are derived from charges by water meter size.

Table 5 shows the schedule of CSO charges by meter size for the commercial and industrial customers. Total monthly charges for flow and customer service are calculated for each customer class using Tables 3 – 5. Refer to Table 1 for a summary of the charges.

Table 5. Schedule of Commercial and Industrial CSO Charges for 2015

Meter Size	Equiv Size	Charge per Meter Size	Meter Count	Number of Bills/Year	Revenue by Meter
5/8 inch	1	$24.18	2,768	12	$803,016
3/4 inch	1	36.08	1,309	12	566,791
1 inch	2	60.26	3,666	12	2,650,893
1.5 inch	3	120.16	3,179	12	4,583,720
2 inch	5	192.32	1,195	12	2,757,899
3 inch	12	421.09	357	12	1,803,941
4 inch	21	757.74	80	12	727,432
6 inch	47	NA	NA	NA	0
8 inch	80	NA	NA	NA	0
10 inch	127	NA	NA	NA	0
			---------------		---------------
Totals			**12,554**		**$13,893,692**

Appendix F
Rate Ordinance

City of Omaha
Jean Stothert, Mayor

June 24, 2014

Public Works Department
Omaha/Douglas Civic Center
1819 Farnam Street, Suite 601
Omaha, Nebraska 68183-0601
(402) 444-5220
Fax (402) 444-5248

Robert G. Stubbe, P.E.
Public Works Director

Honorable President

and Members of the City Council,

Transmitted herewith is an Ordinance to amend Sections 31-145, 31-147 and 31-158 of the Omaha Municipal Code, as it relates to the provision for sewer use fees.

This Amendment sets forth the Schedule of Charges for the period of January 1, 2014 through December 31, 2018, as determined by the April, 2013 update to the August 2006 Sewer Use Study by the Integrated Utilities Group, now known as Red Oak Consulting. This updated Schedule of Charges has been developed to as a part of an ongoing process of the Finance and Public Works Departments to balance actual revenues and necessary expenditures to maintain the solvency of the Sewer Revenue Fund. These changes, if approved, would be effective January 1, 2014.

The Public Works Department requests your consideration and approval of the attached Ordinance.

Respectfully submitted,

Robert G Stubbe 6-9-14
Robert G. Stubbe, P.E. Date
Public Works Director

Referred to City Council for Consideration:

Jean Stothert 6/13/14
Mayor's Office Date

Approved as to Funding:

Stephen B. Curtiss 6/13/14
Stephen B. Curtiss Date
Finance Director

2064htp

ORDINANCE NO. ____________

AN ORDINANCE to amend Sections 31-145, 31-147 and 31-158 of the Omaha Municipal Code, dealing with sewer use fees; to provide for sewer service charges for the period January 1, 2014 through December 31, 2018, subject to an audit of the sewer service charges every five (5) years; to repeal Sections 31-145, 31-147 and 31-158 of the Omaha Municipal Code as heretofore existing; and to provide for the effective date hereof.

BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF OMAHA

Section 1. That Section 31-145 of the Omaha Municipal Code is amended to read as follows:

Sec. 31-145. Rates generally.

Based upon the criteria as established in the August 2006 Sewer Use Study by the Integrated Utilities Group, Inc. and as revised and updated in April of 2009, ~~and in~~ September of 2012 and in April 2013 by Red Oak Consulting (formerly Integrated Utilities Group, Inc.), the sewer service charges shall be levied as determined by the city administration upon the user of the premises, property or structures of every kind, nature and description, which have water service from any supply source and are connected directly or indirectly with the sewerage system of the city.

Section 2. That Section 31-147 of the Omaha Municipal Code is amended in the whole to read as follows:

Sec. 31-147. Schedule of charges.

The total sewer service charge for each sewer service user shall be the sum of four charges: (1) customer charge, (2) flow charge, (3) commercial and industrial CSO charge and (4) abnormal charge; provided that the monthly sewer service charge for a sewer service user shall not be less than the customer charge and the CSO charge for applicable classes.

TABLE INSET:

	-	-	-	2010	2011	2012	2013	2014
(a) -	The customer charge is as follows:							
-	(1)	a. -	For residential sewer service users, per month	9.19	11.26	14.61	18.54	23.45
-	-	b. -	For commercial residential sewer service users, per month	9.19	11.26	14.61	18.54	23.45
-	(2)	For general commercial sewer service users, per month		9.97	11.90	15.28	11.67	12.33
-	(3)	For large commercial sewer service users, per month		9.97	11.91	15.30	11.70	12.38
-	(4)	For general industrial sewer service users, per month		462.61	598.48	632.94	659.98	695.07
-	(5)	For large industrial sewer service users, per month		462.61	598.48	632.94	659.98	695.07
-	(6)	For bulk I sewer service users, per account, per month		458.38	332.38	352.27	372.76	396.31
-	(7)	For bulk II sewer service users, per account, per month		2.28	2.57	3.01	3.26	3.53

(b)	The flow charge for all residential sewer service users shall be, per 100 cubic feet		0.862	1.052	1.301	1.597	1.968
	The flow charge for all commercial and industrial sewer service users shall be, per 100 cubic feet		0.862	1.052	1.301	1.131	1.236
	The flow charge for all bulk sewer service users shall be, per 100 cubic feet		0.588	0.752	0.951	1.220	1.551
(c)	The CSO charge for all commercial and industrial sewer service users, per account, per month, by meter size:						
	(1)	5/8 inch meter				14.47	23.08
	(2)	3/4 inch meter				21.59	34.45
	(3)	1 inch meter				36.06	57.53
	(4)	1.5 inch meter				71.91	114.71
	(5)	2 inch meter				115.10	183.60
	(6)	3 inch meter				252.01	401.99
	(7)	4 inch or larger meter				453.48	723.38
(d)	The abnormal charge for all sewer service users shall be the sum of the following:						
	(1)	For abnormal suspended solids, per ton	192.69	199.05	211.22	220.47	239.68
	(2)	For abnormal BOD, per ton	326.48	325.65	350.10	367.22	399.73
	(3)	For abnormal grease, per ton	—	—	—	—	—
(e)	The charge per day for extra sampling days shall be		473.31	527.68	555.78	586.10	618.90
(f)	The charge for installation of a temporary primary device shall be		983.67	1034.79	1089.88	1149.35	1213.66
(g)	Industrial pretreatment monitoring charge, per month		64.44	63.59	66.96	70.28	74.01

~~(h)~~	~~The charge for septic tank contents disposal shall be, per 1,000 gallons~~	~~22.18~~	~~22.80~~	~~24.57~~	~~26.02~~	~~28.61~~
~~(i)~~	~~City of Omaha hand billing charge~~	~~8.20~~	~~8.63~~	~~9.09~~	~~9.58~~	~~10.12~~

			2014	2015	2016	2017	2018
(a)	The customer charge is as follows:						
	(1)	For residential sewer service users, per month	23.45	26.27	28.50	30.93	33.52
	(2)	For general commercial sewer service users, per month	12.33	13.74	14.40	15.04	15.88
	(3)	For large commercial sewer service users, per month	12.38	13.78	14.46	15.10	15.95
	(4)	For general industrial sewer service users, per month	695.07	744.56	782.80	822.28	868.38
	(5)	For large industrial sewer service users, per month	695.07	744.56	782.80	822.28	868.38
	(6)	For bulk I sewer service users, per account, per month	396.31	499.72	526.21	553.75	585.52
	(7)	For bulk II sewer service users, per account, per month	3.53	3.99	4.24	4.48	4.80
(b)	The flow charge for all residential sewer service users shall be, per 100 cubic feet		1.968	2.233	2.448	2.682	2.941
	The flow charge for all commercial and industrial sewer service users shall be, per 100 cubic feet		1.236	1.311	1.398	1.485	1.595
	The flow charge for all bulk sewer service users shall be, per		1.551	1.636	1.802	1.989	2.184

	100 cubic feet						
(c)	The CSO charge for all commercial and industrial sewer service users, per account, per month, by meter size:						
	(1)	5/8 inch meter	23.08	24.18	27.47	31.28	35.13
	(2)	3/4 inch meter	34.45	36.08	41.00	46.68	52.44
	(3)	1 inch meter	57.53	60.26	68.46	77.96	87.57
	(4)	1.5 inch meter	114.71	120.16	136.52	155.46	174.62
	(5)	2 inch meter	183.60	192.32	218.51	248.83	279.49
	(6)	3 inch meter	401.99	421.09	478.43	544.80	611.94
	(7)	4 inch or larger meter	723.38	757.74	860.93	980.36	1,101.18
(d)	The abnormal charge for all sewer service users shall be the sum of the following:						
	(1)	For abnormal suspended solids, per ton	239.68	215.96	226.93	238.01	250.83
	(2)	For abnormal BOD, per ton	399.73	340.53	357.69	374.84	394.68
(e)	The charge per day for extra sampling days shall be		618.90	637.47	656.59	676.29	696.58
(f)	The charge for installation of a temporary primary device shall be		1213.66	1,250.07	1,287.57	1,326.20	1,365.99
(g)	Industrial pretreatment monitoring charge, per month		74.01	76.23	78.52	80.87	83.30
(h)	The charge for septic tank contents disposal shall be, per 1,000 gallons		28.61	24.60	25.88	27.15	28.65
(i)	City of Omaha hand billing charge		10.12	10.42	10.74	11.06	11.39

The sewer service charges prescribed in this section shall be applicable to water use per meter readings taken or estimates calculated January 1 through December 31 of the calendar year indicated at the top of each such column except for the year ~~2014~~ 2018, which shall remain applicable thereafter until amended.

The sewer service charges provided for herein for the years ~~2010, 2011, 2012, 2013 and 2014~~ 2014, 2015, 2016, 2017 and 2018 may be reallocated among the components of the charge, specifically the customer charge, flow charge, commercial and industrial CSO charge and abnormal charge, when and if it is determined that the allocations provided for herein should be amended to provide for an equitable distribution of the costs of providing such service. An audit of the sewer service charges shall be conducted every five (5) years, to begin five (5) years after the effective date of the amendment codified in this section.

Section 3. That Section 31-158 of the Omaha Municipal Code is amended in the whole to read as follows:

Sec. 31-158. Additional Customer Charges.

In addition to the customer charges set out in section 31-147, the following customer charges are hereby imposed which shall be added to the sewer user billings for new total customer charges.

~~(1) a. For residential sewer service users, per month . . . $0.64~~

~~b. For commercial residential sewer service users, per month . . . 0.64~~

~~(2) For general commercial sewer service users, per month . . . 0.95~~

~~(3) For large commercial sewer service users, per month . . . 3.93~~

~~(4) For general industrial sewer service users, per month . . . 37.67~~

~~(5) For large industrial sewer service users, per month . . . 37.67~~

(1) For residential sewer service users, per month . . . $0.71

(2) For general commercial sewer service users, per month . . . $1.22

(3) For large commercial sewer service users, per month . . . $1.22

(4) For general industrial sewer service users, per month . . . $1.22

(5) For large industrial sewer service users, per month . . . $1.22

That the finance department shall maintain a separate enterprise fund to be used only for storm water management activities and to effect periodic transfers from the sewer revenue fund to the storm water management fund in amounts equal to revenue from the increases in the customer charges listed above.

Section 4. That Sections 31-145, 31-147 and 31-158 of the Omaha Municipal Code, as heretofore existing, are hereby repealed.

Section 5. That this Ordinance shall be in full force and take effect on January 1, 2014.

INTRODUCED BY COUNCILMEMBER

____

PASSED ______________________

ATTEST:

____
CITY CLERK OF THE CITY OF OMAHA DATE

APPROVED BY:

____
MAYOR OF THE CITY OF OMAHA DATE

APPROVED AS TO FORM:

______________________________ 6-18-14
DEPUTY CITY ATTORNEY DATE

2063htp

Appendix G
Financial Affordability Assessment

Economics Center

Financial Capability Assessment for City of Omaha Public Works

March 26, 2013

University of Cincinnati

Summary of FCA

- Omaha plans to spend $2 billion from 2009 to 2027 to implement its CSO Long Term Control Plan.
- The cost for Omaha residents is expected to reach $730 per year or 1.3% of median household income (medium burden).
- Most lower income residents will see wastewater bills in excess of 3% of household income.
- Omaha's financial capability is limited by a number of factors.

Today's Discussion

- Calculation of the Residential Indicator:
  - *How will the cost of the program impact households?*
- Financial Indicators:
  - *What is the capability of Omaha to pay for needed improvements?*
- Special Considerations:
  - *What is the impact on economically disadvantaged areas?*
- Implications:
  - *What does this assessment mean for Omaha's program?*

Residential Indicator: How would the cost of the LTCP impact households?

- Total Sewer Costs
- Cost per Household (CPH)
- Median Household Income (MHI)
- **Residential Indicator**: CPH as a percent of MHI

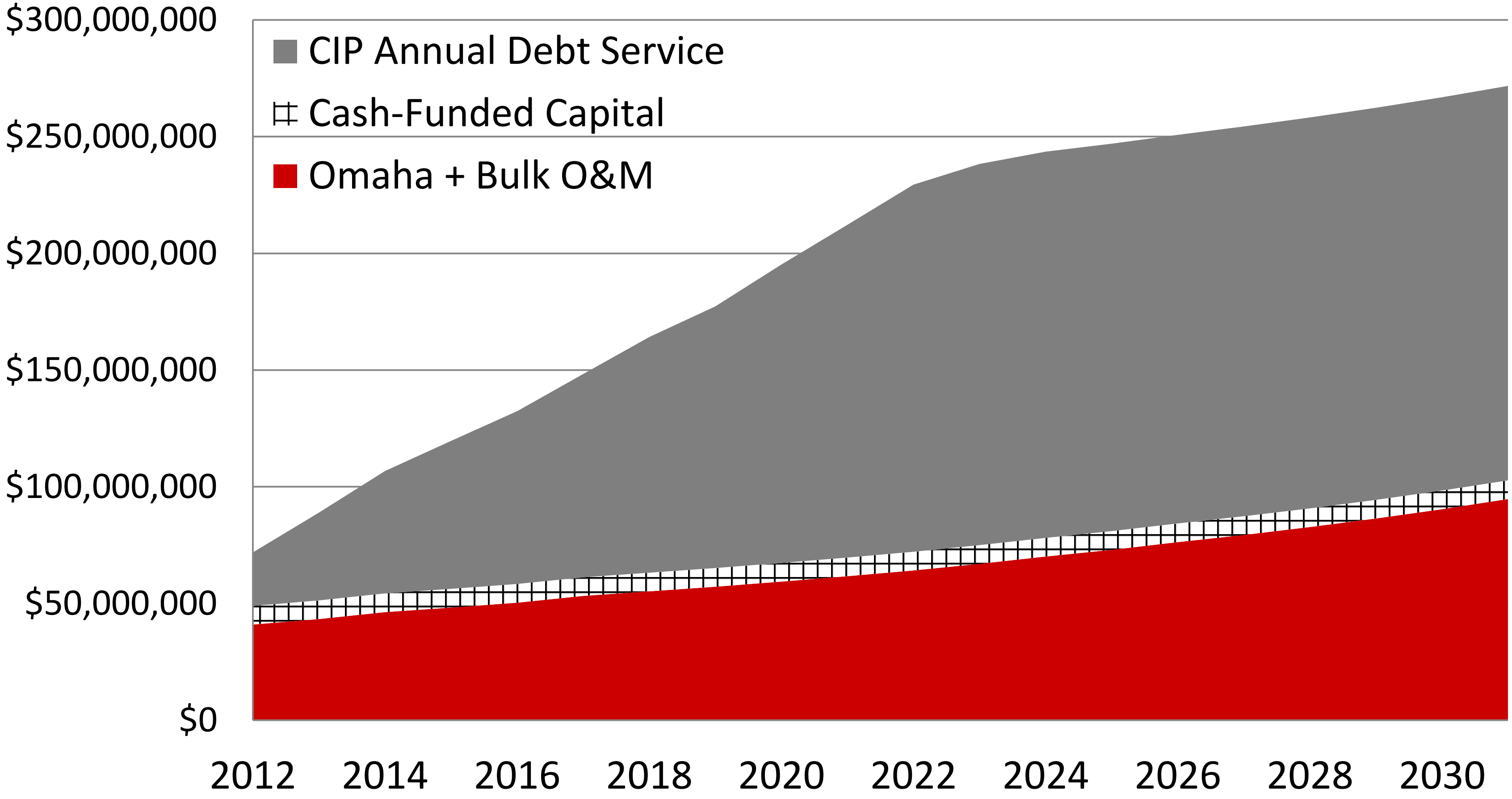
Residential Indicator Calculations: Annual Sewer Costs > $240 Million

- $2 billion LTCP plus O&M and other costs

Existing Omaha O&M	$ 34,796,000
Existing Bulk Community O&M	$ 6,198,000
Existing LTCP Debt Service	$ 22,891,000
Capital Asset Replacement Program (cash-funded)	$ 5,000,000
Sewer Reconstruction/Rehabilitation (cash-funded)	$ 3,000,000
Future O&M (incremental new) – in 2024	$ 29,120,000
Future LTCP and RNC Debt Service – in 2024	$142,564,000
TOTAL	$243,569,000

Economics Center

Total Omaha Sewer Costs



University of Cincinnati

Residential Indicator Calculations: Cost Per Household = $730

- Residential share = 75% of program costs
  - $182,464,500 (75% of $244 Million)
- Number of Households = 250,000
  - Includes all bulk communities and SIDs
  - Excludes households on septic systems
- Cost per household = $730
  - Residential share/households = $182,464,500 ÷ 249,979

Residential Indicator Calculations: Median Household Income

- Median Household Income (MHI) = $56,019
  - For Service Area (most of Douglas and Sarpy Counties)
  - City of Omaha MHI = $46,978
- Communities of Concern are much lower
  - For example, 20th percentile = $24,970

(estimates from 2011 American Community Survey 5-year sample)

Residential Indicator: Summary Calculation

- Residential Indicator

$730 Cost per Household

÷ $56,019 Median Household Income

1.3% Residential Indicator

Financial Capability Indicators

- **Debt**: Bond Rating, Debt as % of Property Value
- **Socioeconomic**: Unemployment, MHI
- **Financial**: Revenues as % of Property Value, Property Tax Collection Rate
- Additional data on local conditions and trends is used to adjust indicator scores.

Note: Debt and Financial Indicators are for Permitee (City); Socioeconomic Indicators are for Service Area.

Bond Rating Indicator

- Preliminary Indicator Score: Strong
  - Rating is AA/Aa1, but...
  - Agencies are concerned about City's debt level, and
  - EPA's use of bond ratings to assess community credit capacity is **problematic**.
  - EPA's scale for scoring bond ratings is **heavily skewed** to the positive side.
- Adjusted Indicator Score: Mid-Range
  - Or treat as irrelevant based on EPA position elsewhere

Debt as % of Property Value Indicator

- Indicator Score: Weak

$ 1.35 billion Direct & Overlapping Debt
÷ $26.14 billion Value of Taxable Real Property
5.2% Debt Percentage

- Without City policy to limit property-tax supported debt service to a rate of 20.875 cents, this could be even higher (weaker).

Debt Per Capita

- Omaha Financial Obligations

  $1,354,691,000 Direct & Overlapping Debt

  ÷ 416,855 Population

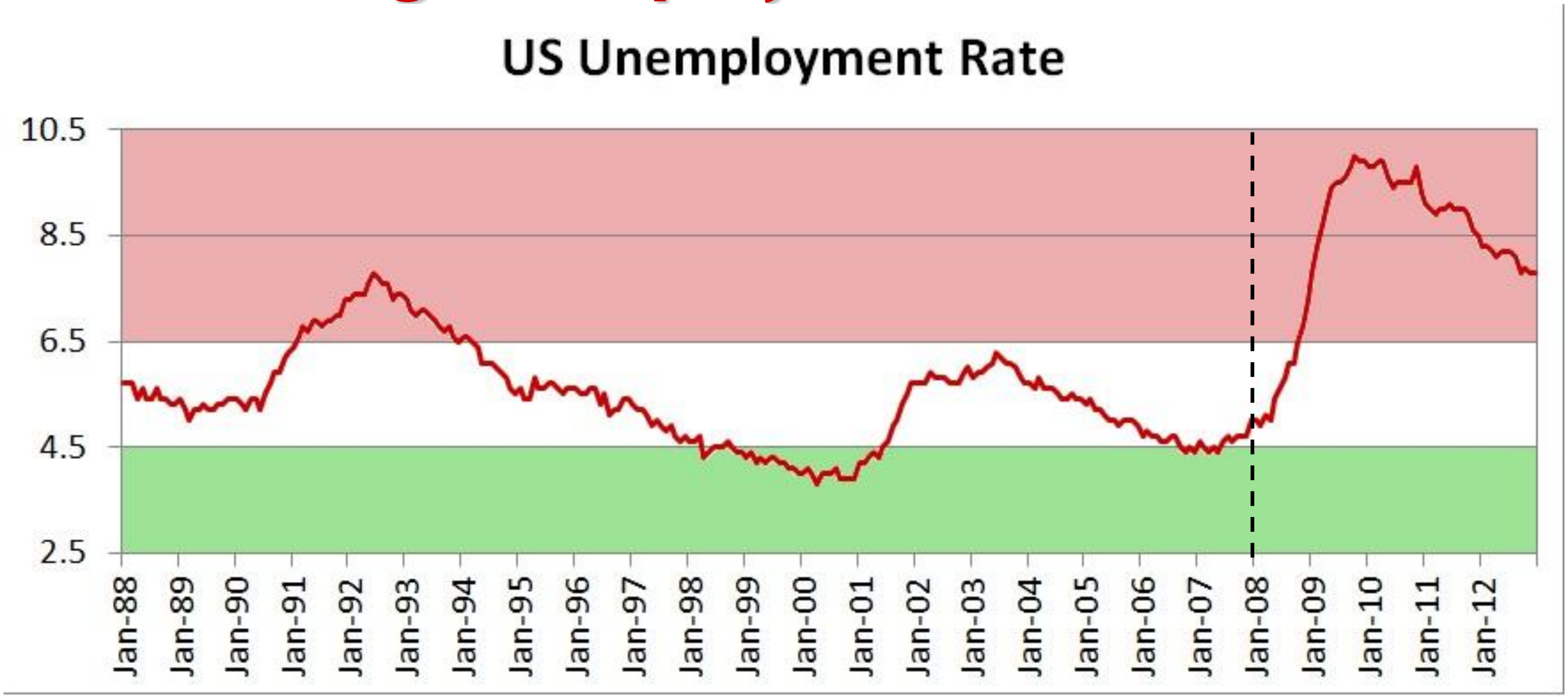
  $3,250 Debt Per Capita

  – Viewed as above average by Moody's
- Pension and OPEB obligations would increase this by 55%.
- Doesn't count existing or planned sewer debt.

Unemployment Indicator

- Indicator Score: Strong …
  - Douglas County's unemployment rate for 2012 was 4.5%, which is well below the national rate of 8.1%.
- But …
  - This indicator fails to account for poor national economic conditions.
  - Indicator should be absolute, not relative: based on long-term national trends.

Rating Unemployment Conditions



20 years prior to Great Recession: 15% above 6.5 (weak); 15% below 4.5 (strong)

Unemployment Indicator

- Indicator Using Local Conditions v. US Benchmark
  - Mid-Range should reflect normal national unemployment conditions: 4.5 to 6.5 percent
  - Unemployment rate for both Douglas County and Omaha in 2012 was 4.5%. (strong end of Mid-Range)
  - Yet nearly 19,000 fewer City residents are working than four years ago (-8.2%).
  - Higher rates in Communities of Concern
- Adjusted Indicator Score: Mid-Range

Median Household Income (MHI) Indicator

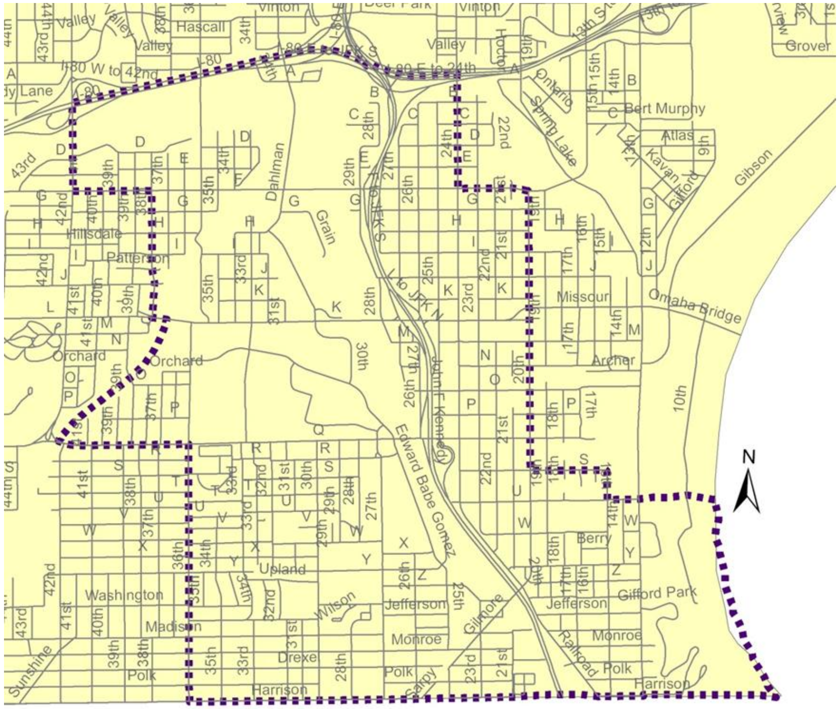
- Preliminary Indicator Score: Mid-Range, but disadvantaged households are concentrated in communities of concern
  - Omaha CSO Area MHI = $37,068 (70% of U.S.)
    - $23,849 for Black/African American householders (45% of U.S.)
  - Federally designated revitalization areas (North & South)
  - … accounting for conditions in these communities …
- Adjusted Indicator Score: Weak

Communities of Concern

- **Pew report (2008)**:
  - Omaha's overall economic conditions are similar to national averages
  - BUT … low-income people burdened by crime index & local tax burden that exceed national averages
  - 30% of African American families live in poverty
  - 40% of African American children live in poverty
  - Particularly concentrated in North Omaha

Neighborhood Revitalization Strategy Area: South

Boundary



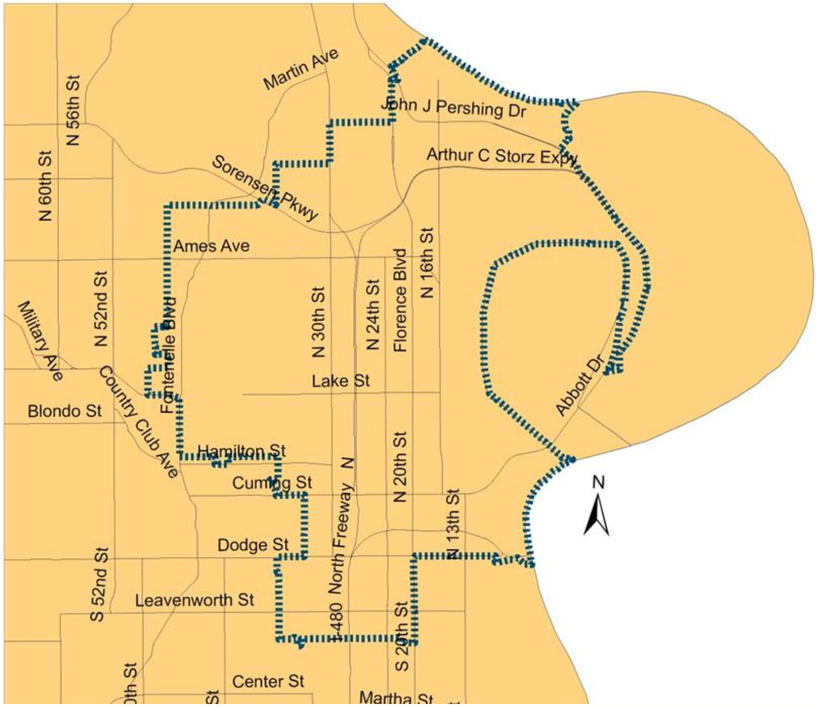
Description

- **Race/Ethnicity**
  - Diverse
- **Median Household Income**:
  - < 75% of City's MHI ($34,090)
- **Unemployment Rate**:
  - Nearly three times City rate
- **2011 Poverty Rate**:
  - 27.1%; 1.75 times the City rate

Federally designated by HUD as a community experiencing a high concentration of economic distress.

Neighborhood Revitalization Strategy Area: North

Boundary

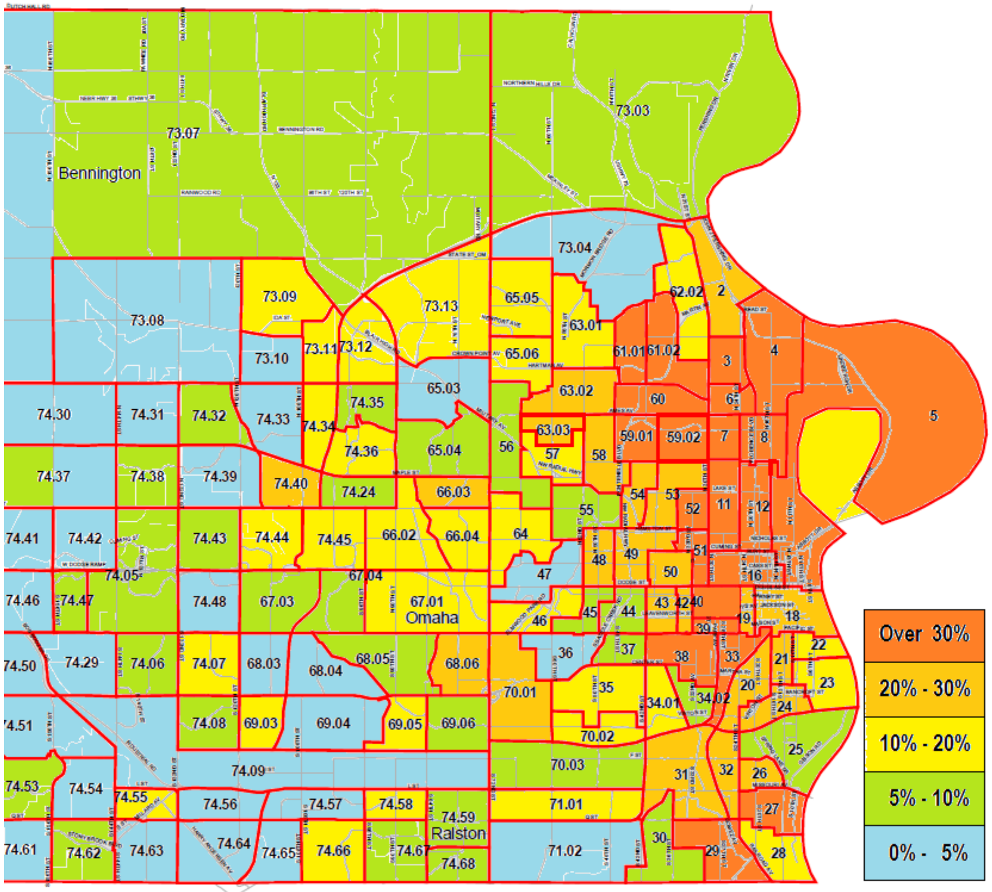


Description

- **16,900 Households**
- **Race/Ethnicity, Distress:**
  - Core is two thirds African American
  - > 75% are low-and moderate-income
  - physical, economic, and social distress;
- **2011 Median Household Income**:
  - $25,165; 54% of City, 46% of US MHI
- **2011 Unemployment Rate**:
  - 2.5 times the City rate
- **2011 Poverty Rate**:
  - 37.2%; 2.40 times the City rate

High Poverty Neighborhoods

- High poverty areas are concentrated east of 72nd, in the City's combined sewer area.
- Construction disruption will disproportionately affect lower income residents.



Tax Revenues as % of Property Value Indicator

- Preliminary Indicator Score: Mid-Range
  - 2.7% of property value
- But total state/local tax burden is much higher, especially for Omaha's lower income households

Household income:	$25,000	$50,000	$75,000	$100,000	$150,000
Tax burden:	10.4%	9.4%	9.0%	9.0%	9.4%

- Adjusted Indicator Score: Weak

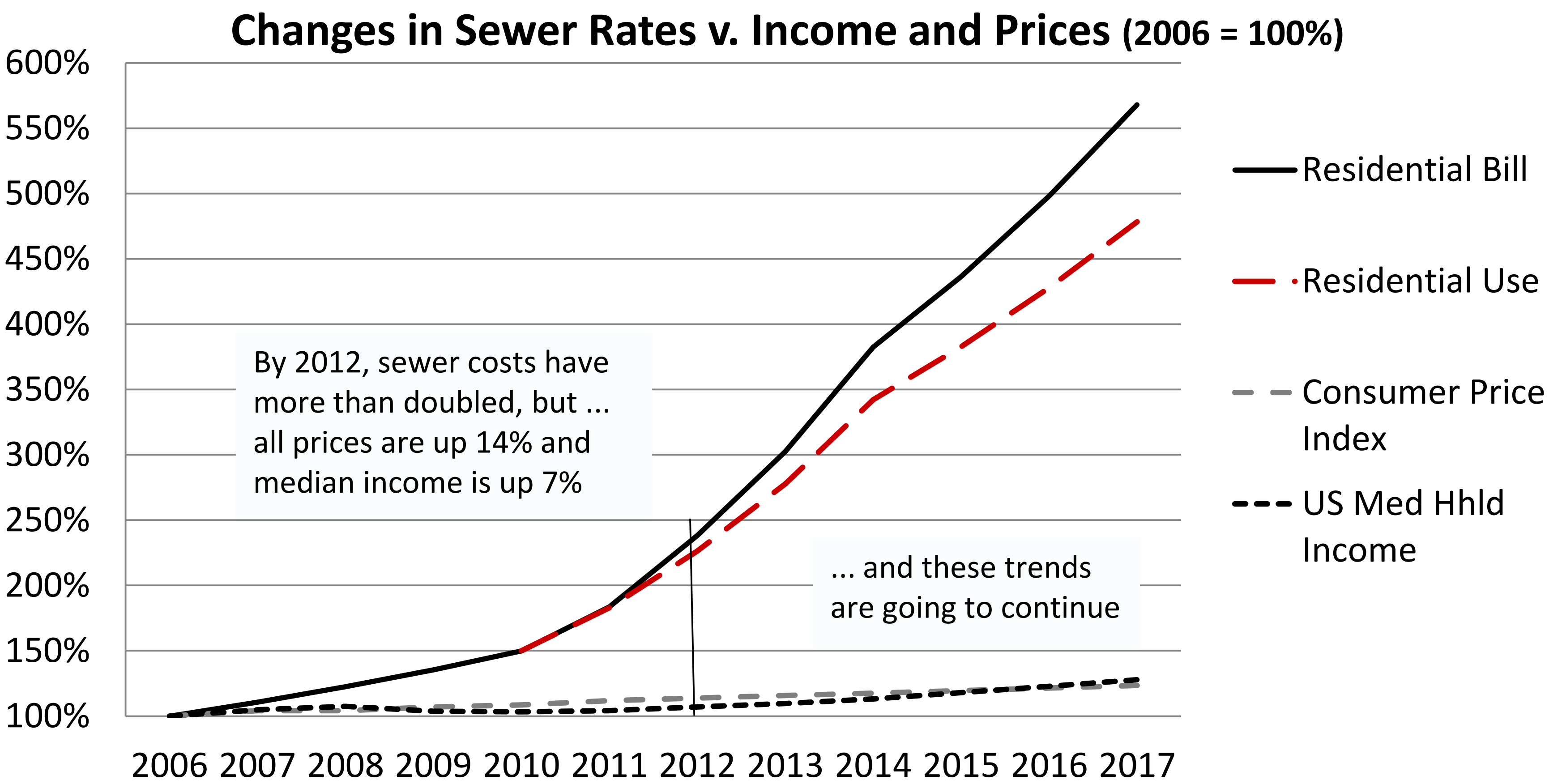
Property Tax Collection Rate Indicator

- Indicator Score: Strong
  - 2011 property tax collection rate was 97.7%
- Reason for Discarding this Indicator
  - Interest rate on delinquencies distorts this measure
  - Unreliable indicator for EPA's purposes

Other Economic Considerations

- Rate increases result in utility delinquencies and revenue leakage
- Consumption by large commercial users has declined steadily
- Local businesses are adversely affected by rate increases
- Cost of program will adversely affect City's competitive position

Omaha Sewer Rates are Rising Fast



Impacts on Customers

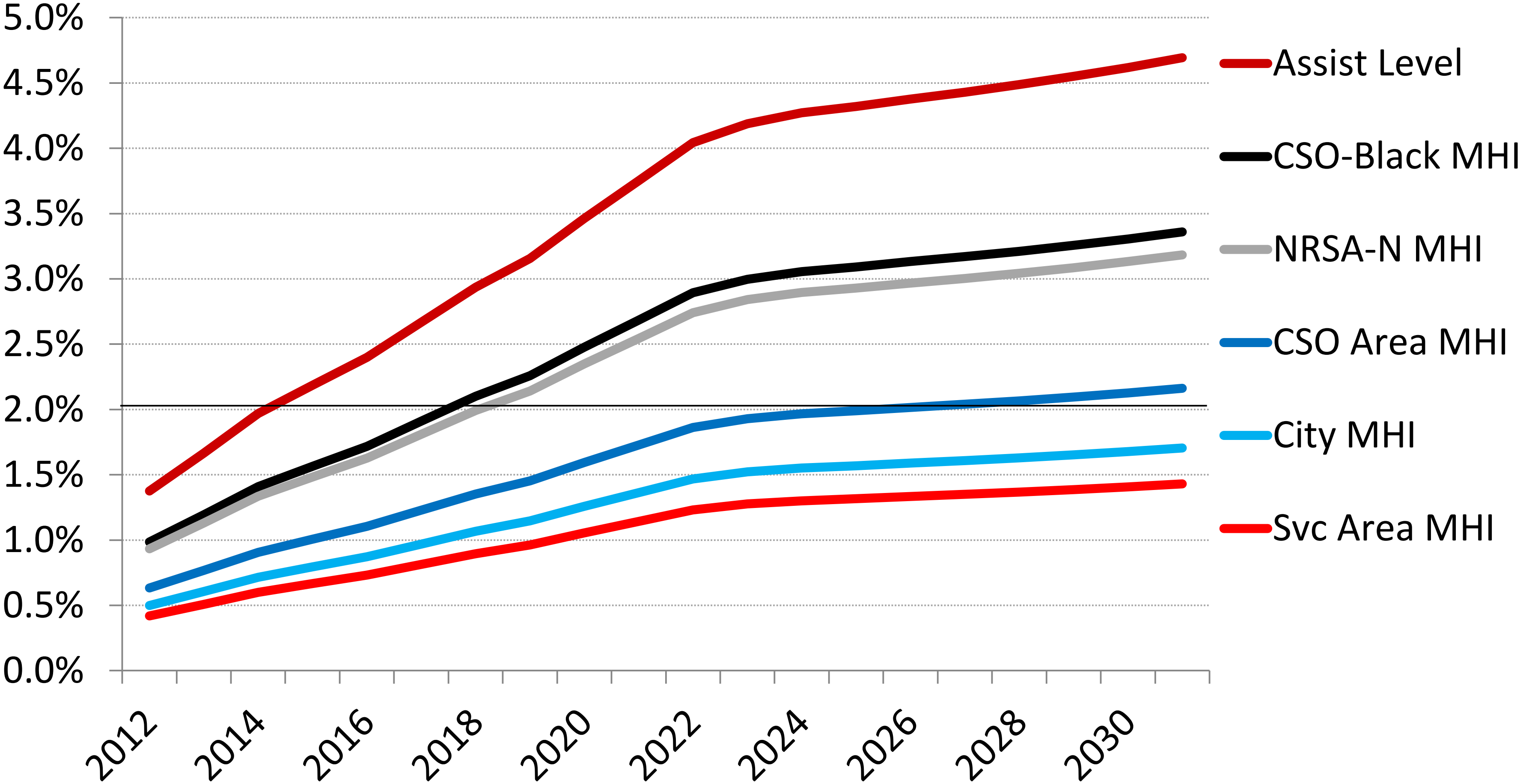
- To implement the $2 billion LTCP within the current 18-year NDEQ administrative order period will mean:
  - Rates double the current level
  - Increasing problems with delinquencies, non-payment
- Such increases will be a particular challenge for lower income households:
  - 1.3 % of median income
  - 2.9 % of low income
  - 4.4 % of poverty level income

Impacts on Customers

- Assistance is available to customers in severe need
  - In 2012, 2/3 of a million dollars distributed
  - This amounted to less than 1.7% of residential bills
  - In only 2 ZIPs did the amount exceed $20 per household
- To have a meaningful impact, program would have to be funded at a vastly larger scale
- Even with more funding, most low income households won't be reached because they live in apartments.

Economics Center

Omaha Sewer Cost as % of Income



University of Cincinnati

Omaha Financial Indicators

Community Indicator	Actual Value	Rating	Standard EPA Indicators Score	Indicators with Local Considerations Score
DEBT				
Bond Rating (Sewer and GO Bonds)	AA/Aa1	Strong	3	Mid-Range 2
Net Debt as % of Full Market Value	5.2%	Weal	1	Weak 1
SOCIOECONOMIC				
Unemployment Rate	4.5%	Strong	3	Mid-Range 2
Median Household Income	$56,019	Mid-Range	2	Mid to Weak 1-2
FINANCIAL MANAGEMENT				
Property Tax Revenues as % of Value	2.7%	Mid-Range	2	Weak 1
Property Tax Revenue Collection Rate	97.7%	Strong	3	- - - -
OVERALL SCORE (average)			2.33	1.4 – 1.6

Financial Capability Matrix

Financial Capability Indicator Score: (Debt, Socioeconomic & Financial Indicators)	Residential Indicator Score: CPH as % of MHI		
	Low (Below 1.0%)	**Mid-Range (1.0 to 2.0%)**	**High (Above 2.0%)**
Weak (Below 1.5)	Medium Burden	**High Burden**	High Burden
Mid-Range (Between 1.5 and 2.5)	Low Burden	**Medium Burden**	**High Burden**
Strong (Above 2.5)	Low Burden	Low Burden	Medium Burden

- Medium overall, but high for many
- Burden is expected to grow

What does this mean for Omaha's Program?

- Implementing $2 billion program on the current schedule will impose a medium to heavy burden, depending on the extent to which actual economic conditions are taken into consideration.
- Omaha is approaching the practical limits of affordability.
  - It is important to balance water quality investment with other local needs (schools, safety, existing obligations).
  - Burden will be most heavily felt by low income residents.

What does this mean for Omaha's Program?

- Omaha must continue to evaluate approach, level of control, and schedule in implementing the LTCP, lest the final result reach a heavier burden, particularly for vulnerable groups of people.
- EPA's recent memo notes that local communities face "difficult economic challenges."
  - Indeed, stronger communities can still be at risk.
  - Must be careful not to cause harm by overly aggressive schedules.

Appendix H
Public Notice Comments

CSO! Clean Solutions for Omaha

MEMORANDUM

Public Comments on the LTCP Update

TO:	File
FROM:	Pat Nelson
DATE:	September 25, 2014

Attached is the public notice for the LTCP Update.

No comments from the public were received on the LTCP Update.

CSO! Clean Solutions for Omaha

August 7, 2014

Subject: Draft Long Term Control Plan Update for the City of Omaha Combined Sewer Overflow Control Program Public Comment Period

Dear Interested Stakeholder,

The purpose of this letter is to advise you of the availability for review and comment of the Draft Long Term Control Plan Update for the Omaha Combined Sewer Overflow (CSO) Control Program. The Draft Plan summarizes the results of a reevaluation of the CSO Controls to determine the most cost effective and beneficial way for the City to control CSOs from its 29 existing CSO outfalls, in accordance with the requirements of the Nebraska Department of Environmental Quality (NDEQ) and the U.S. Environmental Protection Agency (U.S. EPA). According to the City's Amended Consent Order with NDEQ and NPDES Permit, the controls must be constructed by 2027.

No later than noon on August 7, 2014 the Draft Plan will be available to download from the City's CSO Web Site (www.OmahaCSO.com). Hard copies of the Draft Plan are not available, however, an Executive Summary will be available upon request.

Written comments are requested to be submitted by 5 pm on Friday, September 5, 2014. Comments should be directed to Pat Nelson of the CSO Program Management Team, 222 South 15th Street, Suite 1406-S, Omaha, Nebraska 68102 or emailed to Pat at pat.nelson@ch2m.com. Public Meetings regarding the Long Term Control Plan will be conducted at the following dates and places:

Wednesday, August 6, 2014
Westside Community Center
3534 South 108th Street
6:30 p.m. – 8:00 p.m.

Thursday, August 21, 2014
Salvation Army Kroc Center
2815 Y Street
6:30 p.m. – 8:00 p.m.

Tuesday, August 12, 2014
Omaha Public Schools – TAC Building (Cafeteria)
3215 Cuming Street
6:30 p.m. – 8:00 p.m.

The August 12th meeting will be also be available online. To attend this meeting online, register at http://tiny.cc/omahacso.

Please contact Marty Grate, Environmental Services Manager for the City at (402) 444-5225 or Martin.Grate@cityofomaha.org for additional information or if you are unable to access the web site and would like the Draft Plan on a CD.

Sincerely,

Marty Grate
Environmental Services Manager

CSO! PROGRAM OFFICE: CENTRAL PARK PLAZA, 222 S. 15TH ST., SUITE 1406S, OMAHA, NE 68102
(402) 341-0235 • WEBMAIL@OMAHACSO.COM • WWW.OMAHACSO.COM

Appendix I
Sensitive Areas Letters

February 18, 2014

Mr. Randy Lane
Division of Acute Disease Prevention, Emergency Response, & Environmental Health
Iowa Department of Public Health
5th Floor, Lucas Building
321 E. 12th Street
Des Moines, IA 50319-0075

Subject: Inquiry Regarding Public Drinking Water Intakes from the Missouri River
Omaha Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP)
Update of Sensitive Areas Analysis

Dear Mr. Lane:

The purpose of this letter is to confirm there are no new surface water intakes for public drinking water systems along the Missouri River, in the vicinity of the City of Omaha's combined sewer overflow (CSO) outfalls.

The City of Omaha is currently updating its Long Term Control Plan (LTCP) for CSOs. As part of this effort, the City must update or confirm its prior identification of sensitive areas which may be impacted by CSOs. Public drinking water intakes and their designated protection areas are considered sensitive areas.

At the time of development of the original LTCP in 2007-2008, the City of Omaha contacted the State of Iowa, and determined that the City of Council Bluffs has a surface water intake on the Missouri River, located near the Council Bluffs Water Treatment Plant, on the north side of Council Bluffs and south of Eppley Airfield along the east side of the River, as shown in the attached map. No other surface water intakes were identified in Iowa along the Missouri River in the vicinity of the Omaha CSO outfalls.

The City of Omaha would like to know if there are any new drinking water intakes in Iowa along the Missouri River in the vicinity of the Omaha CSO outfalls, or confirm that the information previously obtained regarding the drinking water intakes in Iowa along the Missouri River in this area is still current.

Please contact the City's CSO Program Compliance Team Lead, Pat Nelson, at (402) 609-7512, or myself, at (402) 609-7515 or (402) 444-4923, if you have questions or require further information.

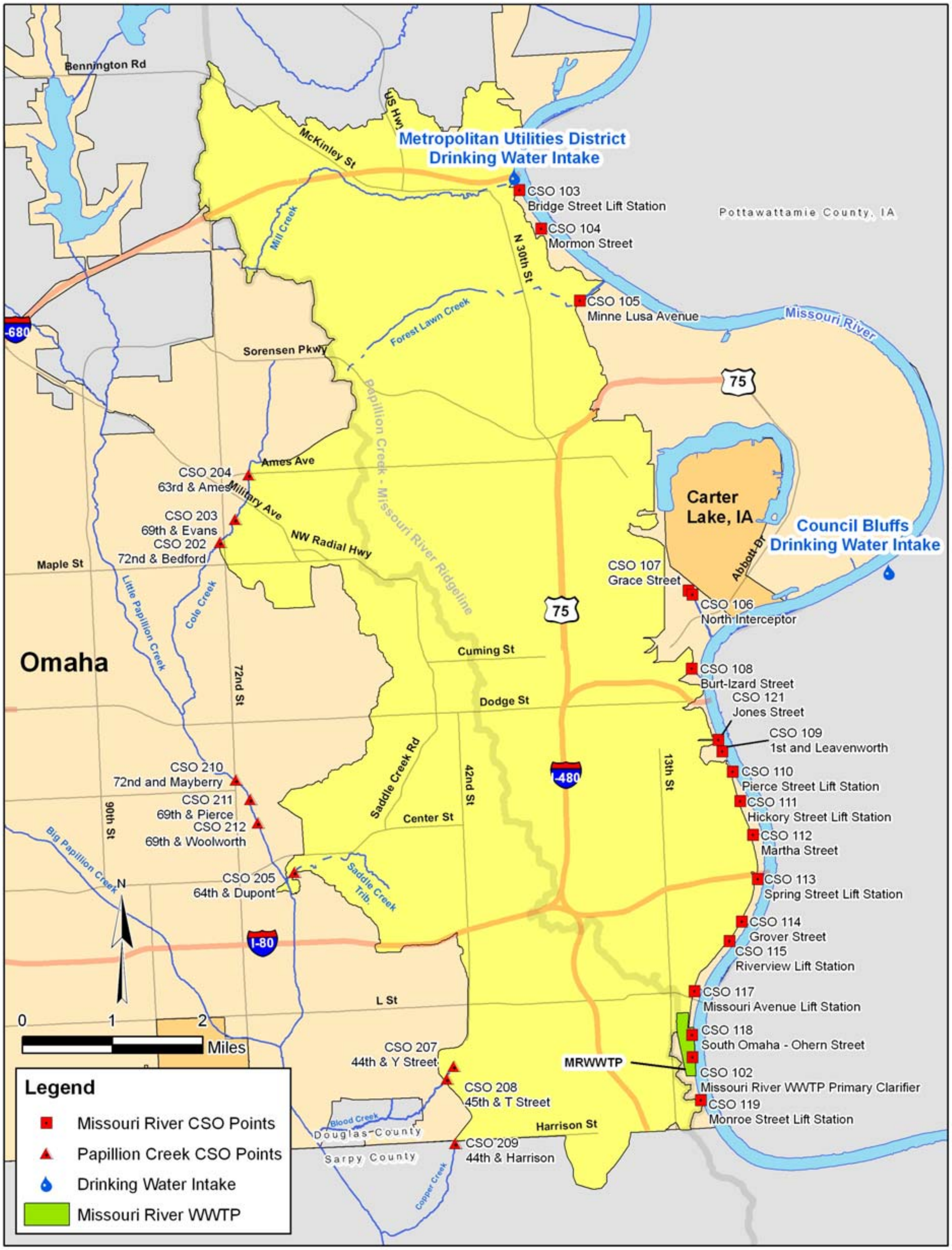
Sincerely,

Jim Theiler, P.E.
City CSO Program Manager
City of Omaha Public Works
(402) 444-4923
jtheiler@ci.omaha.ne.us

cc: Patricia Nelson, CSO Program Compliance Team Lead
Tom Heinemann, Consultant CSO Program Manager
Tiffany McEachen, CSO Program Compliance Team

Attachments:
Figure 2-16 from Omaha LTCP, showing Drinking Water Intakes and CSO Points

FIGURE 2-16
Location of Drinking Water Intakes



February 18, 2014

Ms. Carey Grell
Environmental Analyst
Realty and Environmental Services Division
Nebraska Game and Parks Commission
2200 N. 33rd St.
PO Box 0370
Lincoln, NE 68503-0370

Subject: Inquiry Regarding Threatened and Endangered Species

Omaha Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP)
Update of Sensitive Areas Analysis

Dear Ms. Grell:

The purpose of this letter is to request information about state and federal listed species and critical habitat, and potential habitat along the Missouri River and Papillion Creek, in the vicinity of the City of Omaha's combined sewer overflow (CSO) outfalls.

The City of Omaha is currently updating its Long Term Control Plan (LTCP) for CSOs. As part of this effort, the City must update or confirm its prior identification of sensitive areas which may be impacted by CSOs. Sensitive areas include areas associated with the existence of threatened or endangered species.

At the time of development of the original LTCP in 2007-2008, the City of Omaha contacted the Nebraska Game and Parks Commission to request information about state and federal listed species and critical habitat and potential habitat in streams in the Omaha area. The pallid sturgeon, lake sturgeon, sturgeon chub, blue sucker, and bald eagle were identified as species of concern for Area 1 (*the Missouri River, in the reach from Interstate Highway 680 to just below the confluence with Papillion Creek*). Other stream reaches listed below and receiving CSOs did not have records, nor appear to provide habitat for any listed species.

Area 2: *Cole Creek from just north of Ames Street to its confluence with the Little Papillion Creek.*

Area 3: *Little Papillion Creek from its confluence with Cole Creek to its confluence with Papillion Creek*

Area 4: *Papillion Creek from its confluence with Cole Creek to its confluence with Papillion Creek*

Area 5: *Entire length of Blood Creek*

Area 6: Entire length of Copper Creek

The City of Omaha would like to know if there are any new state or federal listed species or critical habitat, or newly identified potential habitat in the above-listed areas. We are required by our NPDES permit to confirm that the information previously obtained regarding the species of concern in these areas is still current.

Please contact the City's CSO Program Compliance Team Leader, Pat Nelson, at (402) 609-7512, or myself, at (402) 609-7515 or (402) 444-4923, if you have questions or require further information.

Sincerely,

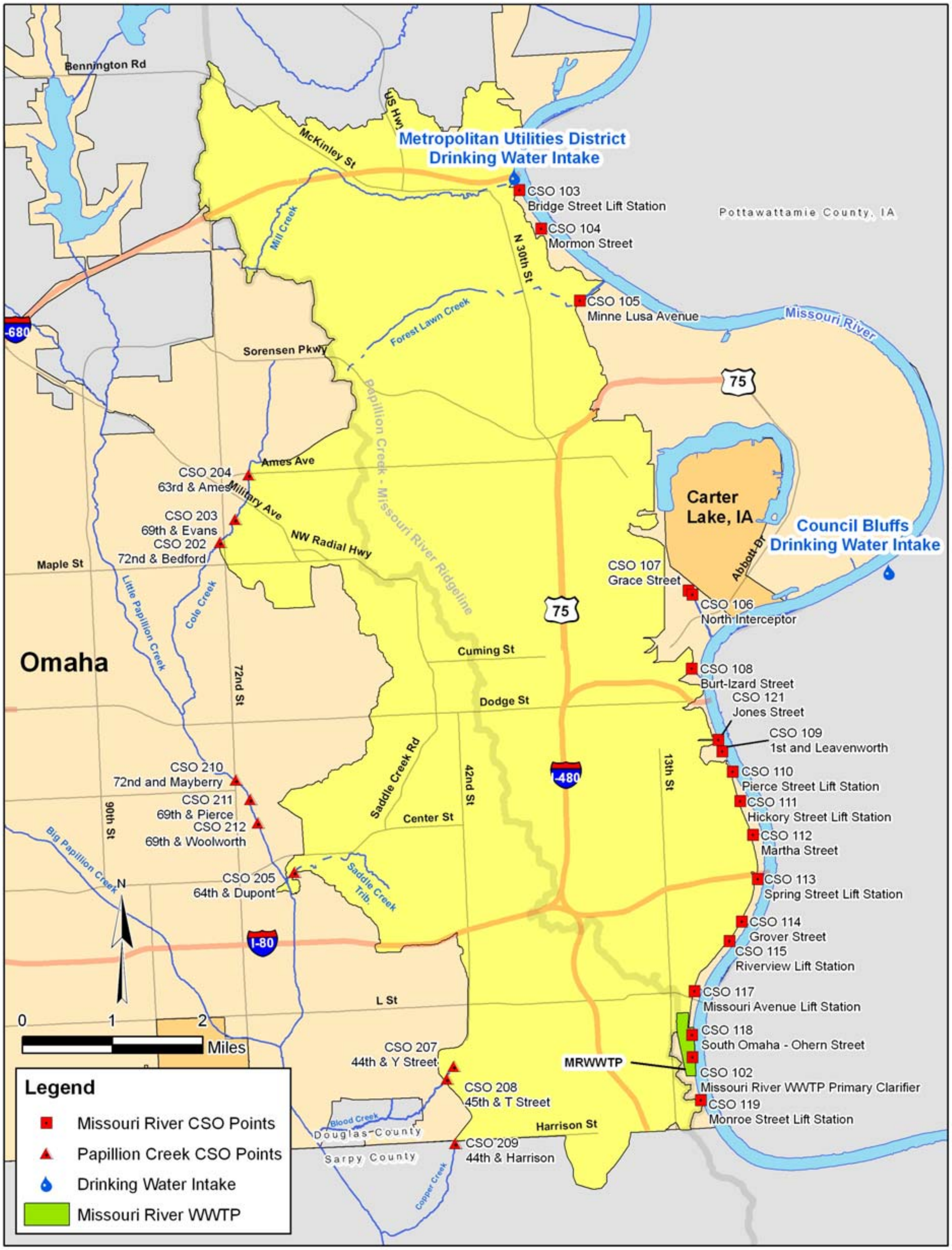
James E (Jim) Theiler, P.E

Jim Theiler, P.E.
City CSO Program Manager
City of Omaha Public Works
(402) 444-4923
jtheiler@ci.omaha.ne.us

cc: Patricia Nelson, CSO Program Compliance Team Lead
Tom Heinemann, Consultant CSO Program Manager
Tiffany McEachen, CSO Program Compliance Team

Attachments:
Figure 2-16 from Omaha LTCP, showing CSO Points
Letter from Nebraska Game and Parks Commission dated February 15, 2007

FIGURE 2-16
Location of Drinking Water Intakes



Nebraska Game and Parks Commission
2200 N. 33rd St. / P.O. Box 30370 / Lincoln, NE 68503-0370
Phone: 402-471-0641 / Fax: 402-471-5528 / www.outdoornebraska.org

February 15, 2007

Patricia A. Nelson
CH2MHill
1620 Dodge St.
19th Floor West
Omaha, NE 68102

Re: Data request for critical habitat in streams in Omaha Area

Dear Ms. Nelson,

Please make reference to your letter dated January 24th, 2007 requesting information about state and federal listed species and critical habitat, and potential habitat that will be used in a Long Term Control Plan for the City of Omaha that will define measures to control combined sewer overflows from its combined wastewater collection system.

The Nebraska Natural Heritage Program tracks occurrences of "at-risk" species and native plant communities within the state. "At-risk" species and communities are defined as those which are declining in Nebraska, declining globally or unique to Nebraska. State listed threatened and endangered species are among those tracked by the Natural Heritage Program. All at-risk species and communities are considered a valuable state resource worthy of ensuring continued existence in Nebraska.

We have determined that the proposed project area is not located in an officially designated Nebraska Game and Parks Commission (Commission) property or property managed by the Commission.

Area 1: Missouri River from Interstate Highway 680 to just below the confluence with Papillion Creek.

There are records of pallid sturgeon (*Scaphirhyncus albus*) and lake sturgeon *(Acipenser fulvescens)* in identified stretch of river. There is also potentially habitat for sturgeon chub (*Macrhybopsis gelida*). The pallid sturgeon is state and federally endangered, the lake sturgeon is state threatened and the sturgeon chub is state endangered. There is also records of blue sucker (*Cycleptus elongates*) which is a Tier 1 species, or a species globally or nationally most at-risk of extinction occurring in Nebraska (Schneider et. al. 2005). Although not strictly aquatic, as you requested, bald eagles *(Haliaeetus leucocephalus)* are state and federally threatened and utilize the Missouri River for foraging and habitat. This species is scheduled for de-listing this summer, but will still be protected under the Bald and Golden Eagle Protection Act.

Pallid sturgeon– Pallid sturgeon feed on small fish and invertebrates and is known to use sites with sharp slopes associated with downstream edges of submerged riverine sandbars. Most occurrence records of the fish are near confluences, islands, and at the downstream margins of sandbars. It is believed that the fish spends some time in the Missouri River, and returns to the Platte River where it may spawn or possibly over-winter. This fish spawns between February 1 and July 31, dependent on river conditions.

Lake Sturgeon – It is believed that the lake sturgeon occupies similar habitats as the pallid sturgeon, but spends a greater proportion of its time in the Missouri than the Platte River. Lake sturgeon feed on invertebrates and small fish and can be found at the downstream margins of island and river confluences. This fish also spawns between February 1 and July 31, depending on river conditions.

Sturgeon chub - Sturgeon chub are associated with fast flowing, turbid water and gravel substrate. The species has been collected in side chutes and backwaters—it is thought that these kinds of areas provide spawning habitat to the fish. Sturgeon chub feed on invertebrates. This fish spawns between February 1 and July 31, dependent on river conditions.

Blue Sucker – This species inhabit main channels of large rivers, and is found in the Missouri River and the lower reaches of its tributaries. Its range has been greatly reduced due to channelization and impoundment of main stem rivers.

Bald eagle– Bald eagles utilize the mature, forested area along the major river systems in Nebraska. The bald eagle southward migration begins as early as October and the wintering period extends from December through March. The nesting season in Nebraska extends from February through mid-August. Disturbances within 0.5 miles of an active nest or within line of site of the nest could cause nest abandonment.

Area 2: Cole Creek from just north of Ames Street to its confluence with the Little Papillion Creek.

This area does not have records, nor appear to provide habitat for any listed species.

Area 3: Little Papillion Creek from its confluence with Cole Creek to its confluence with Papillion Creek.

This area does not have records, nor appear to provide habitat for any listed species.

Area 4: Papillion Creek from its confluence with Big Papillion Creek to the Missouri River.

This area does not have records, nor appear to provide habitat for any listed species.

Area 5: Entire length of Blood Creek.

This area does not have records, nor appear to provide habitat for any listed species.

Area 6: Entire length of Copper Creek.

This area does not have records, nor appear to provide habitat for any listed species.

All federally listed threatened and endangered species are also state listed. However, for assessment of potential impacts on federally listed, candidate or proposed threatened or endangered species, please contact Steve Anschutz, Nebraska Field Office, U.S. Fish and Wildlife Service, 203 W. Second St., Grand Island, NE 68801.

Please note that this correspondence does not satisfy requirements of the Nongame and Endangered Species Conservation Act. Under the authority Neb.Rev.Stat. §37-807 (3) of the Nebraska Nongame and Endangered Species Conservation Act, all Nebraska state agencies are required to consult with the Nebraska Game and Parks Commission to ensure that any actions authorized, funded or carried out by then do not jeopardize the continued existence of a state listed species. This requirement would extend to any state permit issued. Please contact me if you need assistance with determining the potential of an action to affect listed species.

If you have any questions of need additional information on this site or on the jurisdiction of the Commission under the authorities listed above, please feel free to contact me.

Sincerely,

Kristal Stoner
Environmental Analyst Supervisor
Nebraska Natural Heritage Program
Nebraska Game and Parks Commission
(402) 471-5444
Kristal.stoner@ngpc.ne.gov

Schneider, R., M. Humpert, K. Stoner, G. Steinauer. 2005. *The Nebraska Natural Legacy Project – A Comprehensive Wildlife Conservation Strategy.* Nebraska Game and Parks Commission, Lincoln, Nebraska.

February 18, 2014

Mr. Jack Daniel
Public Water Supply Program
Office of Drinking Water and Environmental Health
Environmental Health Unit
Division of Public Health
Nebraska Department of Health and Human Services
301 Centennial Mall South
P.O. Box 95026
Lincoln, NE 68509-5026

Subject: Inquiry Regarding Public Drinking Water Intakes from the Missouri River
Omaha Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP)
Update of Sensitive Areas Analysis

Dear Mr. Daniel:

The purpose of this letter is to confirm that there are no new surface water intakes for public drinking water systems along the Missouri River or Papillion Creek, in the vicinity of the City of Omaha's combined sewer overflow (CSO) outfalls.

The City of Omaha is currently updating its Long Term Control Plan (LTCP) for CSOs. As part of this effort, the City must update or confirm its prior identification of sensitive areas which may be impacted by CSOs. Public drinking water intakes and their designated protection areas are considered sensitive areas.

At the time of development of the original LTCP in 2007-2008, the City of Omaha contacted the DHHS, and confirmed there were no surface water intakes on the Nebraska side of the Missouri River downstream of the Metropolitan Utilities District (MUD) Florence Water Treatment Plant, located on the Missouri River upstream of the City's CSOs, as shown in the attached map. In addition, at that time, there were no drinking water intakes on Papillion Creek or its tributaries. The City of Omaha would like to know if there are any new drinking water intakes along the Missouri River or Papillion Creek, or confirm that the information previously obtained regarding the drinking water intakes is still current.

Please contact the City's CSO Program Compliance Team Lead, Pat Nelson, at (402) 609-7512, or myself, at (402) 609-7515 or (402) 444-4923, if you have questions or require further information.

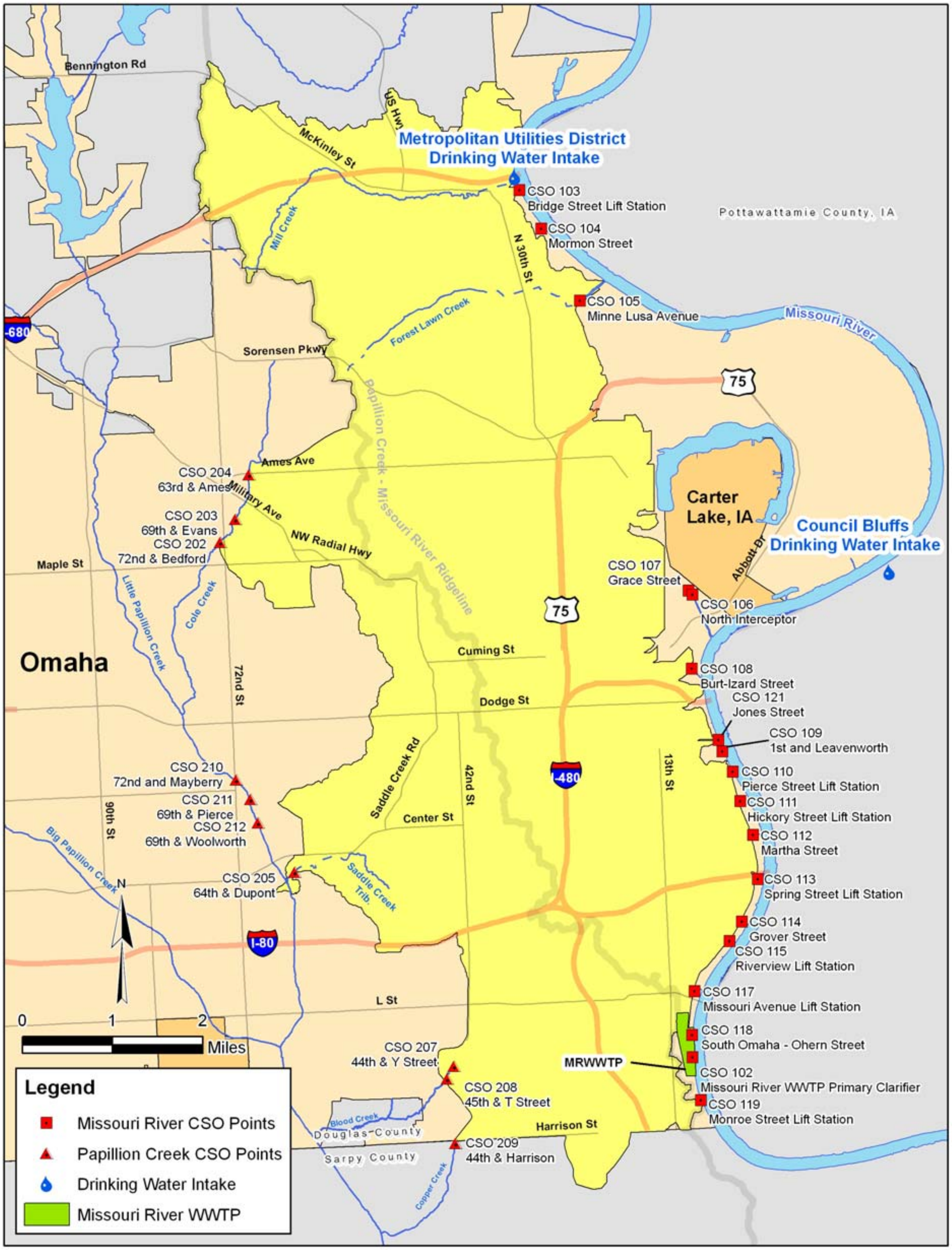
Sincerely,

Jim Theiler, P.E.
City CSO Program Manager
City of Omaha Public Works
(402) 444-4923
jtheiler@ci.omaha.ne.us

cc: Patricia Nelson, CSO Program Compliance Team Lead
Tom Heinemann, Consultant CSO Program Manager
Tiffany McEachen, CSO Program Compliance Team

Attachments:
Figure 2-16 from Omaha LTCP, showing Drinking Water Intakes and CSO Points

FIGURE 2-16
Location of Drinking Water Intakes



February 18, 2014

Mr. John Cochnar
Nebraska Field Office
U.S. Fish and Wildlife Service
203 W. Second St.
Grand Island, NE 68801

Subject: Inquiry Regarding Threatened and Endangered Species

Omaha Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP)
Update of Sensitive Areas Analysis

Dear Mr. Cochnar:

The purpose of this letter is to request information about state and federal listed species and critical habitat, and potential habitat along the Missouri River and Papillion Creek, in the vicinity of the City of Omaha's combined sewer overflow (CSO) outfalls.

The City of Omaha is currently updating its Long Term Control Plan (LTCP) for CSOs. As part of this effort, the City must update or confirm its prior identification of sensitive areas which may be impacted by CSOs. Sensitive areas include areas associated with the existence of threatened or endangered species.

At the time of development of the original LTCP in 2007-2008, the City of Omaha contacted the Nebraska Game and Parks Commission to request information about state and federal listed species and critical habitat and potential habitat in streams in the Omaha area. The pallid sturgeon, lake sturgeon, sturgeon chub, blue sucker, and bald eagle were identified as species of concern for Area 1 (*the Missouri River, in the reach from Interstate Highway 680 to just below the confluence with Papillion Creek*). Other stream reaches listed below and receiving CSOs did not have records, nor appear to provide habitat for any listed species.

Area 2: *Cole Creek from just north of Ames Street to its confluence with the Little Papillion Creek.*

Area 3: *Little Papillion Creek from its confluence with Cole Creek to its confluence with Papillion Creek*

Area 4: *Papillion Creek from its confluence with Cole Creek to its confluence with Papillion Creek*

Area 5: *Entire length of Blood Creek*

Area 6: Entire length of Copper Creek

The City of Omaha would like to know if there are any new federal listed species, new critical habitat, or newly identified potential habitat in the above-listed areas. We are required by our NPDES permit to confirm that the information previously obtained regarding the species of concern in these areas is still current.

Please contact the City's CSO Program Compliance Team Leader, Pat Nelson, at (402) 609-7512, or myself, at (402) 609-7515 or (402) 444-4923, if you have questions or require further information.

Sincerely,

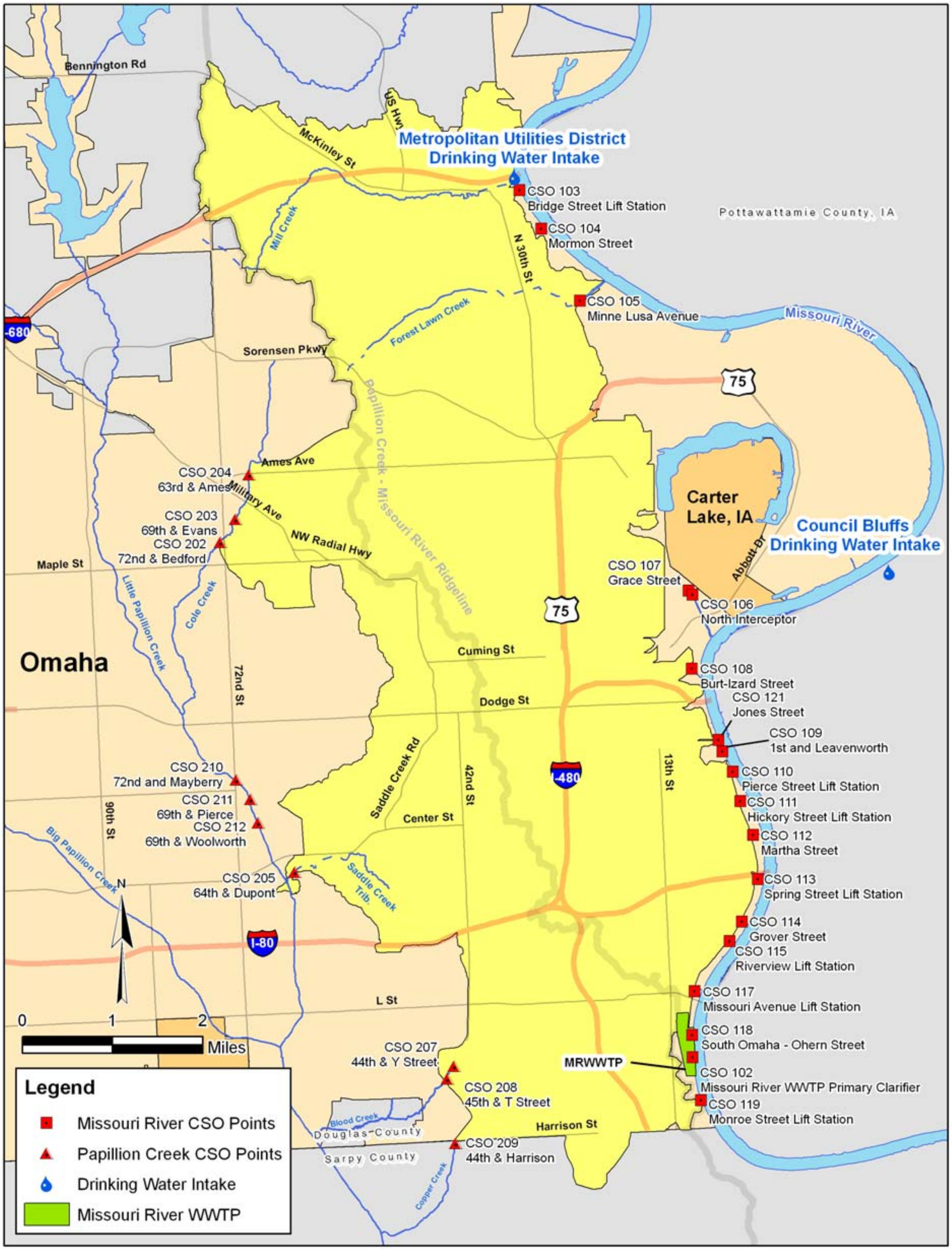
James E. (Jim) Theiler, P.E.

Jim Theiler, P.E.
City CSO Program Manager
City of Omaha Public Works
(402) 444-4923
jtheiler@ci.omaha.ne.us

cc: Patricia Nelson, CSO Program Compliance Team Lead
Tom Heinemann, Consultant CSO Program Manager
Tiffany McEachen, CSO Program Compliance Team

Attachments:
Figure 2-16 from Omaha LTCP, showing CSO Points
Letter from Nebraska Game and Parks Commission dated February 15, 2007

FIGURE 2-16
Location of Drinking Water Intakes



Nebraska Game and Parks Commission

2200 N. 33rd St. / P.O. Box 30370 / Lincoln, NE 68503-0370
Phone: 402-471-0641 / Fax: 402-471-5528 / www.outdoornebraska.org

February 15, 2007

Patricia A. Nelson
CH2MHill
1620 Dodge St.
19th Floor West
Omaha, NE 68102

Re: Data request for critical habitat in streams in Omaha Area

Dear Ms. Nelson,

Please make reference to your letter dated January 24th, 2007 requesting information about state and federal listed species and critical habitat, and potential habitat that will be used in a Long Term Control Plan for the City of Omaha that will define measures to control combined sewer overflows from its combined wastewater collection system.

The Nebraska Natural Heritage Program tracks occurrences of "at-risk" species and native plant communities within the state. "At-risk" species and communities are defined as those which are declining in Nebraska, declining globally or unique to Nebraska. State listed threatened and endangered species are among those tracked by the Natural Heritage Program. All at-risk species and communities are considered a valuable state resource worthy of ensuring continued existence in Nebraska.

We have determined that the proposed project area is not located in an officially designated Nebraska Game and Parks Commission (Commission) property or property managed by the Commission.

Area 1: Missouri River from Interstate Highway 680 to just below the confluence with Papillion Creek.

There are records of pallid sturgeon (*Scaphirhyncus albus*) and lake sturgeon *(Acipenser fulvescens)* in identified stretch of river. There is also potentially habitat for sturgeon chub (*Macrhybopsis gelida*). The pallid sturgeon is state and federally endangered, the lake sturgeon is state threatened and the sturgeon chub is state endangered. There is also records of blue sucker (*Cycleptus elongates*) which is a Tier 1 species, or a species globally or nationally most at-risk of extinction occurring in Nebraska (Schneider et. al. 2005). Although not strictly aquatic, as you requested, bald eagles *(Haliaeetus leucocephalus)* are state and federally threatened and utilize the Missouri River for foraging and habitat. This species is scheduled for de-listing this summer, but will still be protected under the Bald and Golden Eagle Protection Act.

Pallid sturgeon– Pallid sturgeon feed on small fish and invertebrates and is known to use sites with sharp slopes associated with downstream edges of submerged riverine sandbars. Most occurrence records of the fish are near confluences, islands, and at the downstream margins of sandbars. It is believed that the fish spends some time in the Missouri River, and returns to the Platte River where it may spawn or possibly over-winter. This fish spawns between February 1 and July 31, dependent on river conditions.

Lake Sturgeon – It is believed that the lake sturgeon occupies similar habitats as the pallid sturgeon, but spends a greater proportion of its time in the Missouri than the Platte River. Lake sturgeon feed on invertebrates and small fish and can be found at the downstream margins of island and river confluences. This fish also spawns between February 1 and July 31, depending on river conditions.

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Bald eagle– Bald eagles utilize the mature, forested area along the major river systems in Nebraska. The bald eagle southward migration begins as early as October and the wintering period extends from December through March. The nesting season in Nebraska extends from February through mid-August. Disturbances within 0.5 miles of an active nest or within line of site of the nest could cause nest abandonment.

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Please note that this correspondence does not satisfy requirements of the Nongame and Endangered Species Conservation Act. Under the authority Neb.Rev.Stat. §37-807 (3) of the Nebraska Nongame and Endangered Species Conservation Act, all Nebraska state agencies are required to consult with the Nebraska Game and Parks Commission to ensure that any actions authorized, funded or carried out by then do not jeopardize the continued existence of a state listed species. This requirement would extend to any state permit issued. Please contact me if you need assistance with determining the potential of an action to affect listed species.

If you have any questions of need additional information on this site or on the jurisdiction of the Commission under the authorities listed above, please feel free to contact me.

Sincerely,

Kristal Stoner
Environmental Analyst Supervisor
Nebraska Natural Heritage Program
Nebraska Game and Parks Commission
(402) 471-5444
Kristal.stoner@ngpc.ne.gov

Schneider, R., M. Humpert, K. Stoner, G. Steinauer. 2005. *The Nebraska Natural Legacy Project – A Comprehensive Wildlife Conservation Strategy.* Nebraska Game and Parks Commission, Lincoln, Nebraska.

From: Anderson, Michael [DNR]
Sent: Friday, March 14, 2014 1:31 PM
To: 'jtheiler@ci.omaha.ne.us'
Subject: Public Drinking Water Intakes from the Missouri River (Iowa jurisdiction)

Jim – Randy Lane from the (Iowa) Dept. of Public Health passed your CSO inquiry on to me as the appropriate contact for drinking water intakes within Iowa.

I can confirm for you that there are no new surface water intakes for public drinking water systems along the Missouri River in the vicinity of the City of Omaha's combined sewer overflow (CSO) outfalls

NEBRASKA
GAME PARKS

Nebraska Game and Parks Commission
2200 N. 33rd St. ▪ P.O. Box 30370 ▪ Lincoln, NE 68503-0370 ▪ Phone: 402-471-0641 ▪ Fax: 402-471-5528

May 13, 2014

Jim Theiler
City CSO Program Manager
City of Omaha Public Works
Central Park Plaza
222 S. 15th Street, Suite 1406S
Omaha, NE 68102

RE: Update of Sensitive Areas Analysis, Omaha Combined Sewer Overflow Long Term Control Plan

Dear Mr. Theiler:

Nebraska Game and Parks Commission (NGPC) staff members have reviewed the information for the proposal identified above. The City of Omaha has requested information on any new state listed species or critical habitat, or newly identified potential habitat in the target areas identified in the information provided. We previously provided a comment letter dated February 15, 2007, and this update will serve to provide any new applicable information regarding state-listed species.

The general information regarding the species of concern for Area 1 would remain the same (pallid sturgeon, lake sturgeon, sturgeon chub, and blue sucker). The only minor update is for the pallid sturgeon, as its spawning timeframe has been refined to be March 1 through June 30. There are no other changes or new information for these species at this time.

<u>Bald Eagle</u>

The bald eagle is no longer identified as a state-listed endangered species. The bald eagle still does receive protection from the Bald and Golden Eagle Protection Act (BGEPA), and guidance from complying with BGEPA is as follows. The federal Bald and Golden Eagle Protection Act (Eagle Act) (16 U.S.C. 668-668c) provides for the protection of the bald eagle (*Haliaeetus leucocephalus*) and golden eagle (*Aquila chrysaetos*). Under the Eagle Act, "take" of eagles, their parts, nests or eggs is prohibited without a permit issued by the Secretary of the Interior. Disturbance resulting in injury to an eagle or a decrease in productivity or nest abandonment by substantially interfering with normal breeding, feeding, or sheltering behavior is a form of "take." Bald eagles use mature, forested riparian areas near rivers, streams, lakes, and wetlands and occur along all the major river systems in Nebraska. The bald eagle southward migration begins as early as October and the wintering period extends from December-March. The golden eagle is found in arid open country with grassland for foraging in western Nebraska and usually near buttes or canyons which serve as nesting sites. Golden eagles are often a permanent resident in the Pine Ridge area of Nebraska. Additionally, many bald and golden eagles nest in Nebraska from mid-February through mid-July. Disturbances within 0.5-miles of an active nest or within line-ofsight of the nest could cause adult eagles to discontinue nest building or to abandon eggs. Both bald and golden eagles frequent river systems in Nebraska during the winter where open water and forested corridors provide feeding, perching, and roosting habitats, respectively. The frequency and duration of eagle use of these habitats in the winter depends upon ice and weather conditions. Human disturbances and loss of wintering habitat can cause undue stress leading to cessation of feeding and failure to meet winter thermoregulatory requirements. These affects can reduce the carrying capacity of preferred wintering habitat and reproductive success for the species.

To comply with the Eagle Act, it is recommended that the project proponent determine if the proposed project would impact bald or golden eagles or their habitats. This can be done by conducting a habitat assessment, surveying nesting habitat for active and inactive nests, and surveying potential winter roosting habitat to determine if it is being used by eagles. The area to be surveyed is dependent on the type of project; however for most projects we recommend surveying the project area and a ½ mile buffer around the project area. If it is determined that either species could be affected by the proposed project, the NGPC recommends that the project proponent notify the Nebraska Game and Parks Commission as well as the Nebraska Field Office, U.S. Fish and Wildlife Service for recommendations to avoid "take" of bald and golden eagles.

River otter

The Area 4 description in your current letter is confusing, and is different from that as described in our February 15, 2007 letter. For my review, I am using the description from our February 2007 letter which is Papillion Creek from its confluence with Big Papillion Creek to the Missouri River. (If this is incorrect, please provide the correct description for Area 4 for our updated review.) The range of the state-listed river otter has been refined to include the lower portion of Papillion Creek, of which Area 4 would be included. We have developed protocol for addressing potential river otter impacts, and it is included as an attachment for your reference.

Northern long-eared bat

Since your project is a long-term project, we wanted to make you aware of the *proposed* listing of the northern long-eared bat as an endangered species. The listing is not final at this time, but a final determination on the proposed listing is currently expected in October 2014. On October 2, 2013, the U. S. Fish and Wildlife Service (USFWS) proposed listing the northern long-eared bat (*Myotis septentrionalis*) as endangered (78 FR 61045). Critical habitat is not proposed for northern long-eared bat at this time. If this species becomes listed at the federal level, it will automatically become listed for Nebraska, and further consultation with the NGPC and USFWS Nebraska Field Office (NEFO) may be needed.

There are records of northern long-eared bat in Nebraska, and this project is within the range of this species. Northern long-eared bats typically overwinter in hibernacula that include caves and abandoned mines, but may also use other habitats that resemble cave or mine hibernacula, such as abandoned railroad tunnels, storm sewer entrances, dry wells, aqueducts and other similar structures. During the summer, these bats will roost singly or in colonies underneath bark or in cavities or crevices of both live trees and snags.

An evaluation should be done to determine if there is hibernating or roosting habitat available within or near the project area which could be used by this species and could be affected by project activities. If it is determined this species may be impacted by this project, then we recommend further coordination with our agency and the USFWS NEFO to develop conservation measures which can be implemented to protect the species.

For more information about northern long-eared bat, please see the following website: http://www.fws.gov/midwest/endangered/mammals/nlba/.

Thank you for the opportunity to comment on this proposal. If you have any questions regarding these comments, please contact me at (402) 471-5423 or carey.grell@nebraska.gov.

Sincerely,

Carey Grell
Environmental Analyst
Planning and Programming Division

cc: Tiffany McEachen, CSO Program Compliance Team

River Otter Survey Protocol
Nebraska Game and Parks Commission

Background

River otters were historically found in all major waterways of Nebraska. Unregulated trapping was the likely factor leading to the complete disappearance of otters from Nebraska in the early 1900's. From 1986 to 1991, river otters were reintroduced at seven locations: South Loup River, Calamus River, North Platte River, Platte River, Cedar River, Elkhorn River and Niobrara River (Andelt 1992). Their populations have become established and have expanded from these locations.

River otters are very adaptable. They typically live along wooded rivers and streams with sloughs and backwater areas and ponds. Ideal habitat has year-round open water with a plentiful food supply. Otters have been referred to as a "flagship species" for wetlands and aquatic habitats and are an indicator of wetlands with ample and high quality water (Foster-Turley 1996 and Polechla 2000) and often select sites with the least amount of human disturbance (Wilson 1959, Tabor and Wight 1977, Polechla 1990, Testa et al. 1994). Suitable habitat must also have a sufficient food source available. River otters are generalists. The primary component of their diet is fish but crustaceans are a major component of their diet in Nebraska. Fallen trees, logjams, rock piles, and other structures in the water make good habitat for the otter's prey species and thus good habitat for the otter. Beaver dams create deep pools and slow currents that otters frequently utilize for hunting.

River otters are a highly mobile species and require large amount of space to meet their annual requirements. They are active throughout the year and may occupy 50 or more miles of stream course annually (Andelt 1992) and will often move from one area to another. A single day movement was documented of 42 km (Melquist and Hornocker 1983) but daily movements are more likely less than 10km/day (Melquest et al. 2003). The social structure of river otters is not well defined and appears to vary across its geographic range (Gorman et al. 2006a), so local densities are highly variable as otters may be solitary or in small groups.

While on land, otters will utilize "slides" on steep muddy or snowy banks where they slide down into the water on their bellies. When traveling any distance on a slippery surface otters are known to take a running start and then slide up to six meters (twenty feet).

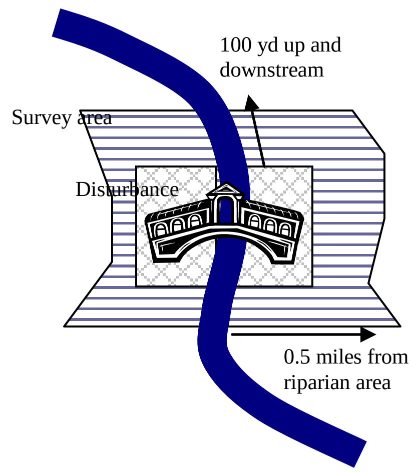
River otters use dens that were dug by other species such as beaver and will also utilize upland dens such as rock, brush and log piles, hollow logs, or tree root structures. They will use a variety of temporary dens and resting sites and appear to prefer sheltered sites that provide protection and seclusion (Melquist et al. 2003). A female with young pups will typically only use one natal den until the pups are sufficiently mobile and self-sufficient which may take 10 weeks. Gorman et al. 2006b found that natal dens were located in areas protected from rapid changes in water levels. Many of the dens in this study were not in the bank, but rather a distance overland and were most often located below the ground. In Nebraska, female otters enter the natal den beginning in late February through April.

Purpose

River otter surveys are designed to ensure awareness and resolution to any potential conflicts between the river otters and potentially disruptive human activities. This is a highly mobile species, and if present, is likely to leave during disturbance. However, otters are especially susceptible to disturbance when they have young pups in the natal den. Den surveys, which include presence/absence surveys, are recommended and, upon consultation with the Nebraska Game and Parks Commission, may be modified from this protocol depending on the situation. These should be considered when a disturbance will be within 0.5 miles of a river, pond, sandpit, or wetland area where river otters are known to exist or are likely to be present.

Den Surveys

River otter dens are notoriously difficult to find and identify, as they will use dens excavated by other animals as well as brush piles, log piles and uprooted tree structures. For this reason, a den survey should begin by establishing presence/absence for the designated area. If river otters are present, a more thorough search for dens is necessary. Otters are highly mobile, and therefore, presence/absence and den surveys should be done within 10 days of the initiation of the construction activities or disturbance. It may be desirable to conduct two sets of surveys, one month or a season in advance and one within 10 days of the project beginning.



Generally the survey area must include:

1. The entire area of disturbance which includes construction areas, equipment staging areas, temporary roads, etc.
2. An additional 100 yards up and down stream from the edge of the area of disturbance
3. At least 0.5 miles from the edge of the riparian/wetland area upland across the entire area of disturbance. Additional survey area may be necessary depending on the landscape context of the site. Tributaries, wetland complexes, sloughs or ponds may increase the necessary survey area.

Presence/absence can be established by identifying sign (scat, tracks, runs, rolls etc.), by finding slides or latrine sites. Otter scat will vary in size, but can generally be distinguished by fish scales. They often disintegrate into a pile of fish scales and reek of fish (Elbroch 2003). In Nebraska, scat is likely to have crayfish shells and may have bones of mammals, birds, or amphibians. Ideal latrine sites for otters in Nebraska tend to be higher areas near the edge of the water and may include sandbars, bank protrusions, rocks or logs which stick out into waterways or sites where tributaries meet a main stream or body of water. They can often be found right near the water's edge but can also be located higher up on a bank, especially if water levels change throughout the year. Often a latrine will be located near a potential den site. Since otters repeatedly use the same latrine sites, scats will usually be abundant in one site, making them easier to find. Otter tracks are 5 to 7.5 cm (2 to 3 inches) across (Elbroch 2003)

Otter slide marks can be an easy way to identify the presence or absence of river otters. They will slip down the steep banks of a body of water and also when they travel overland across snow, ice, or mud. Bridge surveys or aerial surveys after a fresh snow are especially good times to find evidence of otter activity because the snow provides a slippery surface for an otter to slide and slides imprints can be seen in fresh snow. Otters can take a few running steps and then slide up to six meters (20 feet) on the right surfaces and slopes. Winter otter slides can be an easy way to find if otters are in the area, however, presence or absence in the winter will not preclude additional surveys immediately prior to construction (within 10 days) for these highly mobile animals. In some cases, if otters are present there may be preventative measures that can be used to prevent them from using the area prior to construction.

If otters are established in the area, a thorough survey for potential den sites should be conducted. Any potential dens should be monitored to determine which species inhabits the den. Since they are highly mobile, potential dens should be re-checked 24 hours prior to initiating groundbreaking construction. If a river otter den is found in the area of the den survey, disturbance activities should not proceed or should cease and the Nebraska Game and Parks Commission should be contacted immediately.

Michelle Koch, Environmental Analyst Supervisor, 402-471-5438
Sam Wilson, Furbearer Biologist, 402-471-5174

Note: River otter research is currently underway. This protocol is only valid for 1 year. If it has expired, contact the Environmental Analyst Supervisor for any updated protocols.

References

Andelt, R. 1992. Nebraska's Threatened and Endangered Species: River Otter. Nebraskaland, Nebraska Game and Parks Commission, Lincoln, Nebraska.

Elbroch, M. 2003. Mammal Tracks and Sign: A guide to North American species. Stackpole Books, Mechanicsburg, PA.

Foster-Turley, P. 1996. Making biodiversity conservation happen: The role of environment education and communication. Environmental Education and Communication Project, U. S. Agency for International Development, Washington, DC.

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Department of Health & Human Services

DHHS

N E B R A S K A

Division of Public Health

State of Nebraska
Dave Heineman, Governor

February 24, 2014

Mr. Jim Theiler, P.E., City CSO Program Manager
City of Omaha Public Works
Central Park Plaza
222 S. 15th St., Ste. 1406S
Omaha, Nebraska 68102

Subject: Response to inquiry regarding public drinking water intakes from the Missouri River or Papillion Creek near Omaha combined sewer overflow (CSO) outfalls

Dear Mr. Theiler:

This letter is to respond to your request to the Department to confirm that there are no new surface water intakes for public drinking water systems along the Missouri River or Papillion Creek, in the vicinity of the City of Omaha's combined sewer overflow (CSO) outfalls.

There are no new surface water intakes for public drinking water systems in the vicinity of the City's combined sewer overflow outfalls.

If you have additional questions regarding surface water intakes for public drinking water systems, please contact Elizabeth Esseks of this Department (elizabeth.esseks@nebraska.gov ; 402-471-1010). She is the staff person who is most knowledgeable about public drinking water systems that utilize surface water.

Sincerely,

Jack L. Daniel
Administrator
Office of Drinking Water and Environmental Health
Nebraska Department of Health and Human Services